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INJURIES TO JOINTS

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OXFORD
WAR PRIMERS

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INJURIES OF JOINTS

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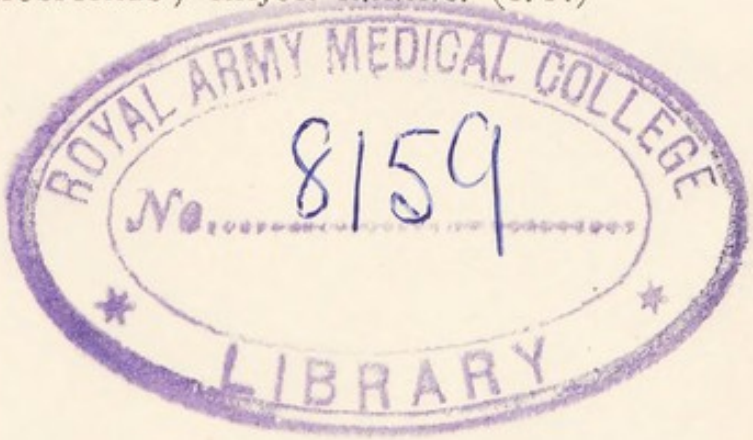

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PREFACE

THE object of this little book is to attempt to give some help in the diagnosis and treatment of injuries of joints in a form which will be useful to the hundreds of practitioners who have left the quiet paths of private practice for the more eventful career of military surgery.

The injuries they may have to deal with may vary from a twist or sprain due to a fall on rough ground to a complicated gunshot wound. For the minor injuries the ordinary advice given in peace time, namely rest, is not enough, as the soldier must be returned fit for duty in the shortest possible time, while the more serious injuries are outside the ordinary experience of general practice.

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CHAPTER I

GENERAL OUTLINE OF PRINCIPLES

THE fundamental principles of treatment depend on a recognition of the fact that the function of a joint is mechanical, that the processes of repair follow the ordinary physiological laws, and that mechanical injury of the area of repair will retard a cure and often give rise to a state of subacute or chronic inflammation, which may confuse the issue, unless the surgeon clearly understands the condition with which he has to deal. Strain of the inferior calcaneo-scaphoid ligament is an example which should be familiar. After a few days' rest the foot is free from pain, but the first route march brings a return of the trouble, which might have been permanently relieved by a small alteration of the heel of the boot to divert the body weight on to the outer side of the foot, and so save the injured ligament from unnecessary strain until it has fully recovered its strength.

It will therefore be necessary to deal not only with injuries of the joints themselves, but also with those of structures about joints, in order that a clear diagnosis may be made.

The two chief difficulties which seem to trouble most practitioners who have not had the opportunity

of handling a large number of joint injuries, are to decide what is the most appropriate immediate treatment, and when and how to commence moving the injured joint, especially after the more serious injuries.

The solution of the first is found in accurate diagnosis of the injury, and in forming a clear idea of the mechanical and physiological factors which enter into the processes of repair. As a simple illustration of this, we will assume that a man jumping from a wall or into a trench lands on the edge of a clod of earth, and violently twists his foot inwards. He feels a sharp stab of pain on the outer side of the ankle, his neighbours perhaps hear a sharp click which makes them think he has broken a bone. By the time the man has limped about and is seen by a surgeon, the whole ankle is swollen and painful. Having excluded a Pott's fracture by running his finger down the fibula and finding it intact, the surgeon makes the diagnosis of 'sprained ankle'. The time-honoured remedy of cold-water bandages or the application of some cooling lotion combined with rest 'till the swelling goes down' is in many cases too frequently adopted; the patient subsequently being allowed up in a soft slipper, which is almost the worst thing he can do in the convalescent stage. Although the ankle is very painful, it will bear gentle but firm handling; the history points to an injury about the external malleolus, and the inference is that there is a rupture of one of the three slips of the external lateral ligament of the ankle, or perhaps an avulsion of a scale of bone

from the tip of the malleolus, which is technically a fracture, but for all practical purposes a sprain. Pressure with a finger over each division of the external lateral ligament in turn will find a point of extreme tenderness, and so we locate exactly the injury.

The treatment carried out should be with the definite object of getting the torn ends of the ruptured ligament to unite by first intention, or to avoid confusion with the terms first and second intention as commonly applied to the history of aseptic and septic wounds, let us say by **immediate** rather than by **delayed** union.

First, the foot should be everted in order to relax the ruptured ligament and bring the torn ends as near each other as possible. Second, avoiding for the present the question of massage, the effusion can be got rid of by firm bandaging over several layers of cotton-wool, the bandages passing not in the orthodox manner from within outwards across the front of the leg, but from **without inwards** so as to keep the foot everted. Third, a rectangular foot-splint should be applied to prevent any recurrence of the ligamentous strain (Fig. 1).

The boot—a comfortable one—should have a couple of wedge-shaped patches of leather put on the heel, base to the outer side, to maintain eversion of the ankle when the patient stands. According to the promptness with which treatment is commenced, all swelling will have disappeared in from twelve to thirty-six hours, with the exception perhaps of a little local swelling round the seat of injury.

It may be advisable in some cases to apply a pad of sticking plaster, sticky side outwards, to fit over the area of injury. This pad should be about three-quarters of an inch wide and half a dozen layers thick; the foot can then be strapped in the everted position, the strapping being applied as a figure-of-eight bandage This makes an excellent local splint.

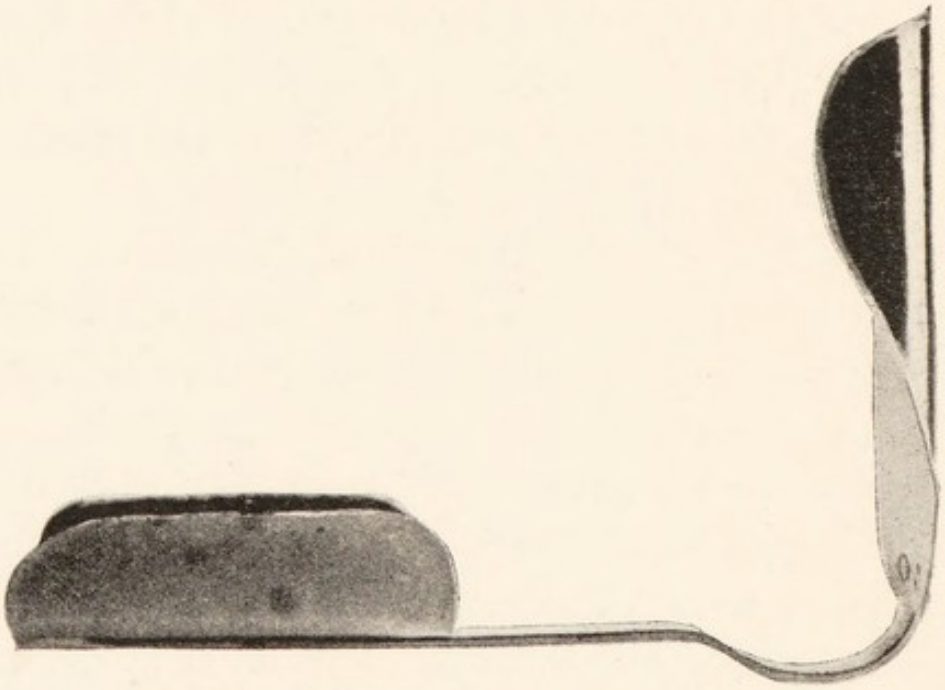

FIG. 1. RECTANGULAR FOOT-SPLINT.

The united effects of the strapping and the wedge heel make it impossible for him to put tension on the torn ligament when walking. The physiological exercise of the foot will prove a better stimulus to the normal processes of circulation and repair than even the best massage. Provided no strain is allowed at the seat of the injury, in a few days the foot will give no further trouble, in a fortnight he may be fit for full duty, even after a bad sprain. If instead of

a boot, he wears a shoe, or still worse, a soft slipper, he is sure to tear the young cicatricial tissue forming between the ends of the torn ligaments, which can then only recover by **delayed** union. Everybody knows that a sprained ankle may make a man lame for many weeks, but the period of incapacity depends largely on the mechanical efficiency of the treatment he receives as well as on the severity of the original lesion.

A rough classification of the injuries of which we propose to treat may be given as follows :

1. **Strains of Muscular Attachments** about joints often give rise to serious impairment of function. From incomplete diagnosis these conditions are often inefficiently treated. They are diagnosed by the fact that there are certain movements which the patient cannot perform because he is suddenly pulled up by pain, which he localizes fairly exactly at some point about a joint. Careful testing of the movement which hurts will generally prove that active contraction against resistance, or passive stretching of a certain group of muscles, causes the pain. Further careful palpation will find a tender spot just at the attachment of a tendon, over an area perhaps no bigger than a sixpence, and a little swelling with a suggestion of œdema or fluid may be felt deep down on the surface of the bone. This tender spot is the key to the situation. It is a small patch of effusion below the periosteum or in the fibres of the tendon which run in and through the periosteum to the

bone, constituting the origin or insertion of the muscle.

The pain is due to tension on this effusion caused by tension on the muscle or by direct pressure on the œdematous spot.

Such an injury may be acute in type, arising from a single sudden wrench, stretching, tearing, or otherwise loosening the strong fibro-tendinous plexus; it may be subacute, arising from repeated smaller injuries, as in the familiar 'tennis' and 'golf' elbows; or either of these may pass on to a chronic stage, never entirely dormant, and liable to become more acute on any provocation, and this chronic stage may continue for weeks, disabling the patient from taking part in active pursuits. The reason why this trifling injury is often so long continued and troublesome is that every time tension is put on the muscle a fresh assault is inflicted on the injured tissues, and this repeated injury maintains the effusion and prevents repair of the stretched or torn fibrils.

Treatment should therefore be directed definitely, first, towards getting rid of the effusion which separates the torn ends of tissues and so allowing them to come into their proper position; second, towards preventing any movement or muscular effort from stretching and tearing the newly formed repair tissue and so making the condition chronic.

This may be done (*a*) by firm pressure with a folded pad of sticking plaster strapped over the area of effusion to promote its absorption and to act as a local splint on the injured fibres; (*b*) by a similar

pad and strap placed on the tendon just above the inflamed area; this acts as a stop, preventing the tension on the muscle from being transmitted in its full force to the injured attachment. This is comparable to the half-turn round a post which a sailor takes with a rope when he wishes to check a movement which he could not stop by the direct application of his strength. This is no new principle, although sadly overlooked by the profession, for every workman who puts a strap round his wrist to ease a strained tendon is putting it into practice. The wonder is that so few surgeons apply it to the deltoid, the quadriceps extensor, the ankle and the foot, as well as to the wrist.

We often have to deal with the chronic case. Here the trouble is that repeated small injuries with repeated efforts at repair have produced a small plexus of new fibrous tissue, which itself impedes the free access of blood necessary for the complete removal of effusion and the conclusion of the processes of repair.

Treatment must then be directed to encouraging a free flow of blood to and through the injured area. This is not effected by a passive congestion, but by massage and alternate applications of hot and cold water, by counter-irritation, and in obstinate cases, where the pain is confined to a very limited area, by puncture with a heated needle, which both destroys implicated nerve-ends and produces an increased flow of blood.

2. **Sprains of Ligaments,** that is, rupture of fibres

of ligaments. This injury may occur anywhere in the extent of the ligament, either at one of its attachments or in the body of the ligament. All the general remarks about the nature of the processes at work made in the previous section apply to these injuries.

First localize the injury accurately, then reduce effusion, and finally prevent repetition of the injury by preventing mechanical strain.

The above two classes of injury should invariably end in recovery without any impairment of movement, the time occupied depending largely on the efficiency of the immediate treatment.

In the more severe types of injury stiffness or ankylosis may arise as a result of efforts at repair. In such cases there must be added to the immediate treatment to secure repair of injured tissues, a carefully considered scheme of after-treatment to restore freedom of movement.

3. **Extensive Rupture of Ligaments, including Dislocation.** In cases of dislocation, obviously, **reduction** of the **displacement** is the first consideration. Next, the joint must be left at rest to allow repair of the extensively torn soft tissue. This repair means a considerable deposit of new fibrous tissue. Short strong bands of fibrous tissue about a joint which impede freedom of movement are spoken of as 'adhesions', and a time may come when it is necessary to break down these adhesions. It is important to know the right time for doing this. It is unfortunate that in many text-books of surgery the phrase 'early passive movement' has been employed without

clearly defining the limits of its usefulness. This is not really difficult if due regard is paid to the histological processes of repair. Take, for example, a posterior dislocation of the elbow without any fracture complications. The dislocation has been reduced and the elbow put in an acutely flexed position to relax the torn anterior ligaments. Between and about the torn ends of the ligaments there is a mass of blood-clot and plastic effusion, part of which will be absorbed and become organized by the ingrowth of blood-vessels and fibroblasts laying down new strands of white fibrous tissue. If we could see this a few days later, the whole area would be a vascular mass, corresponding to the stage of granulations of a surface wound, and, like the surface wound, tender to finger pressure. This tenderness to pressure is an important index, for it means that the cicatrix is still so fresh and vascular that any attempt at passive extension will tear the new tissue, cause pain, more bleeding, and more effusion, the repair of which means a more dense fibrous cicatrix than is desirable, resulting in unnecessarily strong adhesions.

If the surgeon restrains himself and leaves the movement to the patient, in the case of the elbow, slackening the sling each day so that the wrist falls a little lower, but on no occasion so far as to tear the cicatrix, and allows the patient to flex and extend his elbow within the limits allowed by the sling, **without pain,** then we may expect local tenderness to die away, and a natural recovery to take place.

This process of recovery may be expedited by

a judicious exercise of passive movement. The joint should be gently moved through its complete range of movement, and rested until it recovers from the assault. The object is to release the joint from obstructing bands, and this must be done in such a way as to minimize reaction. **Once** and **once only** should it be flexed, extended, pronated, and supinated at each manipulation. This can be repeated each day or at longer intervals according to the degree of reaction produced. The to-and-fro oft-repeated method must be utterly condemned.

We should never add the injury caused by passive movement to an existing active state of reparative inflammation, but wait till the reparative action has quieted down. If the patient's range of voluntary movement the day after passive movement is less than before, it is a clear indication that the joint is still too actively inflamed to undergo passive movement. If after passive movement the pain is less and the range of movement is greater than before, it is safe to go on with both active and passive movement.

4. **Injuries of Joints associated with Fracture,** either into the joint or so near the joint as to affect the proper relation of the joint surface to the line of the limb, and compound injuries including gunshot wounds, which smash bone as well as tear soft parts, introduce new complications, which must be foreseen and as far as possible guarded against by anticipatory treatment. Fragments of bone or masses of new-formed callus may form a mechanical obstruction to

movement. A most conspicuous example of this is to be found in the front of the elbow, where a block of bone may obstruct flexion. This danger is obviated by fixing the elbow in the fully flexed position.

In cases of fracture into the joint or bullet-wounds which have destroyed the joint cartilages, some degree of repair tissue may be formed between the two bones. If this repair tissue remains fibrous, a good functional joint may be secured by treatment which will be referred to later. If this repair tissue should ossify, absolute ankylosis will result, and may call for operation. When bony ankylosis is foreseen as inevitable, the surgeon must decide in what position the joint is to be allowed to ankylose, so as to obtain the best possible function for the limb.

In the upper limb the use of a knife and fork, the difficulties associated with collar-studs and dressing the hair, and manifold other considerations, help us to decide the question, while in the lower limb we desire a firm support for walking with a minimum of limp.

The question of an operation to form a false joint does not arise in the first instance; it is only to be considered when the result of the original treatment has ended in an intolerable condition, and then the patient must help us to decide.

CHAPTER II

BANDAGING, MASSAGE, MOVEMENT

Direction of Bandaging. The traditional teaching of bandaging 'from within outwards over the front of the limb', however useful as a means of training students to obtain dexterity in handling bandages, must be abandoned when treating joints. The bandage in the hands of the surgeon is an important part of the apparatus for retaining the joint in the required position. The bandage is not a mere means of keeping a dressing in position, but should be regarded as a modified splint.

As a general rule the figure of eight is essential about joints, and the position of crossing important. For example, in bandaging a knee to support a strained internal lateral ligament, the bandage should be applied so as to check any abduction movement of the joint and so prevent tension on the injured ligament; therefore a thin pad of wool should be placed over the injured ligament, and the bandages should cross to and fro over this pad. The crossings of the bandage would press on the inner side of the knee, and the upper and lower loops of the eight would tend to pull the thigh and leg towards it and so keep the internal ligament relaxed.

To keep the foot everted at the ankle and relax

the external ligament, the bandage would cross the sole from within outwards and the front of the leg from without inwards; the draw of the bandage as it is put on pulls the outer edge of the sole up towards the external malleolus, and the crossing would be kept well to the outer side. To relax the internal ligament, every movement would be in the reverse direction.

Bandages of calico are more efficient than flannel or domette, for the woollen materials stretch too much to produce an efficient grip of the limb.

Elastic Pressure.—Elastic pressure, to check bleeding or promote absorption without interfering with the general circulation of the limb, can be obtained by using large quantities of cotton-wool, and is best done as follows: first swathe the part in wool and bandage firmly over this, taking care that the bandage is running in the right direction to maintain the desired position. Then apply more sheets of cotton-wool and continue the bandaging rather tighter than the first layer, and so on, layer after layer, each put on tighter than the former. As the swelling goes down the bandages will become loose. Do not disturb the joint by removing the bandage, but keep up the pressure by an additional bandage over everything. This can be removed and reapplied as often as necessary without moving the joint or disturbing the position of the wool padding. The more wool is used the tighter can the bandage be applied without fear of doing harm or hurting the patient.

Massage.—It should be clearly understood that massage of a joint does not include movement. A masseur who will not massage without moving a joint will often do more harm than good, because he disturbs tissues which should be left at rest to undergo repair.

1. Massage immediately after the injury, before effusion has taken place, checks hæmorrhage into the part, stops effusion of lymph, relieves pain, and so leaves the tissues ready to commence immediate union, like a clean cut which is immediately closed edge to edge.

As an illustrative example, take once more rupture of the anterior division of the external lateral ligament of the ankle-joint. Immediately after the injury, when the boot is removed, there may be a swelling below and in front of the malleolus as big as a pigeon's egg. If vibratory massage is at once given by pressing the pulps of all the fingers firmly on this and communicating a firm vibratory movement from the wrist, this swelling will disappear in a few minutes. A small pad and a firm bandage to evert the foot is then applied, and the patient can walk home without any great swelling round the ankle. The art of vibrating is of course only to be acquired by practice, and is a muscular effort on the part of the masseur, which soon becomes very fatiguing, hence the numerous mechanical vibrators on the market.

If the patient has to hobble home without this immediate treatment, the whole region of the joint

is so swollen that much valuable time may be lost in getting rid of the effusion before the tissues can really set about the process of repair.

2. Once general swelling has made its appearance, the joint should be put in such a position that the injured tissues are relaxed, and gentle rubbing in the direction of the venous circulation will help to get rid of the effusion. If there is any fear of doing harm by inadvertently moving the joint, it is better to rely entirely on elastic pressure and rest and elevating the limb to hasten absorption of exudates.

3. Massage of muscles, by gentle deep kneading, by stroking, and by gentle pinching and rolling between the fingers, is of great assistance in maintaining the nutrition and circulation of a limb when the nature of the injury demands prolonged fixation, but it must be done without moving any part undergoing the process of repair. Anything which improves nutrition aids repair.

4. Deep-pressure massage with coarse vibration, followed by firm rubbing, is of great service in promoting circulation in masses of cicatricial tissue resulting from the repair of severe injuries. Dense fibrous tissue is not elastic, hence the blood-vessels in it cannot expand easily in response to changes of pressure. Patients with such cicatrices complain of 'rheumatic' pains; these are probably due to the same cause as shooting pains in corns when a fall in the barometer precedes a thunderstorm, and are entirely due to imperfect adjustment of blood-pressure. Massage not only relieves this pain temporarily,

but helps to induce more elasticity and better circulation in the cicatricial masses.

Movement.—Movement is always bad for an actively inflamed tissue — by 'inflamed' we mean a tissue that is actively hyperæmic as the result of a lesion, and not in the narrow sense of septic inflammation, and for the present purposes we include the active hyperæmia, which is part of the process of healthy repair.

Movement is of three kinds :

1. Involuntary reflex movement.
2. Voluntary movement.
3. Passive movement.

1. **Involuntary Reflex Movement** should be controlled by efficient fixation. When a patient with an injured bone or joint is awake, and the injured part is not completely fixed, he unconsciously keeps it at rest by means of his muscles. This muscular guard is a nerve-muscle effort, and is itself exhausting to the patient. When the patient falls asleep his nervous and muscular systems sleep also ; the injured part deprived of the muscular guard moves, there is a spasm of pain, a reflex contraction of the muscles, which again causes pain, and the patient is awake. This ought to be prevented by proper fixation, for pain, loss of sleep, and constant muscular action, even though unconscious or subconscious, are all exhausting.

2. **Voluntary Movement** is the natural physiological function of muscles and joints, and is the best physiological stimulus to their proper nutrition and well-

being. Pain is nature's method of controlling voluntary movement which may be harmful, and the exceptions to this rule are very few. Hence early active movement which causes no pain can seldom be harmful, and is often beneficial. This can often be obtained by fixing a joint so that one particular harmful movement cannot be performed—all harmless movements being but little impeded. This makes for good nutrition and rapid repair.

3. **Passive Movement** being performed by a second person, regardless of warnings by pain, should never be resorted to unless the surgeon knows exactly what he wants to do and why. It should practically be limited to forcing a free path for movements which are obstructed by adhesions. When adhesions are thus broken down under an anæsthetic the process should be thorough, and if possible, carried out by one firm movement. I would again emphasize the fact that repeated to-and-fro movements are liable to cause unnecessary damage, increased reaction and effusion, and an increase of pain. Having broken down adhesions, it should be sufficient to put the joint through its full range of movement once a day, and once only, until the patient can perform the movement voluntarily.

CHAPTER III

PAIN AND STIFFNESS IN RELATION TO DIAGNOSIS AND TREATMENT

PAIN and stiffness in and about joints are valuable aids to diagnosis and treatment.

In cases of recent injury about joints, where the whole region of the joint is swollen, the patient very often complains that the whole joint aches, and says that he cannot bear it to be touched.

If the surgeon approaches the case gently he should be able to determine at once whether the injury is a serious one of the joint itself, or merely some less important injury of structure outside the joint.

To do this it is necessary to avoid hurting the patient, because then the muscular resistance excited by the pain will make further accurate examination very difficult. An injured joint resents any sudden jar or jolt, and when there is effusion in the cavity of the joint, any movement of it may raise the tension, and thus cause pain.

The hands should therefore first be laid on the limb above and below the joint very gently. If the history of the injury suggests that it is most likely a rupture of some ligament, the hands can be passed gently over the joint, feeling for some point of acute tenderness over the ruptured ligament. Next the

limb may be held firmly above and below the joint and very gently moved.

Localized Pain.—If it is found that some movements—those which do not put tension on the suspected ligament—do not cause much pain, and are not strongly resisted, while the least movement in the direction which stretches the suspected ligament is immediately resisted and causes sharp pain in the region which was found to be most tender to touch, it will be pretty clear that the injury is located to one structure or group of structures, muscular or ligamentous, on one side of the joint. The surgeon has then a guide to help him to decide in what position he is to place the limb, and he can confirm his diagnosis later when the swelling and first tenderness have passed off.

The diagnosis of severe joint lesions is often obscured by swelling, and, indeed, in many very serious injuries involving bone and ligaments, bony deformity may be entirely masked. The surgeon should at once be put on his guard by the fact that any movement of the joint is at once resisted and causes pain. We therefore get a rule of guidance :

1. Pain on movement in every direction suggests a lesion in the joint or in parts intimately connected with it.
2. Freedom of movement in one or more directions, but not in all, suggests a lesion of some groups of structures outside the joint proper.

Pain due to Contusion of Joint Cartilage may not make its appearance until two or three weeks after

the accident. This condition is not described in text-books. It occurs in a very typical form in the shoulder-joint in association with Colles's fracture of the lower end of the radius. A patient falls heavily on the hand and sustains a Colles's fracture. The fracture is treated, but no complaint is made of the shoulder. A fortnight or three weeks later, when the fracture is getting better, and greater freedom of the limb is allowed, the patient experiences pain when he tries to move the shoulder. He considers this due to stiffness, and goes on moving his shoulder, and soon both pain and stiffness become worse. The doctor too often tries passive movement, and the shoulder gets still worse. A vague diagnosis of 'rheumatism' is often made, and later the patient, failing to obtain relief, does nothing, and in three or more months his shoulder recovers. What has really happened is that at the time when he fell on his hand he bruised or crushed the shoulder-joint cartilage. Cartilage, like the cornea, is a non-vascular structure. When the cornea is injured, no repair can take place till a little leash of new vessels grows in from the nearest part of the sclerotic. When repair is complete, these vessels disappear, leaving a fine hair streak leading from the sclerotic to the nebula, which is the cicatrix at the seat of injury.

Much the same process occurs in an injured joint cartilage. The débris of crushed cells and cartilaginous tissue cannot be cleared away till new vessels have grown in, constituting a process of reparative inflammation. In the injury of the

shoulder associated with a Colles's fracture, this process starts while the patient has his arm in a sling, and goes on quietly without his knowledge. At the end of a fortnight or so the vascularization of the cartilage is active, and the effect of movement is to rub the inflamed cartilage and add to the pre-existing injury, consequently the result of movement is that there is more pain.

The seat of the inflamed area is within the joint, and movement is limited and resented in every direction.

Rules. I will formulate certain rules which may be helpful in deciding whether to move a joint or not.

(*a*) A joint may be assumed to be free from arthritis when even one of its movements is free.

(*b*) Traumatic arthritis follows an injury after an interval of free movement, lasting usually over a fortnight.

(*c*) Restricted movements due to adhesions are noticed very shortly after the occurrence of injury.

(*d*) Except when following serious injuries, adhesions restrict the movements of joints in one or more, but not in all directions.

(*e*) A joint, the seat of arthritis, should not be moved until all inflammatory symptoms have subsided.

(*f*) If adhesions are broken down under an anæsthetic, the joint should be put through its complete range of movement, otherwise a recurrence of symptoms may be expected.

Pain in Cicatrices.—Pain at the site of a healed

injury is often very confusing to the practitioner. Very often after an injury due to violence, repair is only accomplished by the formation of a considerable mass of cicatricial tissue. If there has been a suppurative wound associated with much bruising and tearing of the soft parts, as in a shrapnel or bullet wound which has driven shattered bone through the soft parts, there must be for a long time a mass of cicatricial tissue in the deeper parts of the wound, often out of proportion to the size of the surface wound of entry.

After the sepsis has been overcome and the wound has healed, these cicatrized areas remain tender; shooting pains are felt, and are sometimes called neuritis, though there is no real inflammation of nerves; often the pain passes off when the patient uses the limb, but reappears at night; such cicatricial areas are also sensitive to changes of atmospheric pressure. Pain of this type is generally due to irregularities of blood-pressure. If such an area were superficial it would be a dusky scar, obviously the seat of venous congestion, and the treatment would be to promote vascular activity. To test this in deeply situated cicatrices about joints, all that is necessary is to promote a rapid flow of blood to the surface by lightly slapping and massaging the skin; as soon as a rosy flush appears on the skin, ask the patient to move the joint, and if he can do so with less pain and stiffness than before it will be obvious that the slight alteration in blood-pressure has made all the difference.

The treatment advised will therefore be :

(*a*) To use the limb with tolerable freedom.

(*b*) To assist the restoration of free circulation by deep massage.

(*c*) To relieve pain at night, by hot applications to the surface, so that the patient may have longer periods of undisturbed sleep.

Electricity, especially high frequency current and diathermy, and also hot-air baths and radiant heat, relieve pain of this type, but in all cases the venous congestion and pain return as the limb cools down.

As these measures are often not available, a very simple remedy which is always accessible may be substituted, namely :

Contrast Baths.—Contrast bathing with hot and cold water. Two buckets are required, one with the hottest water the patient can bear, and the other with the coldest that can be procured. In the case of a foot or wrist the injured limb is plunged first into the one and then into the other as fast as the patient can change them for five or ten minutes ; in other parts two sponges may be used, one for hot and one for cold water. The effect is to cause the small vessels to dilate and contract rapidly. The treatment thus acts as a species of gymnastics for the muscles in the vascular walls. Besides relieving the pain the result is an improvement in the physiological efficiency of the tissues at fault. This is not achieved to anything like the same extent by hot air and the various electric treatments.

CHAPTER IV

STIFFNESS AND LIMITATION OF MOVEMENT

STIFFNESS and limitation of movement may be due to several different causes ; and the type, significance, and treatment vary accordingly.

First there is a stiffness or limitation of movement due to muscular resistance which is associated with pain, the result of some inflammatory or traumatic lesion. Such stiffness is a natural physiological phenomenon; it has been referred to already in the discussion on the meaning of pain, and needs no further mention beyond a reminder that limitation of every movement of a joint is an indication of arthritis or of a serious injury of the joint, while limitation of only certain movements indicates only a local lesion, most probably outside the joint.

Next there is stiffness, or limitation of movement which we may call mechanical in origin, due to fibrous adhesions, to blocking of the range of movement by fragments of bone or deposits of callus, and in the extreme case it may be due to bony ankylosis.

1. Fibrous adhesions about a joint are the result of cicatrix formation after trauma or an inflammatory lesion. Enough has already been said of the danger of increasing the amount of cicatricial tissue by

injudicious passive movement too early in the course of repair.

On the other hand, too prolonged fixation gives the newly formed cicatrix time to stiffen, but this is the lesser of the two evils. When the local effusion and tenderness abate, the patient may be allowed to commence gentle active movements. He is not likely to carry these out sufficiently roughly to tear or damage newly formed scar tissue, because pain will act as a check.

On passive movement, a joint with fibrous adhesions conveys a characteristic sensation to the hands of the surgeon, which differs on the one hand from muscular resistance associated with pain, and the abrupt blocking of movement caused by a bony obstruction on the other. The cessation of movement is definite and unmistakable, but it is not associated with pain, unless the surgeon exerts a little force to put tension on the fibrous band. If in any doubt whether there is disease of the osseous elements of the joint, an X-ray photograph should be taken, when the clear structure of the bone, smooth and even contours of the joint surfaces, and the absence of blotched or cloudy patches in and about the ends of the bone, will definitely exclude active disease.

On the Breaking down of Adhesions.

The treatment then is to break down the adhesions under gas. It is no use making half-hearted attempts; these only give rise to effusion and increased stiffness. Every resisting band must be stretched

or ruptured by steadily continued and increasing tension. Sudden jerking movements must be avoided because (*a*) they are inefficient, (*b*) they cause unnecessary irritation of the tissues and unnecessary effusion, (*c*) they may break a bone instead of rupturing the fibrous band.

In the case of the shoulder the arm is first abducted, care being taken not to strain the joint by over-abduction. An essential rule, especially in old people, is to control the manipulation by a comparison with the sound arm, as considerable variations in the range of movements are to be noted in different individuals. An assistant should fix the scapula and, with his fist in the axilla, put pressure upon the head of the humerus to prevent dislocation. First with the arm lying at the side of the chest, and afterwards in the position of abduction, the humerus should be rotated inwards and outwards. This movement should be performed very slowly and yet very thoroughly. It is the movement most likely to cause fracture near the joint. The last and most frequently neglected movement is that of forcing the elbow back while the arm is fully abducted. During all these movements, the scapula is fixed. It should now be released and allowed to participate in the complete elevation and abduction of the limb, lest it should have formed adhesions separately from those about the joint.

The same principles apply in breaking down adhesions of other joints. In the case of the elbow, if the adhesions are tough, care must be taken not to produce a fracture. In such an instance, it is

a good practice to protect the humerus and bones of the forearm by applying splints of sheet metal above and below the elbow. It will then be practically impossible to produce a fracture excepting at the olecranon, which has to be carefully guarded.

The most striking results are often brought about in the case of the knee, if we remember one very important point, and that is, to secure the full rotatory range. If we confine ourselves to ordinary flexion and extension, we miss those cases of adhesions which follow displacements of the semilunar cartilage and injuries to the internal lateral ligament. In breaking down adhesions in the knee to correct the stiffness following fracture of the lower end of the femur, the thigh should be carefully splinted, as the bone may easily be fractured again even after several months.

After adhesions have been broken down, the treatment should consist of massage and both passive and active movements. The passive movements should be carefully regulated, the active should be unlimited. As soon as the patient has sufficiently recovered from the anæsthetic, he should be put through all his movements. He will then be convinced of the freedom of the joint and this will prove a valuable asset towards recovery.

Blocking of Movement by Bony Obstructions may be due to many causes, such as :

(*a*) Myositis ossificans traumatica, which is peculiarly associated with dislocations of the elbow, will be dealt with when discussing injuries of the elbow.

(*b*) Fragments of fractured bone, or even a projecting end of bone in an uncomplicated fracture about a joint.

(*c*) Excessive formation of callus near a joint.

(*d*) Unreduced dislocations.

The occurrence of myositis ossificans can neither be foreseen nor prevented, but the other conditions can be foreseen, and ought to be prevented, though in septic compound wounds, such as occur in the present war, failure is sometimes inevitable. It is, however, all the more important to understand the difficulties and the means of meeting them, for it is only in the earlier stages of treatment that the obstruction can be dealt with easily.

Obstruction of movement of a joint by a projecting end of fractured bone occurs most frequently in fractures about the condyles of the humerus. It is the lower end of the upper fragment which usually projects forwards. This is entirely due to imperfect reduction of the displaced fragments. It should be prevented by proper complete reduction in the first instance. If, for any reason, the lower fragment slips back during treatment, it should be again brought forward before the callus is too hard to be forced.

So long as callus is tender on pressure or manipulation, it is safe to say it is not too hard to be twisted or forced by manipulation so as to adjust an erroneous or imperfect reduction.

Passive movement is undesirable in the stage of repair during which the seat of a fracture is still vascular and tender, and not consolidated, and there-

fore permits of forcible readjustment of the position of the fragments of bone; this corresponds to the tender vascular stage in the cicatrization of soft parts. So, just as tearing the soft cicatrix means more effusion and excessive cicatricial tissue, the necessity forcibly to twist or readjust callus after it has begun to form carries with it the penalty that the increase of exudate may result in excessive formation of bony callus. Small displaced fragments should not be left where they will obstruct the movement of the joint. The ideal treatment is to get them back into their place. A common example where this can be done is found in the fracture of the anterior edge of the lower articular surface of the tibia, which often occurs in association with Pott's fracture of the fibula. All that is here needed is to dorsiflex the foot when setting the fracture; the surgeon then pushes the wedge-shaped piece of bone back into position, where it is held by keeping the foot dorsiflexed.

At the elbow fragments of bone blocking full flexion will usually be pushed aside when putting the joint into full flexion. If the fragment will not get out of the way, there should be no hesitation about readjusting or removing it by operation.

The formation of excessive callus, i. e. excessive osseous formation in the exudates of blood and lymph about the seat of injury, may be determined by the violence of the original injury, which of course is beyond the surgeon's control, but is often due to unnecessary irritation of exudate at a later stage by imperfect fixation, by allowing injudicious movements,

or by unwise attempts at passive movement before the callus is firm enough to withstand them. Everything that has been said about the dangers of too early or too rough passive movement in connexion with fibrous cicatrices in soft parts applies much more strongly where the process of repair includes ossification, for fibrous bands can generally be stretched or ruptured if necessary, but osseous formations are not so easily disposed of when once they are fully formed.

It is a physical law that matter occupies space; therefore, if no space is left in which excessive callus may form, it cannot be formed. This method of meeting the difficulty can be employed at the elbow, for if the joint is fully flexed during treatment of a smash about the condyles, no excess of callus can form in front to block flexion; behind, the broad tendon of the triceps serves the same purpose. The only exception to this rule of full flexion in elbow injuries is when the olecranon is fractured.

Ankylosis may be fibrous or osseous, and is a serious menace to movement. It arises when the cartilaginous surfaces of the joint have been injured, leaving raw surfaces between which repair tissue may be formed.

This repair tissue may only go the length of fibrous tissue; by judicious exercise this may gradually stretch and a reasonably useful joint result. Attempts at violent stretching or rupture of the fibrous tissues connecting the joint surfaces are generally to be regarded as injudicious, because they excite increased

exudate which forms a basis for more cicatricial tissue, and also because violent handling may excite the bone cells communicating with the joint through the injured cartilage to activity, and then the osteogenetic cells will invade the area of exudate and produce osseous repair.

Hence, in a case of fracture into a joint, or of a bullet having traversed the joint and ploughed up the osseous cartilages, the line of treatment must be directed towards obtaining healing of the breach of surface on each bone separately, and allowing the union from one to the other to be as slight as possible. When sufficient time has elapsed for repair to have commenced, slight movements should be allowed. These should be such movements as would tend to produce non-union in the fracture of the shaft of a long bone. Part of the treatment of ununited fracture of a long bone is to manipulate the seat of fracture roughly, so as to produce fresh exudation and vascular activity and to excite osteogenetic processes. It is therefore obvious that violent movements of a joint, instead of securing non-union between opposing surfaces, may have the opposite effect.

When bony ankylosis is seen to be inevitable, or is seriously to be feared, the position in which the limb is placed during treatment is of great importance. The guiding factor is the function of the limb.

In the upper limb, usefulness of the hand is of first importance, and treatment is planned accordingly. A limb with an ankylosed joint may still be very useful.

In the lower limb, weight-carrying and locomotion demand stability, and this must guide the surgeon. In injuries about the vertebræ, the object is to preserve the erect attitude, because the spine must carry the weight of head and shoulders. If a hunch back is once formed by yielding at the seat of injury, the weight of head and shoulders will tend to increase the deformity.

Neurotic Stiffness of Joints.—It frequently happens that after some injury which has caused a considerable amount of pain, stiffness of the joint persists long after local repair is complete, without any mechanical cause being apparent.

These cases are among the so-called cases of neurotic or hysterical joints. They really depend on a persistence of the habit of keeping the joint still which was acquired during the stage of acute painfulness. The fault is often in the patient, sometimes the surgeon must share the blame. An instance of the latter state of affairs came under the author's notice about two years ago. A boy injured his knee: the doctor very properly fixed it on a straight splint till all pain and swelling had disappeared. He so strongly impressed on the mind of the boy and his mother that he must not move the knee or he might have a relapse, that more than a year later the boy appeared in hospital suffering from a ' stiff ' knee.

Practical demonstration that the knee was not really stiff by moving it through a small angle greater than the boy had accomplished since his accident, and insisting that he should himself do so voluntarily,

followed by drill in moving the joint, effectively obliterated the memory or suggestion or hysteria that the joint could not be moved. These cases are just as likely to occur among the young and athletic as among the feeble and debilitated. The surgeon should never forget that they may occur, and should be particularly careful to distinguish them from cases of malingering. The latter is a conscious effort to simulate disease, and is usually clumsy and easily detected; but a neurotic joint is accurate in its simulation, because it depends on a persistence of the reflex nerve-muscle guard of an injured area after the real pathological condition which excited the reflex has ceased to exist. There always has been a genuine cause for these cases; it may be only slight, but nevertheless real. The higher conscious nervous system has failed to take control of the situation; the case is one for education, not punishment.

CHAPTER V

ON CONTRACTION OF SCAR TISSUE AND COMPOUND INJURIES ABOUT JOINTS

THE behaviour of large and deep scars has been studied mainly in connexion with bruises and burns. In the present war there have been a large number of extensive wounds from shell fire and compound wounds of bones and joints with large exit wounds. Moreover, there has been added a great deal of phlegmonous and gangrenous change in the tissues, leading to considerable loss of tissue. There has, therefore, in the last nine months been ample opportunity of applying the lessons learned in civil practice and to test their truth.

It is necessary to take a brief view of the histological changes going on at the site of the wound, and to see how they are to be controlled in order to prevent stiffness of joints and mechanical disabilities due to the contracting scar.

Roughly one may divide the process of repair, whether in epithelium, connective tissues generally, or bone in particular, into three stages.

First: Early repair processes include the removal of dead tissues, sloughs, and necroses, and the establishment of an active hyperæmia with the formation of new loops of blood-vessels permeating the mass of blood-clot, exudate, and damaged tissues.

In a surface wound this includes all stages up to the establishment of granulation tissue.

Second: The second stage is that of immaturely formed repair elements, especially the laying down of fibrous tissue elements and bone elements to form cicatrix and callus. In this stage the seat of injury is still hyperæmic, but as the formed elements mature, the vascularity gradually diminishes, and the whole seat of repair passes gradually into the third stage.

Third: The mature scar consists of fully formed fibrous tissue elements and hard callus. The fibrous tissue has become white owing to the disappearance of active hyperæmia, and in some cases, owing to contraction of fibrous tissue, repair of other parts of the wound is impeded for want of blood.

About joints—say, the front of the wrist, the back of the knee, the flexure of the elbow—there is a great tendency for the new scar to go on contracting till the limb is fixed in a useless, flexed position. Owing to the contraction of the scar, the blood-vessels cannot expand freely, and the whole area becomes dense, white, and anæmic.

The first stage: during the first stage the region of the wound or injury must be left very much at rest. Fractures should be put up in the best position, torn tissues brought together as far as possible, and then left for the new repair blood-vessels to grow between fragments. These grow in the plastic exudate; therefore any rough handling, injudicious massage or movement, will only tear them.

Free exit must be given to all discharges in septic cases, that the tissues may be as little as possible sodden in poisonous toxins and as much as possible nourished and fortified by the food elements and antibodies in the blood fluids.

Therefore the surgeon should at once decide in what position the limb is to be treated, and endeavour not to move it until repair is well established.

In the second stage : passive movement is apt to tear newly formed tissues, causing bleeding and increased organization of scar tissue. On the other hand, it is possible now gently and gradually to change the position of the limb.

It is during the end of this stage, when the immature tissue elements are becoming matured, that the tendency to contract takes place ; therefore if the limb has not already been put in the position opposed to the deformity which is feared, it should be done now.

For example : in a bullet-wound through the condyles of the humerus, with extensive loss of tissue and suppuration in front of the elbow, there will be a large scar formation.

First, the fracture must be reduced, the arm put in the flexed position, and free drainage and dressing provided for.

Next, as soon as the bone becomes fixed the elbow should be placed at a less acute angle, and as soon as possible in the extension splint shown on the diagram (Figs. 31 and 32). All this stage of treat-

ERRATUM

Page 46, last line
For Figs. 31 and 32 *read* Figs. 7 and 8

ment should be completed before the contraction of the new fibrous tissue shows itself.

Next, as soon as the union of the bone is firm enough the surgeon should risk straining the callus a little by getting the arm out to full extension and allow epitheliation to take place in this position.

In such a case there will be a large granulating surface with epithelium growing in from the side. The granulations in the centre are apt to become heaped up and excessive; this should be prevented by pruning them down with scissors or even scraping them away with a sharp spoon.

The more the granulations, the bigger the mass of organized fibrous tissue formed, and the more trouble from contraction.

Skin-grafting is not to be relied on to do away with the contractility of the underlying scar tissue. Therefore the elbow should be kept fully extended till epitheliation is complete, and the new fibrous tissue has become adapted to the extended position, and has no longer a vicious tendency to contract.

Rules. So far as possible, having regard to fractures, the following rules should be observed:

(*a*) The strong muscles in the axillary fold when torn by shrapnel must not be allowed to heal with a short stiff scar. Therefore the arm should be abducted.

(*b*) Wounds in the flexure of the elbow should be treated with the elbow extended.

(*c*) Burns and septic wounds of the front of the wrist and palm of the hands and fingers must

be treated in hyperextension. The splint shown in diagram will be found useful (Figs. 2 and 3).

(*d*) For wounds in the flexure of the hip, the thigh should be in line with the body and a little abducted.

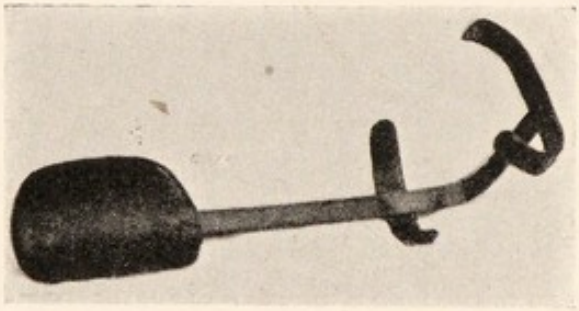

FIG. 2. SHORT HAND SPLINT.

(*e*) In wounds in the back of the thigh the knee should be kept straight.

(*f*) The foot must in any case be kept at right angles to the leg.

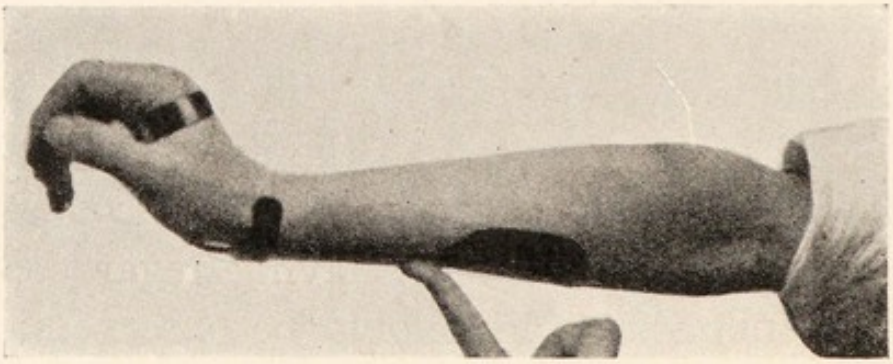

FIG. 3. SHORT HAND SPLINT. APPLIED.

Third stage : when wounds have already reached the contracting or fully contracted state they are not hopeless.

Continuous extension on a splint will make the scar tissue yield: daily passive stretching is of comparatively little value, for the fibrous tissue is

only irritated and contracts all the more in the intervals. The extension, therefore, must be continuous. As the moorings of the scar become stretched the thin glazed epithelium over it shrinks, and the healthy surrounding skin becomes loose and stretches towards the scar, and so in time with *continuous* stretching, aided by massage, many of the most stubborn contractions, such as occur after deep burns, can be overcome and made supple.

The moral, however, is that although it may take a little longer for the wound to get covered with epithelium, it saves time and an infinity of trouble to put the limb in the stretched position at once or as early in the second stage of repair as possible.

Further, prevent excessive formation of fibrous tissue by pruning down excessive granulations. Granulations consist of loops of new capillaries, and it is along the walls of these that the fibroblasts lay down new fibrous tissue.

Fully matured fibrous tissue has no more tendency to contract than any other tissue, and as a scar takes a long time to become composed of fully mature tissue, extension of the scar must be prolonged.

The author has by steady stretching alone obtained good mobile wrists and hands in cases which had been crippled by contraction after burns for several years.

Ischæmic Paralysis.

Ischæmic paralysis of the hand is a condition sometimes associated with fractures of the upper limb, chiefly about the elbow and upper forearm.

It is often associated with tight bandaging, but the paralysis may also be due to pressure from within the arm. The pressure of the broken ends of bone, the tearing of muscles followed by the formation of fibrous tissue, extensive hæmorrhages, may each give rise to this condition, but it is more often associated with clumsy splints and over-zeal in an effort to make them effective by tight bandaging.

It is marked by paralysis and contracture of the muscles of the forearm. It usually comes on suddenly, and the contracture is part of the initial process, and is due to partial coagulation of the proteids of the muscles, caused by lack of oxygen and blood supply. It is therefore a species of coagulation necrosis allied to rigor mortis.

Diagnosis.—The position of the hand is characteristic. The metacarpo-phalangeal joints are extended, and the fingers are curled up. If the wrist is passively flexed, the tension of the extensors and relaxation of the flexors cause the fingers to extend without any voluntary effort on the part of the patient. Microscopic examination of the muscles shows a considerable fibrosis—it is therefore a fibrous myositis with which the surgeon has to deal.

The condition is easily distinguishable from one dependent merely on the involvement of nerve. It does not confine itself to any particular nerve-track, but generally affects all equally. Sensation is rarely lost, and muscles supplied by the same nerve may vary considerably in their involvement. The circulation is badly affected, and the nutrition shows

serious damage. The finger-nails become black and the fingers mummify. The paralysis is rarely complete.

Treatment.—The author has long since discarded operative procedures such as lengthening of tendons or shortening of bones, as he finds that a properly conducted mechanical campaign is far more effective, if the muscles are gradually stretched, joint by joint, beginning at the fingers.

First. An assistant passively flexes the wrist to allow the fingers to extend, and each finger is separately strapped to a little gutter-shaped splint, so that they cannot curl up.

Second. A day or two later, or in milder cases at the same sitting, the metacarpo-phalangeal range is stretched and the palm and splinted fingers are bandaged to a flat metal splint. The whole hand and fingers are now rigidly fixed with the wrist flexed.

Third. The wrist is now from day to day extended a little and fixed. This is continued until the wrist is hyperextended. This hyperextension of wrist and fingers is maintained for some time in obedience to the principles laid down concerning the extension of scars, massage being systematically practised.

The reader will note that by this simple procedure he does much more than any operation would effect. He stretches *all* the scar tissues in the direct order of their tension: those most contracted are attacked first. The muscles most infiltrated with fibrous tissue are really the seat of a diffuse scar, and the effect of continuously stretching them releases the pressure upon the vessels.

As a result the circulation of the fingers is rapidly restored, and quite soon fingers which were originally shrivelled like a bird's feet fill out and develop fatty pulp, the scar tissue becomes pliable and, where the destruction of muscle has not been too extensive, function returns.

CHAPTER VI

JOINTS OF UPPER LIMB

1. **Sterno-clavicular Joint :** Ligaments :—

Above—Interclavicular from one clavicle to the other and attached to the top of sternum between.

Behind and in front—comparatively weak sterno-clavicular ligaments.

Below—The strong rhomboid or costo-clavicular ligament attaching the clavicle to the sternal end of the first rib.

There is a complete meniscus dividing the joint into two synovial cavities.

The security of the Joint depends mainly on the ligaments, the shape of the joint surfaces not contributing much.

Movement of the Joint occurs only in association with movements of the shoulder and arm.

Rest of the Joint. In cases of synovitis or other conditions demanding it, rest can therefore only be obtained by controlling the arm, by bandaging it to the trunk and supporting the elbow by a sling so that the weight of the arm hanging on the outer end of the clavicle shall not drag on the joint.

Dislocations of the Sterno-clavicular Joint :

1. Dislocation of clavicle upwards.
2. Dislocation of clavicle forwards.
3. Dislocation backwards.

As the rhomboid ligament is very strong, total dislocation which requires total rupture of this ligament is rare, and most displacements of the sterno-clavicular joint are therefore only partial subluxations, and not complete luxations.

Diagnosis.—Complete dislocations are unmistakable, and when recent are easily reduced by ordering the patient to take a deep breath and manipulating the arm over a pad or the surgeon's arm in the axilla, so as to lever the clavicle out and replace the inner end in the notch in the sternum, the difficulty then being to keep it in position. In posterior dislocation the end of the clavicle is said to cause trouble sometimes by pressure on the trachea or the great vessels, especially the innominate artery when it has a 'high bifurcation'. This complication is extremely rare.

Exact diagnoses of the subluxations are not quite so easy, for they may be confused with fractures of the inner end of the clavicle near the joint when contours are obscured by swelling: pain and tenderness in the situation of the joint are essentially a feature. In the case of fracture, there may be upward tilting of the inner fragment, but owing to the wide and strong attachment of the rhomboid ligament there may be a fracture without much displacement. The diagnosis can usually be made by manipulation: in the case of fracture the break may be felt, or it may be localized by finding the point of maximum tenderness to be over the bone, not over the joint. Measurements are of little value in comparing the two sides owing to the diffi-

culty of getting clearly defined points from which to measure.

Treatment.—Reduce by manipulating the shoulder.

Fixation consists in a local retention by pad and strapping.

The pad is made of strapping folded six or eight times, sticky side out, big enough to make a flat pad covering the inner end of the clavicle and top of the sternum. By being moulded to the shape of the underlying structures, and by sticking to the skin, a pad of this sort gives a considerable amount of local control. The pad is fixed down by a broad strip of adhesive plaster arranged in bandolier fashion over the shoulder.

The arm and shoulder should be fixed very much as for a fractured clavicle. Strips of plaster can be arranged round the shoulder so as to draw it backwards or forwards as may be required in the individual case. The sling supporting the elbow can be shortened when it is found that by raising the shoulder the inner end of the clavicle is kept in position better.

The surgeon should not allow himself to be tied down to one routine method of adjusting the strapping and bandages, but be prepared to modify these to meet the peculiarities of each case. Unless from local pressure no serious symptoms accompany this lesion. The movements of the scapula are hardly ever affected and I have never had occasion to arthrodese or wire the bone. A temporary metallic fixation might be needed in recurrent displacement in the case of a young woman.

2. **Acromio-clavicular Joint.**—Ligaments :
   1. Superior, fairly strong.
   2. Inferior, strong.
   3. Coraco-clavicular.

The front and back of the joint are covered by the attachments of the deltoid and trapezius muscles respectively.

The only common injury is dislocation of the outer end of the clavicle upwards. As the joint surfaces are practically flat there is nothing to retain the bone in position except the ligaments. It is essential, therefore, that after rupture these should unite well and be short and strong. If they do not the patient is left with a shoulder in which the recurrent slip of the joint may give annoyance, perhaps in the middle of some important movement in connexion with his work.

Treatment is very simple, replacement is easy. Retention of the bones in position long enough to ensure strong repair is almost entirely neglected by the majority of the profession. Place a firm pad about two and a half inches long by one and a half inches broad over the outer flat part of the clavicle. Put a clove hitch round the wrist and sling the wrist from the neck with the elbow at a right angle. Place a second pad with a hole in the centre of it to lodge the olecranon so as to avoid a pressure sore. Pass a long scarf or a broad bandage under the elbow and knot it over the pad on the shoulder. As the knot is drawn tight, the whole arm, humerus, and scapula, and therefore the acromion process, are drawn up and the clavicle is drawn down (Fig. 4).

The writer very often makes pads used in this way of many folds of sticking-plaster, sticky side out, as

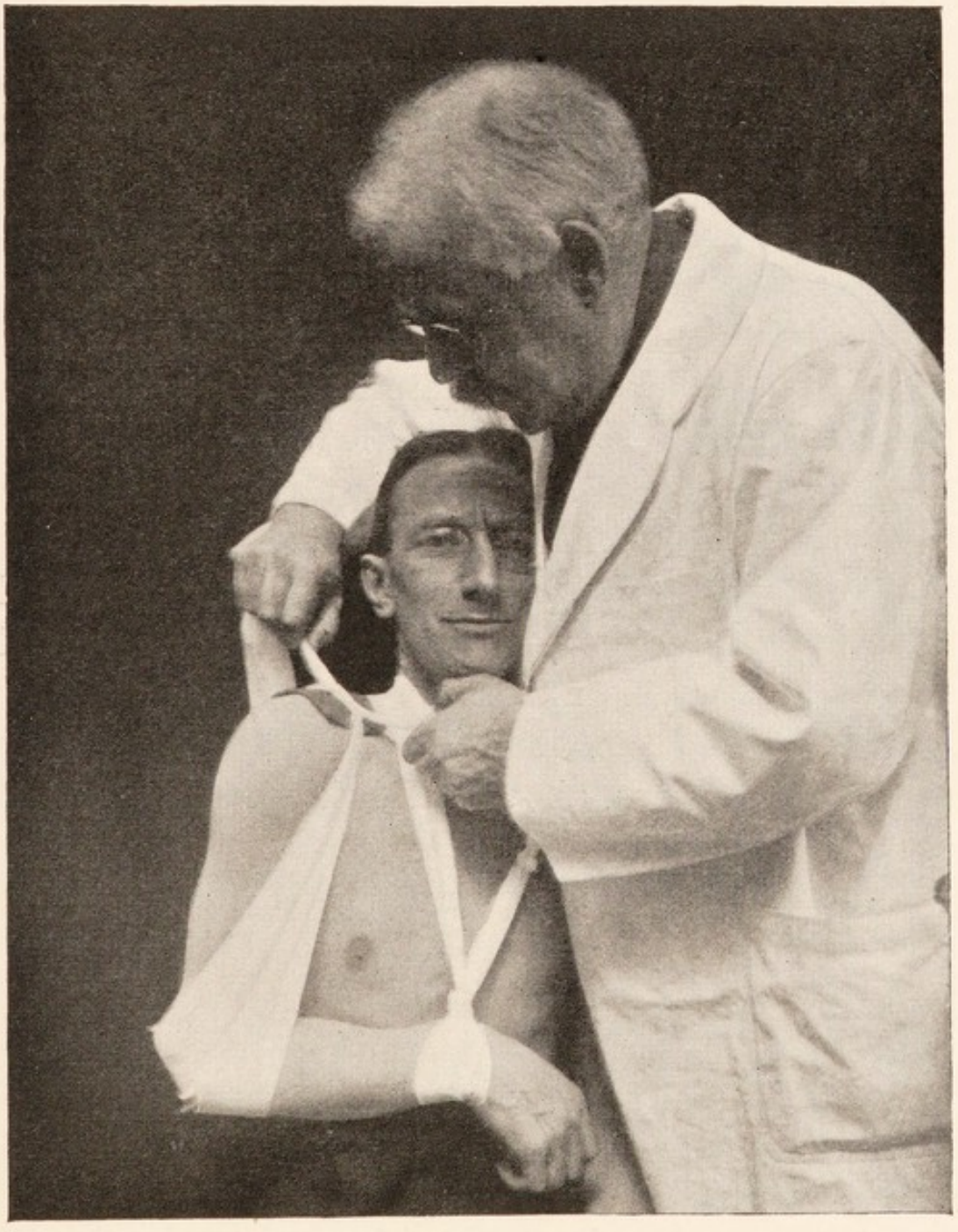

FIG. 4. PUTTING UP ACROMIO-CLAVICULAR DISLOCATION.

these adhere to the skin and do not shift. Such a pad is stiff enough to act as a local splint.

The result of this simple procedure is highly satisfactory.

3. **Shoulder-joint.**—Ligaments :
   1. Capsular with the so-called gleno-humeral thickenings in it.
   2. Glenoid ligament which slightly deepens the glenoid cavity.
   3. Coraco-humeral.

The ligaments are not of much clinical importance, as they are really not of much effect in securing the bones in position. The structures which really secure the joint are the muscles attached round the head of the humerus, whose tendons near their insertion blend with the capsule. The most important are :

1. The subscapularis, which covers the front of the joint and is inserted into the lesser tuberosity and the bone below for half an inch.
2. Supraspinatus, above.
3. Infraspinatus, above and behind.
4. Teres minor, behind.

The last three are inserted in order on to the three facets of the great tuberosity.

Below, the joint is not supported by muscle and the capsule is very lax to permit of free elevation of the arm, and it is through this weak portion of the covering of the joint that the head of the humerus escapes in cases of dislocation.

Good X-ray photographs of every injured shoulder-joint should be obtained without delay, for there is no joint so likely to provide traps for the unwary surgeon, and a patient who cannot raise his arm high

enough to let him fasten his collar or brush his hair remembers his surgeon daily, and not with thankfulness.

Text-books do not as a rule pay sufficient regard to the anatomical position of muscles in relation to their mechanical effect when a joint is put out of gear by some lesion in its immediate neighbourhood.

Now at the shoulder the muscles round the scapula, supraspinatus, infraspinatus, teres minor, and subscapularis converge on the head of the humerus ; the latissimus dorsi, teres major, and pectoralis major converge on the region of the bicipital groove and ridges.

If there is a fracture about the upper part of the shaft of the humerus the tendency of all these muscles will be to pull the humerus towards the trunk, and if the humerus is left hanging beside the body the lower fragment will be displaced inwards roughly at right angles to the axis of the humerus, and the resulting distortion in the neighbourhood of the joints cannot but interfere seriously with the mobility and function of the joint.

Turning again to the muscles, we find that they have a wide fan-shaped distribution over the back and front of the chest, but all converge in a conical fashion towards the shoulder. The axis of this cone runs outwards and slightly upwards.

In order to neutralize the distorting cross tension of the muscles, the humerus should be pulled out in the line of the axis of this cone ; the general pull of the muscles will then be along the axis of the humerus straight on to its articulation with the scapula.

This is not explained in text-books of surgery, and is a departure from the traditions which have descended to us from our forefathers.

In every case of doubt, or where there is a complicated smash about the shoulder, the surgeon knows that if he can get the arm well extended in abduction at rather more than a right angle from the side he has at least got the muscular resistance pretty nearly in line with the axis of the limb, and has disarmed the muscles of their most vicious distorting tendencies. This position and its applications will be referred to in connexion with fractures and fracture dislocations.

The rule can, however, be made: if in difficulty, play for safety by efficient extension in a fully abducted position.

Dislocations of the Shoulder.—Practically every uncomplicated dislocation of the shoulder occurs by rupture of the inferior part of the capsule. The head of the humerus escapes through the rent, the lower fibres of the subscapsularis muscle in front of the joint are often injured at the same time. Dislocation therefore occurs most frequently with the arm abducted when a twist with the muscles attached about the bicipital groove giving a fulcrum, or a blow on the upper end of the humerus, forces the head out below the glenoid. This infraglenoid dislocation is rarely seen by the surgeon, because muscular action or the direction of the violence causes the head of the humerus to slip up either forwards under the coracoid process, or backwards under the spine of the scapula.

Of simple dislocations there are therefore usually two types, the anterior or subcoracoid, and the posterior or subspinous.

Some have been at unnecessary pains to subdivide these still further, according to the amount of tearing of soft parts and the greater or less distance that the head of the humerus has been free to travel.

For our present purpose such subdivisions serve no useful purpose.

Diagnosis.—Diagnosis of dislocation of the humerus depends on recognition of the fact that the head of the humerus is not in its normal position in the glenoid cavity under the acromion process of the scapula, and by its discovery in some other situation. Normally the rounded contour of the shoulder is produced by the deltoid muscle lying over the head of the humerus. If the head is not in the glenoid cavity, the contour is flattened immediately below the acromion process, and a finger pressed in under the acromion process fails to meet the immediate resistance of the rounded head of the humerus. In fracture of the neck of the humerus without dislocation the flattening of the contour is a little lower down, but the head is felt in situ *immediately below* the acromion. The only exception is fracture of the neck of the scapula, when the head and glenoid cavity may go adrift together. The second point which completes the diagnosis is that the rounded mass of the head is felt in some other situation.

In simple anterior dislocation without fracture of the neck the position of the arm is characteristic.

The head lies in front of the neck of the scapula. The elbow is abducted and cannot be brought to the side, and the mobility of the joint is reduced almost to zero, thereby distinguishing the condition from fracture of the humerus, in which there will be abnormal mobility at the site of fracture, whether the head be dislocated or not.

On examination all movements of the arm are restricted, and in particular the elbow cannot be brought to the side, nor can the hand be put on the other shoulder.

Reduction of Anterior Dislocation of the Shoulder.— It was Kocher of Berne who first pointed out that in ordinary dislocations of the shoulder the coraco-humeral ligament is rarely torn and that the spasmodically contracted subscapularis muscle binds the head of the bone down to the ventral aspect of the scapula.

The head is usually lodged near to or actually on the edge of the glenoid.

The method of reduction known by Kocher's name is generally accepted as the best and simplest method of reducing anterior dislocations. It depends on tiring out the subscapularis muscle until it relaxes ; when this happens the dislocation in many cases is reduced without any effort.

The method of tiring out the subscapularis muscle is by rotating the arm outwards with the elbow bent till the resistance of the muscle is overcome.

There is no force or violence required ; the procedure is not painful, and can be carried out without an

anæsthetic. Therefore the patient may sit up in a chair; the surgeon places one hand on the flexure of the patient's elbow, and leans on this to produce slight extension; with the other hand he grasps the patient's forearm near the wrist, and slowly but firmly rotates the arm outwards. There should be no hurry and no attempt to twist the head suddenly into the joint. If dealing with a powerful man it may be several minutes before the muscle ceases to resist. While the arm is being rotated outwards the head of the humerus, if not already resting on the edge of the glenoid cavity, travels visibly outwards till it impinges on it. The relaxation of the muscle is usually sudden, and if the surgeon is keeping a firm downward traction on the limb he feels the head slip downwards a little towards the lower part of the glenoid; at the same time the head of the humerus rolls over the edge of the glenoid, and into its proper place. Simultaneously with the relaxation of the muscle, the resistance to adduction disappears, and the elbow can be brought in towards the front of the chest; the arm may then be rotated inwards, when the hand will without difficulty be placed on the patient's opposite shoulder.

Students and others may sometimes be seen to rotate the arm out and then suddenly attempt to adduct the elbow and rotate the arm inwards, apparently with the idea that by so doing the head of the humerus will be twisted into place, and very often they fail, because they are working on a mistaken idea.

The head rolls outwards over the edge of the glenoid; by keeping up a downward traction—a part of the manœuvre omitted by some surgeons—the head is drawn down nearer the point at which it rolled out. In the majority of instances the head will roll into place so suddenly that the reduction is effected before the surgeon has time to adduct the limb and rotate inwards.

When, however, the head is poised on the brink of the glenoid cavity, a little gentle pressure of the elbow towards the front of the chest will upset it over the edge. If reduction is not effected gently, force will certainly fail; therefore it is bad practice to lose patience and resort to force.

Under an anæsthetic, with the muscles fully relaxed, a very small rotary movement will often effect reduction.

A large proportion of cases of death under anæsthesia have occurred when the anæsthetic was administered for the reduction of a dislocated shoulder. If an anæsthetic is to be administered the patient must be properly prepared for it.

The old method of reduction with the heel in the axilla is practically obsolete in its original form, which was that the surgeon placed his foot (with the boot off) in the axilla and exerted traction on the arm first outwards and then downwards, using his foot as a fulcrum over which he levered the head outwards. The method, though effective, involves too much risk of bruising nerves and vessels in the axilla. It is to be avoided.

Traction first outwards in an abducted position, then more and more upward till the arm is being pulled straight upward, is a manœuvre which is sometimes indicated, and is quite sound practice.

In certain cases Kocher's method may fail the surgeon, and in such instances steady traction of the arm in the abducted position, accompanied by a side-to-side swing, will prove effective. The surgeon places the patient's axilla over his flexed thigh while one assistant pulls the arm and another fixes the scapula. Gentle traction completes the operation. With appropriate machinery, old dislocations of many weeks' standing can be reduced on this principle (Fig. 5).

For the very rare variety of shoulder dislocation known as luxatio erecta, traction upwards is the direct method of reduction, because in this variety the arm is pointing straight up above the head and fixed in this position by the muscles, while the head is below the glenoid.

Backward Dislocation of the Shoulder is comparatively rare as the result of accident. The head escapes through the lower and posterior part of the capsule, sometimes tearing the lowest fibres of the teres minor; the head then lodges somewhere under the acromion process or spine of the scapula, lying in the infraspinous fossa.

Diagnosis.—The head is not in the glenoid fossa, but can be seen and felt on the dorsum of the scapula. The arm is usually directed forward and rotated inward with more or less adduction, unless the head

is displaced far towards the middle line of the body under the spine of the scapula, when there may be some abduction.

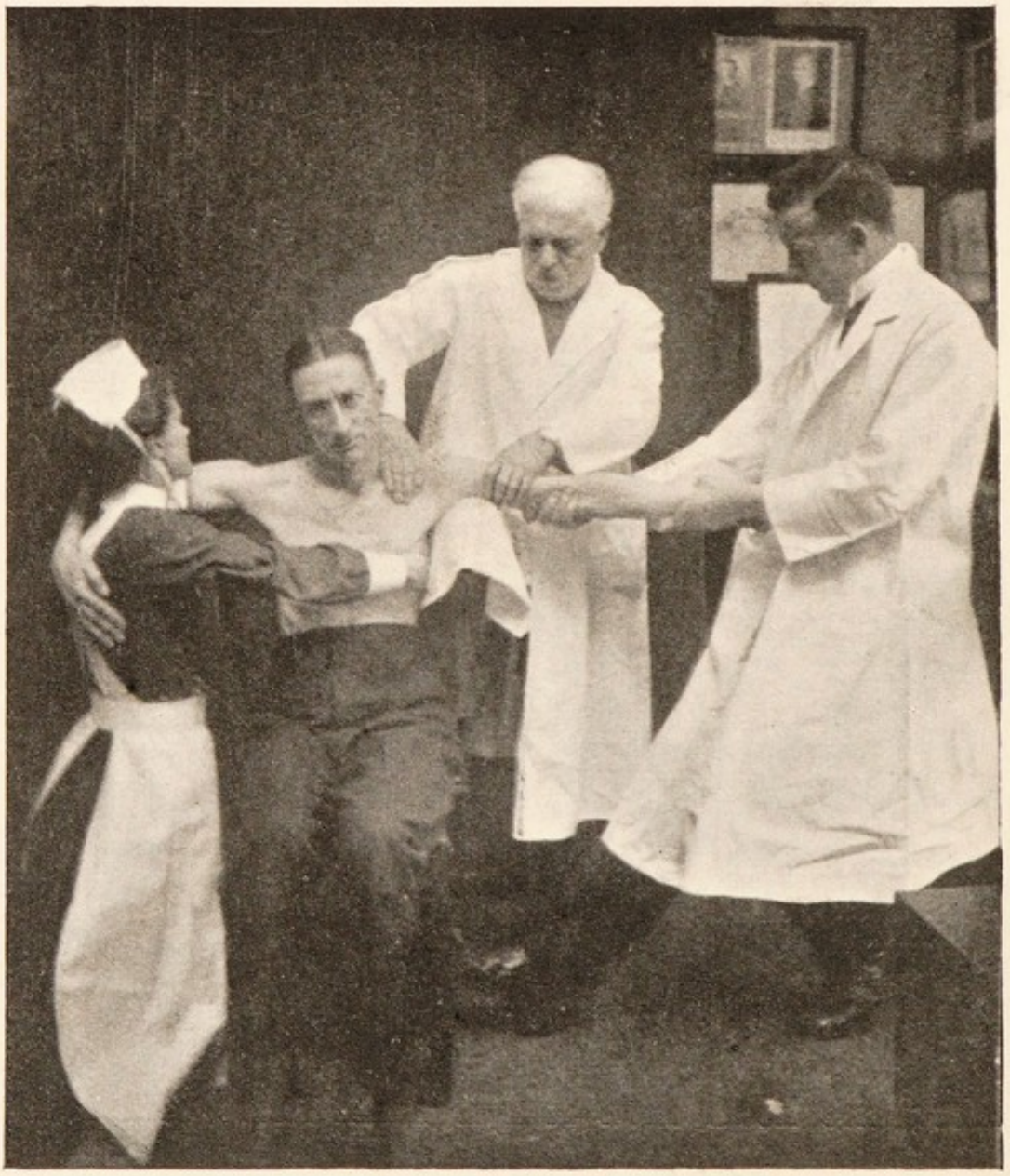

FIG. 5. REDUCING DISLOCATED SHOULDER.

Motion is very definitely limited.

Reduction is effected by traction in the line of the arm with gentle rotatory movements, adduction to

clear the head from the posterior margin of the glenoid, and gradual raising of the arm so as to turn the head down to the lower part of the glenoid margin and allow it to return by the way it left.

After-treatment.

1. Bandage the arm to the side for two or three days to keep the parts at rest, till blood-clot and effusion are absorbed and repair commences.

2. Next carry the arm in a sling, but do not allow the patient to abduct the arm, although small voluntary movements are permitted.

3. Allow gradual increase of movements and practise rotations for about three weeks.

4. Finally secure full abduction by passive movements and exercise.

The risk of causing a recurrence by early abduction makes it necessary to run the risk of a few adhesions, which may have to be stretched as recovery takes place.

Complications.

Fracture of the Glenoid. — In forward dislocations the capsule is not always torn; the margin of the glenoid may give way, either by separation of part of the glenoid ligament and some stripping of periosteum, or by fracture of the bone at the anterior edge of the glenoid cavity.

Reduction presents no difficulties, but the head slips forward again very easily. It is therefore necessary to keep the head of the humerus well back

by supporting the elbow well across the front of the chest and strapping the upper part of the humerus back as in the well-known Sayer's method of fixing a fracture of the clavicle.

Fixation must in this case be maintained longer than in a simple dislocation.

Diagnosis is made by crepitus on manipulation, by the ease with which the head slips forward again after reduction, and if doubt exists reduction should be confirmed by the X-ray photograph.

Fracture of the Greater Tuberosity may occur in conjunction with a dislocation or as a distinct injury without dislocation. It seems to be produced by avulsion of a wedge-shaped piece of bone by the muscles; **when there is no dislocation** the fragment of bone is drawn slightly upwards and backwards by the action of the muscles attached to it (supra- and infraspinatus and teres minor).

The fragment cannot be brought down to the humerus, so the humerus must be brought up to the fragment by abducting the arm from the side, rotating it outwards and bending the elbow till the hand rests on the back of the neck.

The arm is easily fixed in this position by putting a clove hitch round the wrist and passing the bandage behind the head under the opposite axilla, and by a firm spica bandage over the injured shoulder. If the patient is very restless, fix the limb in this position with a spica bandage of plaster of Paris including the chest and arm.

If the arm is not fixed in this position, the fragment

and the callus formed round it will block abduction by impinging on the acromion process, and the patient will not be able to reach his back collar-stud, or, if a woman, her hairpins.

The preservation of the ability to do common daily actions, however trivial, is much more important to the patient than the ability to perform some unusual movement which is hardly ever required. If the position of the fragment is unsatisfactory, a screw will fix it, but the operation will be rarely needed.

Dislocation with Fracture of the Greater Tuberosity is a much more difficult problem. First, because the fragment of bone attached to the external rotator muscles lies under the acromion process and may get into the way of the head when reduction is attempted. Reduction should be performed under an anæsthetic :

1. If after reduction it be possible to retain the arm in an abducted and externally rotated position without reproducing the dislocation, this is the position which will secure the best functional result.

2. If the arm must be treated first by the side in order to let repair of the capsule take place (i.e. if the dislocation is allowed to take precedence of the fracture), then it is desirable to abduct the arm fully before the newly formed callus is hard. In this way the lump of bone and new callus forming on the outer side of the upper end of the humerus is pushed against the acromion, and can be to some extent pushed out of the way, clearing a free path for fuller abduction than would otherwise occur.

This involves risk of reproducing the dislocation, and must therefore be done with caution.

3. The question of operation to screw the fragment down into position may be considered.

The technical difficulties in the way of performing such an operation, so effectively that the result will be distinctly better than that obtained by non-operative means, are considerable.

Because :

1. The fragment of bone is often small.
2. It is tucked away under the acromion by the retraction of the muscles inserted into it and cannot be easily pulled down into position.
3. The screws fixing it must be put into cancellous bone, which does not hold very well in any case, and gives very little security when there is muscular tension.

Fracture of the Neck of the Scapula.—Fracture of the neck of the scapula may at first sight be mistaken for a dislocation, because the head of the humerus and glenoid drop together, leaving a vacant space under the acromion. On examination, however, the arm is not fixed in an awkward position as is usual in ordinary dislocations, but is fairly movable. The elbow can be brought to the side and the whole arm lifted into position. Sometimes the irregularity at the seat of fracture can be felt from the axilla. An X-ray photograph is essential.

Treatment is obviously to lift the arm with the attached glenoid into position and keep it there by

binding the elbow up to the shoulder exactly as for acromio-clavicular dislocation (Fig. 4).

Absorbent wool is placed in the axilla between the arm and the body to prevent soreness of the skin, and the whole arm is then bandaged to the body to keep it at rest.

Dislocation of the shoulder associated with fracture of the neck of the humerus will be discussed below in the section on 'Fractures of the neck of the humerus'.

Fractures of the Neck of the Humerus

It is customary to divide fractures of the neck of the humerus into :

1. Separation of the epiphysis in children.
2. Fracture of the anatomical neck in old people.
3. Fracture of the surgical neck.

It will be of advantage briefly to consider our experience of the after-progress of these cases before discussing methods of treatment. The result of long experience is that the functional result is surprisingly good even in cases which one may say have had no scientific surgical treatment in the first instance. Of cases which may fairly be put in this class the author may claim to have had a large experience amongst sailors alone, without mentioning cases which have had treatment on various lines ashore.

In any case several weeks after injury the only thing to be done is to break down adhesions and start active and passive movements to increase the range of movement of the arm. Ultimately, very good movement is usually obtained, the patient being able

to put his hand to the back of his neck. On examining this range of movement more critically it is found that a great deal of it is movement of the scapula, while true movement at the shoulder-joint itself is somewhat limited.

When these results are compared with those obtained after excision of the head of the humerus for disease or ankylosis after septic arthritis, one is forced to admit that there is not much to chose between them.

The conclusion is that if practically untreated cases do so well, it ought to be possible by carefully directed manipulation to get such good functional results that operation should only be resorted to in very exceptional cases, when there is some clear indication that there is a difficulty to be encountered which operation alone will surmount. Such cases are so rare that out of many hundreds of instances of this fracture which have passed through the author's hands he has only performed an open operation in four instances, and two of these were for the relief of intra-axillary pressure.

1. **Separation of the Epiphysis** in children can be reduced by traction and manipulation described below ; once the ends are brought in apposition there is little tendency to recurrence of displacement, and simple fixation to the side with a moderate wool pad in the axilla completes the treatment.

2. **Fracture of the Anatomical Neck,** the so-called 'intra-capsular fracture' of a former generation, occurs generally in old people, frequently from a direct

blow on the shoulder. The line of fracture is never exactly that of the anatomical neck of the humerus, but usually includes in the upper fragment a portion of the shaft in the inner side and sometimes a piece of the tuberosities.

Diagnosis.—The shoulder is bruised, swollen, and painful, but the head of the humerus is in the glenoid cavity.

The fracture is often impacted, in which case crepitus will not be obtained on manipulation. On measurement from the prominent point on the posterior border of the acromion to the external condyle shortening is not more than half an inch.

Treatment.—If impacted, never attempt to disimpact. Further, the upper fragment is often attached to the lower fragment only by a strip of periosteum or an extension of a muscular insertion, and in consequence, forcible manipulation is strictly contraindicated. There is usually little lateral displacement of the fragments. All that remains therefore for the surgeon to do is to make the patient comfortable with a modest pad in the axilla, bind the arm to the side of the body, and wait for union.

Massage of the shoulder, not movement, may be employed from the beginning. After a week repair will have commenced, the muscles round the shoulder will no longer be contracted, nor will they be prone to sudden spasms, and support of the elbow in a sling and a light controlling bandage round the body is all that is necessary.

Three weeks after the injury union should be far

enough advanced for the patient to attempt gentle active movements with impunity. Recovery with a satisfactory range of movement should be complete in about six weeks.

3. **Fracture of the Surgical Neck.**—Fracture of the surgical neck occurs below the tuberosities; there is often considerable displacement of the fragments and sometimes serious error of alinement.

Accuracy of alinement is of paramount importance in all treatment of fractures. If the two fragments are allowed to unite at an angle to one another or with a rotational discrepancy, the limb which results will work about as well as a pair of wheels with a twisted axle. If the axle is straight, the wheels will go round true—it does not matter how much the axle may be patched so long as it does not hit any working part. So with a broken bone, if the alinement is correct, the line of action of muscles in relation to joints will make for good function; local projections and irregularities do not matter unless they interfere with nerves or muscles, or in the case of a fracture near a joint form a mechanical block to free movement.

One observes from a clinical and radiographic examination of recent cases exhibiting deformity that the upper fragment is abducted by the muscles attached to the great tuberosity, and rotated outwards.

The upper end of the lower fragment is drawn in toward the trunk by the pectoralis major, teres major, and latissimus dorsi, which are all **internal rotators** as well as adductors. It is further drawn up by the

biceps and deltoid against the inner aspect of the upper fragment, so increasing deformity. If the upper fragment will not come into line with the lower, the lower must come into line with the upper.

Treatment.—Traction on the arm in the axis of the humerus, gradually abducting and rotating outwards till the arm is at right angles to the body or even straight upward parallel to the side of the head, will disengage the lower fragment from the inner side of the upper fragment. In this position the line of traction of the pectoralis major, latissimus dorsi, and teres major is in the axis of the shaft, so these muscles no longer exert a lateral distorting force.

While an assistant is extending the limb in this way the surgeon with his hands feels when the bones have completely disengaged. He then asks the assistant to relax the tension on the limb, while he tries to guide the ends so that they engage end to end.

If they do engage, they can often be gently pressed together and made to lock sufficiently to allow the arm to be brought down to the side slowly and gently, and with a pad in the axilla the arm is securely fixed to the body, with the elbow bent to an angle of forty-five degrees and the wrist slung from the neck. These movements should be performed with gentleness and judgement to avoid injury to nerves and vessels.

Experience has shown that once this manœuvre is successfully accomplished the ends are not likely to disengage, and all that is necessary is to wait for union and then gradually commence movement.

If the shape of the line of fracture is such that the fragments will not lock properly and therefore disengage when the arm is brought down to the side, the arm must be fixed in the abducted position. In this position the line of traction of the pectorals and latissimus is practically the axis of the limb, and therefore will only pull the two ends towards each other and not laterally, and usually the fragments will not slip.

The whole arm, shoulder and upper limb, is swathed in one layer of cotton-wool. It is best to roll up a whole length of cotton-wool and apply it like a bandage. Over this a plaster bandage is applied to the arm and upper part of the chest, rubbing it firmly in round the shoulder and axilla and again firmly round the bony points about the elbow. A proper grip of the condyles of the humerus prevents shortening of the limb ; to make sure of the external rotation the forearm should be included ; if the elbow is bent till the hand is behind the head, the position is not in any way uncomfortable, and the success of the functional result is assured.

Two lengths of strong webbing, like horse-girths or something not quite so wide, one round the axilla and fixed on the opposite side of the table, and the other over the top of the shoulder and fixed to the bottom of the table, give an excellent resistance against which to pull. A roller towel or folded sheet will do, but being more bulky is more apt to get in the way of the surgeon's hands when manipulating the shoulder.

Fracture of the Neck with Dislocation of the Head

of the Humerus.—Fracture with dislocation is more often a fracture of the surgical neck than of the anatomical, and is a most formidable condition to treat, as the functional result is often not satisfactory to the patient. The luxation is usually of the anterior type.

Diagnosis.—The limpness of the arm, abnormal mobility and crepitus, all point to a diagnosis of fracture; the absence of the head from the glenoid cavity should not be overlooked, therefore an examination of the region immediately under the acromion should never be omitted. An X-ray is indispensable. Of course manipulation of the arm has no effect on the position of the head.

To follow the ancient practice of letting the bones unite *in situ*, and later attempt reduction, is to ensure a very poor result.

There are only two lines of treatment :—

(*a*) Manipulation.

(*b*) Open operation.

(*a*) Manipulation systematically carried out under full anæsthesia is often successful. The patient may be fixed with webbing straps, as described above, and an assistant extends and abducts the arm up to the extreme limit of having the arm parallel to the head. This gets the shaft of the humerus right out of the way, and also pulls the pectoralis major well up out of the way.

Meanwhile the surgeon by direct digital pressure on the displaced head may be able to roll it back into the glenoid cavity, when the rest of the process is

exactly the same as described in the previous section on 'Fracture of the surgical neck'.

(*b*) Operation is indicated (1) when manipulative replacement fails; (2) when there is serious pressure on axillary vessels or nerves by the displaced head.

The writer's opinion is that manipulative treatment is so often successful that it should be tried first whenever the state of the limb permits.

The Operation.—The head being usually somewhere below the coracoid process, the ordinary anterior incision from the tip of the coracoid will usually be chosen.

(*a*) The displaced head should if possible be replaced; McBurney's method is very useful, as it enables the surgeon to control the head without unnecessary handling. It consists of drilling a hole through the shaft of the upper fragment and passing a blunt hook through it, to facilitate manipulation for reduction.

(*b*) In rare instances, where the injury is not quite recent and pressure symptoms exist, removal of the loose head may be the only solution of the difficulty. The resulting false joint is sometimes not very effective, as the muscular attachments which form after excision are not a perfect imitation of the natural condition, and the shape of the end of the bone is seldom moulded by muscular action to form a very efficient joint. The writer has, however, seen very useful joint results after removal of the head.

Stiff Shoulder.—After any of the previous accidents, dislocation or some form of fracture, there may be

considerable cicatricial contractions about the shoulder-joint preventing freedom of movement. The nature of the stiffness is determined as a rule by the fact that the arm has been kept in a sling hanging by the side with the forearm across the front of the body, and it is in this position that the contracting tissues have become consolidated.

The patient can often raise the arm forward pretty well, but this is done mainly by moving the scapula.

Abduction from the side is very limited, and rotation both outwards and inwards is usually very slight.

The injury being an old one, and an X-ray having demonstrated that there is no active pathological condition about the shoulder, treatment may be commenced.

Treatment is directed with two objects: first to obtain increased mobility at the shoulder-joint, and second to train the patient to move the scapula more freely, and thus increase the mobility of the limb as a whole, even if the actual mobility at the shoulder is lost. The latter method alone can be attempted in the case of bony ankylosis at the shoulder, and the best position of the arm to obtain the most satisfactory result will be discussed later.

Stiffness due to **adhesions** about the shoulder-joint. —The procedure is to break down adhesions under an anæsthetic as described in a previous section (*v.* p. 36.)

The shoulder should then be massaged and rubbed; as soon as the patient comes out from the anæsthetic—gas should be used for preference—he should be made to perform all movements. As his deltoid is

out of training from disuse he cannot lift his arm voluntarily at once, but it is necessary that he should perform the full range of movement. This he can do by getting his hand on the wall and creeping up with his fingers until the elbow, arm, and side are flat against the wall. If the patient will resolutely do this a few times every day he will have a useful arm.

Ankylosis of the Shoulder is not such a disabling condition as one would expect, provided it is ankylosed in a convenient position. The reason is that by increased mobility of the scapula, the hand can be got into almost any position commonly required when at table or putting on clothes.

First, the arm should be abducted about sixty degrees or more from the side—movement of the scapula will easily replace this amount of abduction. *Second,* the arm should be rotated out far enough for the hand to be brought to the back of the head when the shoulder is raised. *Third,* the elbow should be a little in front of the mid-axillary line, for convenience in handling a knife or fork at table, playing a piano, &c.

If these three points are attended to during the treatment of an injury of the shoulder in which ankylosis is inevitable, the muscles about the scapula will soon learn to increase their range of movement. To hasten this the patient should assiduously practise all possible movements of the arm.

A patient with an arm ankylosed in this position can perform all ordinary movements so unobtrusively that many people will fail to observe he has any limitation of movement at the shoulder.

Injuries about the Elbow

Whilst the elbow-joint proper has a pure hinge movement, the radio-ulnar joint, by which supination and pronation of the forearm are accomplished, is closely connected with it, and the two together are essential to full and free use of the hand. Any defect in the muscles, ligaments, or articular surfaces connected with these movements is so annoying to the patient that he declares that they make his joint 'practically useless'. This applies particularly to the numerous varieties of muscle strain which occur round the elbow, each one of which gives no trouble except in a particular movement.

The Ligaments about the Elbow-joint are :

1. Internal lateral of the elbow-joint.
2. External lateral of the elbow-joint.
3. Anterior capsular of the elbow-joint.
4. Posterior capsular of the elbow-joint.
5. Orbicular of the radio-ulnar joint.

Note that the external lateral and anterior ligaments both send strong bands into the orbicular ligament.

The joint is further supported by the mass of muscular origins and insertions closely investing it. Of these the most important are :

Behind
1. Triceps tendon, which forms a strap binding the back of the joint when the elbow is flexed.
2. The anconeus lying close to the bone on the outer side of the olecranon.

3. Pronator radii teres and the other superficial flexor group from the internal condyle.
4. The superficial extensor group from the *front* of the external condyle.
5. Biceps to the bicipital tuberosity of the radius with which a bursa is connected.
6. The brachialis anticus to the coronoid process of the ulna.

The attachments of any of these muscles may be torn or partially detached by violent movements of the elbow in handling implements of toil or sport—hence such terms as ' tennis elbow ' and ' golf elbow '.

Muscle Strains about the Elbow

Diagnosis is made

(1) by the patient's statement that only certain movements cause pain and sudden disability;
(2) by localizing the tender spot by palpation in the attachment of some muscle;
(3) by the exclusion of bone injury by an X-ray photograph.

Strain of the insertion of the Triceps may have to be distinguished from :

1. Bursitis of an adventitious bursa which is superficial to the tendon and should present no difficulty.
2. Fracture of the olecranon—which is often only an avulsion of the tip, in other cases a fracture through to the sigmoid cavity; even then the dense periosteum may prevent displacement, but the seat of fracture can usually be recog-

nized by feeling the crack in the bone. An X-ray decides the point.

3. Chronic strain of the triceps tendon may cause inflammation of the bursa situated between the tendon and capsule of the joint and gives rise to pain on pressure by the finger or on tension of the muscle.

Treatment.—Extend elbow, apply a straight splint along the front of the arm with pad over seat of injury and firm pressure to limit effusion.

1. If the injury is a recent one repair will be complete in a few days and movement will not cause pain.
2. In cases in which repeated strain has made the area of insertion tender, a firm pad alone over the seat of injury will suffice; but if acute it will be necessary to apply a splint as well. To stop strain on the triceps from being conveyed to the seat of injury apply a pad of sticking-plaster to the tendon of the triceps just above the olecranon and fix with two firm turns of strapping round the arm.
3. Very chronic conditions with a deeply seated small collection of fluid which is not absorbed may be successfully dealt with by the hot needle (Fig. 6), followed by pad and strapping.

Strain of Common Extensor or Flexor Origins.—It may be possible at times to localize the injury to one muscle, especially if it is only supination or pronation which causes pain, by carefully testing which muscular action is the cause of pain, by

passively putting strain on the various muscles, and by eliciting tenderness on pressure over the origin from the external or internal condyle.

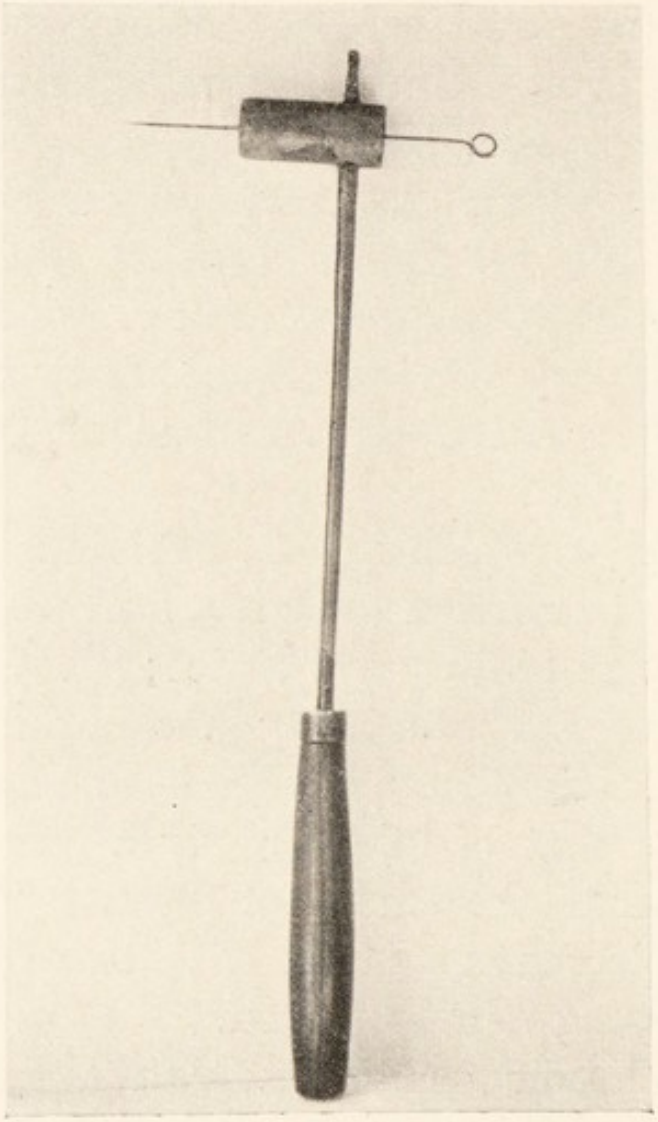

FIG. 6. NEEDLE.

Treatment.—If the injury is a recent one, fix the limb with the injured muscle relaxed, and apply pressure so as to hasten absorption and prevent effusion of fluid.

In more chronic cases a pad should be applied by

means of a strap round the top of the forearm, just below the flexure of the elbow in this case. To complete the recovery massage and graduated exercise are needed.

Brachialis anticus.—Strain of this muscle at its insertion into the base of the coronoid process is easily localized. The muscle must be relaxed by flexing the elbow, while strain is to be relieved by fixing a strap just above the elbow.

Biceps.—Strain at its insertion into the bicipital tuberosity on the radius or inflammation in the bursa under the insertion is localized by tenderness on pressure between the upper parts of the radius and ulna, but still more by the fact that passive resistance to flexion and especially supination is painful. Pain on supination distinguishes strain of the biceps from that of the brachialis anticus, for the biceps is a powerful supinator of the forearm as well as a flexor of the elbow, the brachialis anticus being only a flexor of the forearm.

Sprains of ligaments about the elbow are comparatively unimportant as the security of the joint depends much more on muscles than on ligaments. Localization and treatment are fairly obvious.

Fractures about the Elbow-joint

There is one golden rule regarding fractures of the elbow: they should all be treated with the elbow fully flexed and the forearm supinated, with the single exception of fracture of the olecranon, which requires full extension.

Fracture of the Olecranon Process.

1. It may be merely an avulsion of a small piece of bone attached to part of the triceps tendon.
2. The fracture may be right across the body of the olecranon process, but the fragment is retained in position by intact periosteum or expansions of the triceps insertion.

Treatment in either of these cases is full extension of the elbow on an anterior splint and a firm pad above the olecranon to stop the triceps from moving it. There being no displacement of fragments in the first instance, none can now occur and union will be complete in three weeks.

3. Fracture across the olecranon with displacement. Here the triceps has already contracted and pulled the fragment out of position, and it is not always easy to obtain perfect apposition and operation may be needed.

Treatment, therefore, is to operate and fix the fragment into position by a screw, a nail or kangaroo tendon, except in the very old or very young. We do not advise operation in the very old, because a reasonably good elbow is obtained by fixing with splint and pad, and the aged are not likely to indulge in very active pursuits. Do not operate in the very young, because screws near epiphyseal cartilages are undesirable; good control can generally be obtained, and an excellent result follows careful treatment with splint and pad.

It is not right to open clean joints at the seat of war, and excellent results can be obtained by fixing

the arm in full extension upon a straight splint. The triceps may be rendered sufficiently powerless to allow of adjustment of the olecranon, by placing a pad under pressure over the muscle a couple of inches above the olecranon.

Fractures about the Condyles

The great risk in fractures about the condyles is that the full range of flexion will be lost either by imperfect reduction or by excessive formation of callus, and the knowledge of this risk directs the line of treatment required.

Fracture immediately above the Condyles, although **not exactly an injury** of a joint, must be considered as such because if improperly treated the function of the joint is hampered.

The injury usually occurs by a fall on the forearm or elbow. The humerus breaks immediately above the condyles, the elbow-joint with the lower fragment is displaced backwards, leaving the lower end of the upper fragment projecting forward in front of the lower and constituting a mechanical obstruction to the flexion of the joint unless reduction is complete.

The best means of reduction—I would almost venture to say the only means of complete reduction—is a combination of complete flexion of the elbow with downward traction of the forearm. If the limb is then bandaged in complete flexion, with the forearm supinated, i.e. the palm towards the shoulder—a good result in every case of simple uncomplicated fracture is practically assured.

The tendon of the triceps muscle arranged like a strap round the back of the joint is a perfect splint. The coronoid process of the ulna tucked into the coronoid fossa steadies the lower fragment in front. No excessive callus can form in front to form an obstruction, because there is no room for it.

After three or four days, when absorption of immediate exudates is well advanced and repair has begun, and when in particular the muscles have come to rest, the elbow need not be so acutely flexed, but the forearm should be slung by the wrist close under the chin.

Between the second and third weeks, when bony union is fairly secure, the wrist may be dropped two or three inches, and the patient may practise active movements daily, producing full flexion and then allowing the arm to fall down to the limit allowed by the sling. If the movement can be satisfactorily performed the sling can be lengthened every two or three days until a right angle is reached, when it can be discarded altogether.

Rule.—In any injury or inflammatory condition of the elbow, which has been treated in full flexion with the wrist slung under the chin, the test of recovery is twofold :

(*a*) The absence of tenderness on manipulation about the joint is a sign that the second part of the test may be tried, namely :

(*b*) Lengthen the sling and allow the wrist to drop three inches. If after two days the patient can move the hand from this position back to

the neck, all is well, and a daily increase in the range of movement can be arranged.

If, however, the elbow becomes stiff in the new position, it is an indication that the joint or the structures about the joint resent movement—the muscles are on guard, and this indicates that the repair is not far enough advanced to allow movement without damaging the site of repair.

If this happens the elbow should be again put up in the acutely flexed position and an interval of a week allowed before the test is repeated.

A warning must be given against the old right-angled internal splint for the elbow. Satisfactory use of this splint is extremely difficult. Distortions about the elbow are frequently produced by its use, and it is therefore to be regarded as a dangerous device.

First, it provides no easy means of preventing backward displacement of the lower fragment. *Second,* it leaves room for the formation of excessive callus in front of the elbow. *Third,* it is very easy with this splint to press unduly on the internal condyle, tilting the lower fragment outwards and so throwing the joint out of true alinement, and this condition may not be noticed till the patient begins to use his arm—it is therefore an insidious danger.

We may therefore say that the internal right-angled splint for treatment of elbow-joint injuries is to be regarded as absolutely obsolete.

There are cases of compound injury to the elbow, such as bullet-wounds with suppuration, in which

it is impossible to treat the elbow in the fully flexed position. A simple form of extension splint for these cases will be described below under 'Compound Injuries'.

Fracture of the Condyles involving the Joint usually means a fracture running from the trochlear surface to one or both sides, breaking off one or both condyles.

This fracture is produced by falls on the elbow; the sigmoid surface of the olecranon lodged in the trochlear surface of the humerus acts as a wedge and splits the condyles, breaking off one or both with more or less splintering. This is the most common fracture about the elbow, in adults being commoner than the supracondylar variety.

Diagnosis.—The characteristic feature of this fracture is widening of the condyles owing to the split between them. There is also the usual backward displacement of the elbow, and in addition the elbow and olecranon may be displaced to one side or the other. The triceps and olecranon are intact. The X-ray photograph will show the exact nature of the split.

Treatment.—Reduction. The surgeon takes the lower end of the humerus in one hand with the thumb above one condyle and the forefinger above the other —the elbow is thus in his hand. With his other hand he pulls the forearm in the line of the limb and gently but resolutely brings the elbow into full flexion with the forearm in full supination. While performing this movement the hand grasping the

condyles feels any movement that takes place among the fragments, and by following that movement by gently grasping them they can usually be coaxed into better apposition.

Flexion must be resolute so that any fragment displaced forward is pushed aside out of the way. If any fragment is lodged in front of the joint and blocks full flexion, it should be replaced and fixed by operation should manipulation fail.

The further treatment is exactly that already described, and the most punctilious attention must be given to the rule for testing for recovery before allowing movement. Early passive movement is harmful.

The function that is secured under this line of treatment, by allowing the hand gradually to descend from the fully flexed position till the elbow is at a right angle and then discarding the sling and allowing gravity and movement to restore the tension, is usually excellent.

The range of movement will be from full flexion to some point between a hundred and thirty-five degrees and full extension. Six to eight weeks after the injury, when repair is complete, the last few degrees of extension can usually be restored by forcible movement with or without gas, followed by passive and active exercise.

The elbow often remains permanently broader than the other, which is merely a cosmetic defect, and in the presence of excellent function is not resented.

Operation.—The temptation to operate and screw

the fragments into position is very great. It is true that this operation successfully performed reduces the broadening of the condyles and therefore leaves a more artistic elbow. Some of the results of operation are absolutely perfect, but the writer's experience is that the average result from the point of view of good functional movement obtained by careful treatment without operation is rather better than that secured by operative methods.

The dangers of operation are increased to an alarming extent if performed where cleanliness cannot be assured.

Fracture of the Coronoid Process of the Ulna

Occurs sometimes in association with backward dislocation of the elbow, and is sometimes produced by muscular violence.

The injury is distinguished from mere muscular strain by the greater disability of the arm, by crepitus on local manipulation, and by the X-ray photograph.

Treatment.—All that is necessary is to flex the forearm completely; this relaxes the brachialis anticus, which is the most important muscle. The tip of the coronoid dips into the coronoid fossa of the humerus, and the parts remain in their normal positions and union will be satisfactory.

It is very rare for the fragment to be displaced so far or to be so engaged in muscles that it cannot be replaced by this means.

Fracture of the Neck of the Radius

May occur with or without dislocation of the head of the radius forwards on to the front of the capitellum or external condyle.

Treatment.—(*a*) For the simple fracture of the neck the treatment is full flexion of the elbow with the forearm supinated.

(*b*) When the head is dislocated as well as broken off, the displaced head may impede free flexion. The simplest treatment is to remove it. The lump of callus which forms round the broken end of the neck forms an excellent head under the moulding forces of the ordinary movements of the part.

Fracture of Head of Radius.—Fracture of a portion of the head of the radius is not uncommon. It is very apt to interfere with supination.

Treatment.—The rule is to manipulate until supination is easily attained. If failure results then the loose piece can be removed. One of the chief causes of 'clicking' elbow is mal-union of a small portion of the fractured head of the radius.

Dislocations of the Elbow

Dislocation of the elbow is a much more serious accident than is commonly supposed, because after this injury in the adult, impairment of function often follows, and a frequent cause of this impairment is the condition known as myositis ossificans traumatica.

Myositis Ossificans Traumatica.—This condition, which is frequently associated with dislocation of the

elbow, has not received the notice it deserves. Its onset is insidious, and when well established it results in a locking of the elbow-joint, for which no satisfactory treatment has been found.

So far as the mode of its onset can be interpreted, the following may be taken to be a fairly accurate picture.

The original injury results in considerable tearing of muscular attachment from bone accompanied by a large amount of hæmorrhage. With the torn muscular attachments fragments of periosteum and osteogenetic tissue are pulled away, and it is probably these which are the originators of the formation of new bone along the interfibrillary and intermuscular septa. There does not seem to be any way of absolutely preventing detached osteoblastic tissue from forming bone, but we can at least apply our knowledge of the behaviour of cicatrix formations in general, and take care to avoid all that will be likely to provoke the rapidly growing tissues to unnecessary activity.

The usual history is that the patient has suffered from a posterior dislocation of the elbow-joint. The X-ray photograph shows absolutely no fracture or splintering of bone; the outlines of the bones are quite clean and unbroken.

The dislocation is reduced, and after the first effusion has passed away all seems to be going well. Four to six weeks later, however, the patient begins to complain of increasing stiffness, and the practitioner very probably is tempted to resort to passive movement—which is a dangerous procedure.

An X-ray, taken when this stiffness begins, shows a suspicious cloudiness about the attachments of some muscle, usually the brachialis anticus. Two or three weeks later this shadow has become clearly defined, and may even show traces of bone structure. Some years ago we removed the whole of this new bone formation in a considerable number of cases with most unsatisfactory results, because in the majority of instances osteogenesis took place again in the region from which the bony formation had been removed—even when care had been taken to make the operation as complete as possible.

It has already been pointed out that the process of repair in an injured area will be completed with the minimum amount of cicatrix, whether fibrous or osseous, if it is left severely alone in a good position of rest ; it has also been laid down as a rule that up to a certain stage of repair movement is injudicious, because it is apt to excite further effusion and increased activity of production of formed tissues, either fibrous or osseous as the case may be.

The systematic use of X-rays has proved that myositis ossificans occurs more or less in a very appreciable proportion of dislocations of the elbow, especially in young subjects.

Treatment.—From personal experience the lesson learned has been that every dislocation of the elbow is to be regarded as a serious lesion. After reduction and fixation in full flexion, the limb must be kept at rest till repair has become absolutely complete, just as if the case were one of fracture, and that early

passive movement or permission to use the arm freely for all purposes must not be given till the stage at which osteogenetic tissues in or about the site of injury have become completely quiescent and are not likely to be excited to harmful activity.

It is interesting to note that myositis ossificans does not result from fracture of the coronoid process nearly so often as from an apparently simple posterior dislocation.

If the explanation given above is correct, the reason for this must be, first, that the break is a clean one through bone, and not a rough tear of muscle attachments, and therefore osteogenetic cells are not retracted into the muscle to the same extent ; and, second, that the fractures having been recognized, most surgeons would naturally keep the limb quiet for a longer period, so that direct union of the bone takes place, the whole process of repair is completed, by which time the period of danger is past.

The sites at which these bony deposits among muscle are most prone to form are :

1. About the insertion of the brachialis anticus.
2. About the biceps.
3. In the lower part of the triceps where the backward displacement tears the shortest fibres of the triceps from their attachment on the back of the humerus just above the olecranon fossa.

Backward Dislocations.—Backward dislocations may be directly backwards, backwards and outwards, or sometimes backwards and inwards.

1. The head of the radius may go with the ulna.

2. The ulna may pivot on the radius.

3. The orbicular ligament may give way and the head of the radius take a separate course from the ulna, forwards or outwards.

Diagnosis is made by localizing the relative positions of bony points. The particular landmarks are the two condyles of the humerus and the tip of the olecranon, which should be in line when the elbow is extended.

Fixation of the joint is characteristic of dislocation.

Treatment.—Reduction is generally easy, first by hyperextension and traction to disengage the coronoid process, then fixation in acute flexion.

After-treatment.—Two or three days later, nearly full flexion of the elbow with the wrist slung short up under the chin is required. Complete rest should be continued for three weeks, then movement may be allowed, but not work.

This seems unnecessary, but it is a wise precaution, in view of the possibility of myositis ossificans supervening, and any error in the form of too much movement may provoke excessive bone formation.

Forward and **lateral** dislocations are not so frequent as posterior dislocation. The lateral dislocation may be associated with fracture of one or other condyle.

The reduction of these deformities is usually very easy. If an anæsthetic is given, the slightest movement may cause the bones to slip back into place when the muscles are thus relaxed.

The treatment is the same as for posterior dislocation, but the fear of myositis ossificans is very much

less because these displacements, unless very extreme in degree, are associated with less laceration of muscular attachments. The after-progress should be carefully watched, and the slightest sign of increasing stiffness after movement has been free should be taken as an indication for immediate complete rest with the elbow acutely flexed again.

The Radius.—Dislocations of the head of the radius, apart from dislocations of the ulna, necessarily mean rupture of the orbicular ligament.

The head of the radius is much more closely associated with the radio-ulnar joint than with the elbow-joint, for except in extreme flexion the head of the radius does not articulate with the humerus at all, and in all positions it is in intimate relation to the ulna.

If the orbicular ligament is torn, the movements of supination and pronation may cause the head of the radius to move to and fro instead of pivoting on its own axis.

Therefore, in fixing an arm after reduction of the head of the radius, it is desirable that no to-and-fro movement should occur to disturb the immediate repair of the torn orbicular ligament.

This is most securely obtained, as a rule, by flexing fully in full supination, because then the radius resting on the capitellum cannot slip forward and can generally be easily controlled in every other direction by a pad and bandage.

The Question of Supination.—In all injuries of the elbow, the successful issue of which is doubtful, great care must be taken to preserve supination.

One will remember that in holding a cup and saucer the palms of the fingers must be facing upwards under the saucer ; if the radio-ulnar articulation becomes ankylosed or stiff in any other position, the patient cannot hold a tray, plate, or any such object horizontal, and therefore constantly spills things, and this is a daily annoyance which can be avoided by a little forethought on the part of the surgeon.

Ankylosis of the Elbow.—The common position of ankylosis of which patients complain is with the forearm at an angle of 135° or more to the upper arm. The history usually is that the arm was originally at a right angle and became stiff in that position, but the angle gradually increased afterwards, from which we learn that we must allow for gravity causing an alteration in the angle after stiffness appears to be complete.

The most useful position of the elbow is a compromise. For ease in getting the hand to the mouth, flexion at an angle of 45° is the most convenient, but then there is difficulty, for instance, in reaching over a table for an object lying on it. If, however, the angle is too great, it is impossible to get the hand to the mouth or button a coat. Hence for general purposes an angle just over a right angle is the best compromise, for by bending the head forward the patient can feed himself and yet have a fairly long reach.

Compound and Septic Wounds of the Elbow.—Bullet-wounds in the present war, so different from those of the Boer War, have nearly all been septic, and many have been through and in the immediate

neighbourhood of the elbow-joint, especially in the left elbow.

The risks of bony ankylosis would seem to be very great, as frequently the bullet has shattered bone or ploughed through the joint, injuring joint cartilages.

In spite of the havoc of splintered bone and pro-

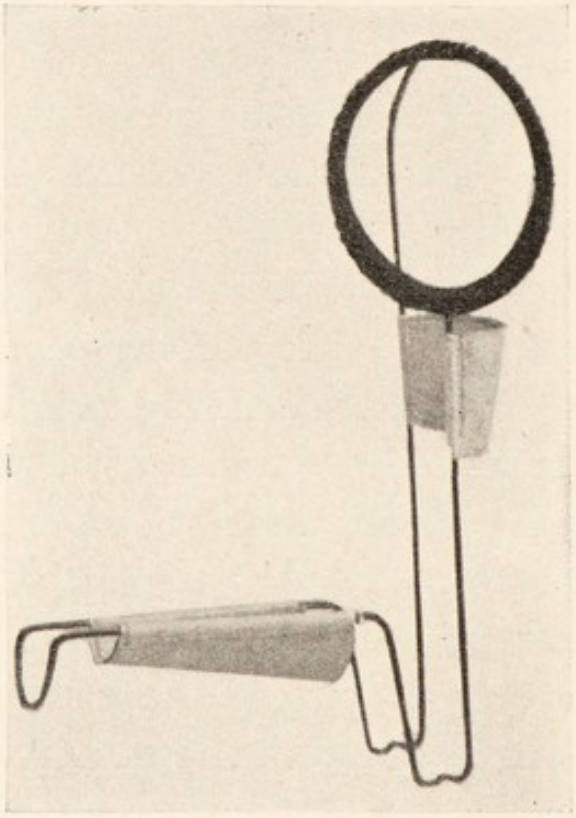

FIG. 7. ELBOW EXTENSION SPLINT.

longed suppuration, many cases are recovering with a surprising range of movement.

For many months after the inflammatory symptoms have subsided the mobility of the joint can be increased if the general principles already referred to are applied. To attempt to break down adhesions in the traditional manner is to invite failure. By waiting until pain subsides and then gently increasing the range of movement by an alternate 'stretch and

rest', the author has been able to obtain excellent function in elbows where an X-ray photograph could offer neither hope nor encouragement. During the

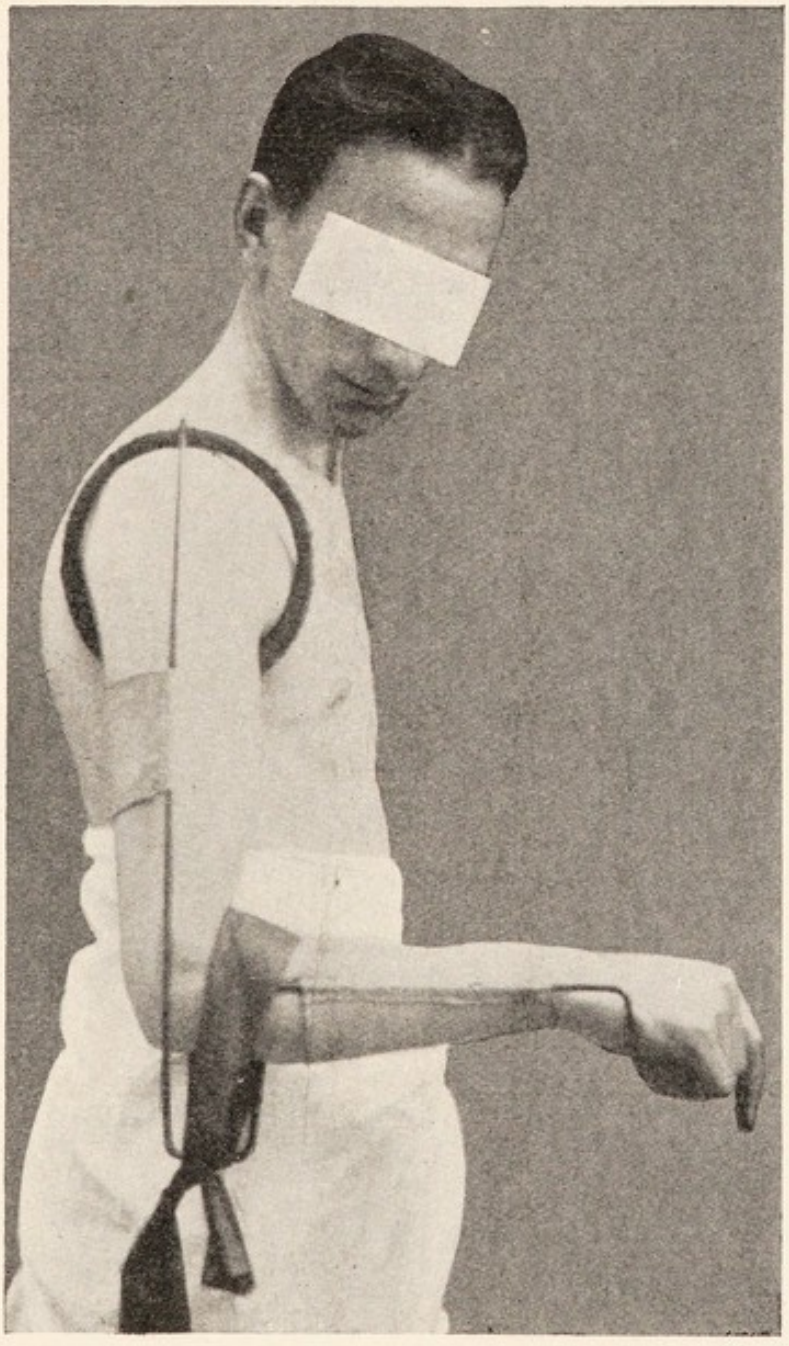

FIG. 8. ELBOW EXTENSION SPLINT. APPLIED.

suppurating stage a splint should be used which allows of easy access to the wound while the elbow is kept fixed (Figs. 7 and 8).

Injuries of the Wrist-joint and Carpus

Strains of some of the Muscular Attachments about the carpus are not uncommon, and the relief afforded by a firm strap round the wrist is well known to the working man.

In addition to these, we have synovitis in the tendon-sheaths, often brought on by a hard spell of some unaccustomed form of work, such as rapid trench-digging or lifting weights.

Bricklayers, for instance, are prone to a synovitis of the sheath of the extensors of the left thumb (ext. ossis metacarpi and ext. primi internodii pollicis). It is almost invariably on the second day of work after a long period of rest that this condition shows itself. It is the repeated full abduction required in picking up and laying bricks that brings on this condition in muscles which are out of training.

For these simple but often disabling conditions the best treatment is a few days' rest, with massage and firm bandaging, followed by gentle exercise. If neglected in the first instance, the slight effusion and considerable tenderness may become chronic, with acute exacerbation, whenever the patient attempts to work.

Sprains of the Wrist.—If an X-ray photograph is taken of every 'sprained' wrist it will be found that a very large number of them are really cases of fracture of some bone of the carpus, or of a styloid process, and not merely an injury of a ligament.

Fracture of a carpal bone, if the patient is careless and uses the wrist roughly, may result in considerable permanent stiffness.

Rule.—Every injury about the wrist below the level of a Colles' fracture may be safely treated with the wrist dorsiflexed (Figs. 2 and 3). Once the wrist has been put into this position, and fixed on the splint shown, the patient may move his fingers after the first effects of the accident are past, without any fear of disturbing repair.

If the lesion results in ankylosis of the wrist, the grasp of the fingers will be good if the hand is dorsiflexed—a fact known to every schoolboy who first flexes the wrist of an opponent when he wants to break his grip. The result of treatment of wrists in any other position is very often stiffness in a position of partial flexion, in which the grasp of the hand is weak. Dorsiflexion of the wrist may in some cases of injury about the joint not be really essential, but it can never be wrong.

Fracture of the Carpus.—Like sprains of the wrist, fractures of the carpus are usually produced by falls on the hand. The bone most commonly fractured is the scaphoid, and it is usually broken right across its narrow part.

The characteristic point in making a clinical diagnosis is that the maximum tenderness and swelling are found on pressure in the 'Anatomist's snuff-box', the name given to the hollow between the tendons of the extensor ossis metacarpi pollicis and extensor secundi internodii pollicis. If this is found, the

'sprain' is usually a fractured scaphoid; the diagnosis may be confirmed by X-ray.

This fracture is easily distinguished from Bennett's fracture of the base of the first metacarpal, as in the latter case maximum tenderness is half to three-quarters of an inch lower down on the ulnar side of the metacarpal, just at the upper end of the first intermetacarpal space. One half of the scaphoid is often dislocated, usually on to the dorsum.

Treatment.—Put the wrist into the dorsiflexed position, or, if this is not possible because a displaced fragment on the dorsum blocks the movement, first try to reduce the displacement by flexing the wrist and pressing the fragment down into its place; if successful, dorsiflexion will be easy.

If this is not successful an attempt should be made to push the displaced fragment out of the way by forcible dorsiflexion. If this method is unsuccessful, no time should be wasted, but an incision should be made over the offending fragment and usually the smaller one removed. By ensuring that the wrist is in complete dorsiflexion before he leaves it, the surgeon will save the patient weeks of trouble and will be sure of a good movable joint in a case which might have ended in a stiff one. The wrist should be kept dorsiflexed for two or three weeks.

In old-standing cases where stiffness has occurred, it is often necessary to administer gas and wrench the wrist into dorsiflexion in order to improve the value of the hand. The hyperextension splint (Fig. 2) must then be worn continuously for three

or four weeks, and at night for some weeks more to prevent contraction during sleep. Operation in the chronic case is only partially successful.

Dislocations of the Wrist and Carpus.—Colles's classical description a century ago of the fracture of the lower end of the radius which goes by his name,

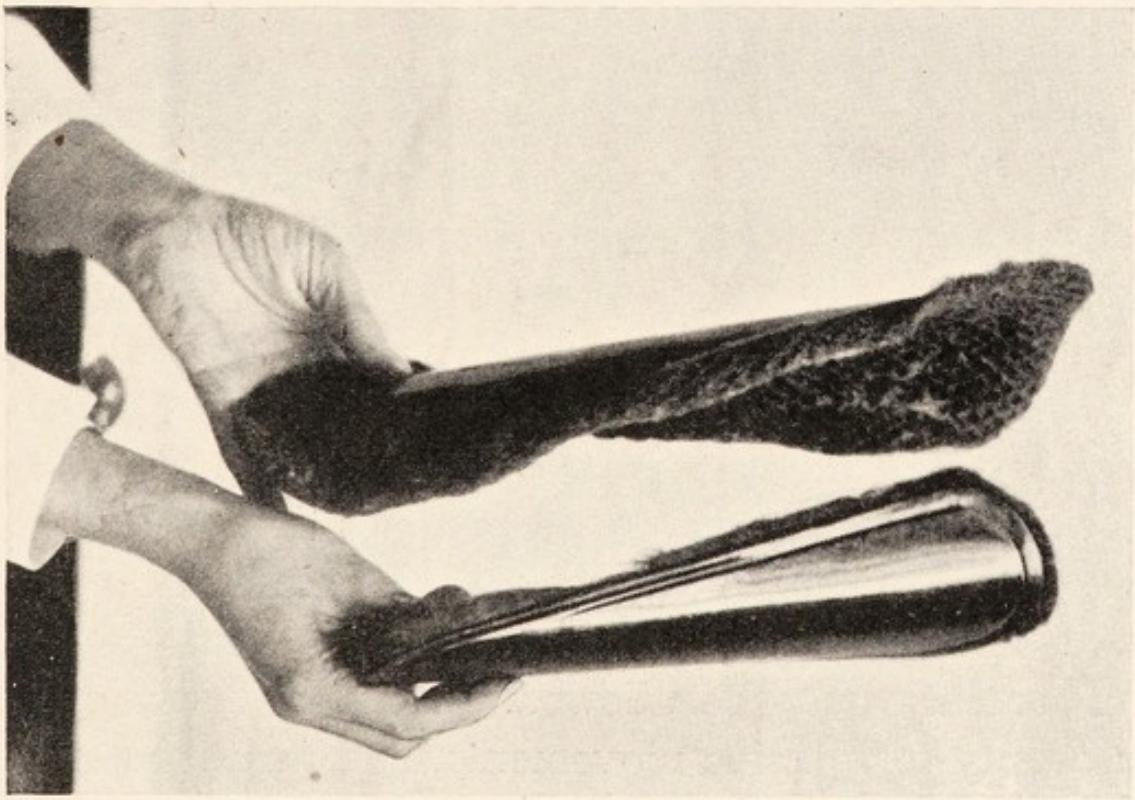

FIG. 9. COLLES'S FRACTURE SPLINTS.

definitely put an end to the confusion between this condition and dislocation of the wrist.

In dislocation of the wrist-joint (radio-carpal joint), a comparatively rare injury, the displacement is below the radius, and the styloid process of the radius is in its normal position and relationship to the head and styloid process of the ulna. In Colles's fracture the

displacement is half to three-quarters of an inch above the wrist-joint, and even if there is no displacement, tenderness on pressure half an inch above the wrist distinguishes a Colles's fracture from any other. Definite pain on pressure localized at one point in a bone which is either a common site of fracture or in a particular case a suspected site of fracture, is an almost certain proof of one, and should be regarded as such till an X-ray photograph proves that there is no fracture, and then it is certain that the localized tenderness is due to bruising of the periosteum from direct violence, giving rise to a localized inflammatory periostitis.

The dislocation, whether backward, forward, or lateral, is usually easy to reduce. Fixation for purposes of resting the part efficiently is most easily secured in a slightly dorsiflexed position. Massage may be commenced at once ; if all pain and tenderness have disappeared after a week, gentle active movements may be allowed. There is usually no necessity for passive movements, and as a matter of experience, disabling adhesions do not commonly occur in a wrist fixed in dorsiflexion.

Fracture of the Posterior Part of the Lower End of the Radius, not including the styloid process or anterior border of the articular surface (Barton's fracture), may occur as a complication of a posterior dislocation.

Diagnosis :

1. It is not a Colles's fracture, because the styloid process of the radius is in its normal position with

respect to the styloid process of the ulna ; and further, on running a finger down the palmar aspect of the radius on to the styloid, the point of tenderness characteristic of a seat of fracture is not found.

2. Such a point of tenderness is found in the dorsum of the radius, probably with crepitus.

Treatment is the same as for Colles's fracture.

Colles's Fracture.—Colles's fracture, in its typical form, is one in which the radius breaks about three-quarters of an inch from the lower end ; the lower fragment being displaced backwards, and usually rotated towards the ulnar side, producing the characteristic dinner-fork deformity. It is produced by a fall upon the outstretched and pronated hand.

The fragments may engage strongly and are sometimes impacted.

The posterior displacement and rotation puts the joint out of true relation to the normal action of muscles ; further, the posterior border has several grooves through which tendons run, and when this is displaced backwards it acts as a check on the tendons and is a very material factor in producing functional stiffness of the wrist.

It is therefore desirable that the displacement should be fully reduced, and the normal lines of muscular action restored.

Treatment. Reduction. The traditional method of reduction, by taking a grip of the hand as if shaking hands, still appears in text-books. It is quite inefficient in any stubborn case, for it is mechanically impossible to try to replace a small fragment like the

detached lower end of the radius by traction and manipulation through a chain of small bones like the metacarpus and carpus through their ligaments.

The grip the author uses is shown in the figure

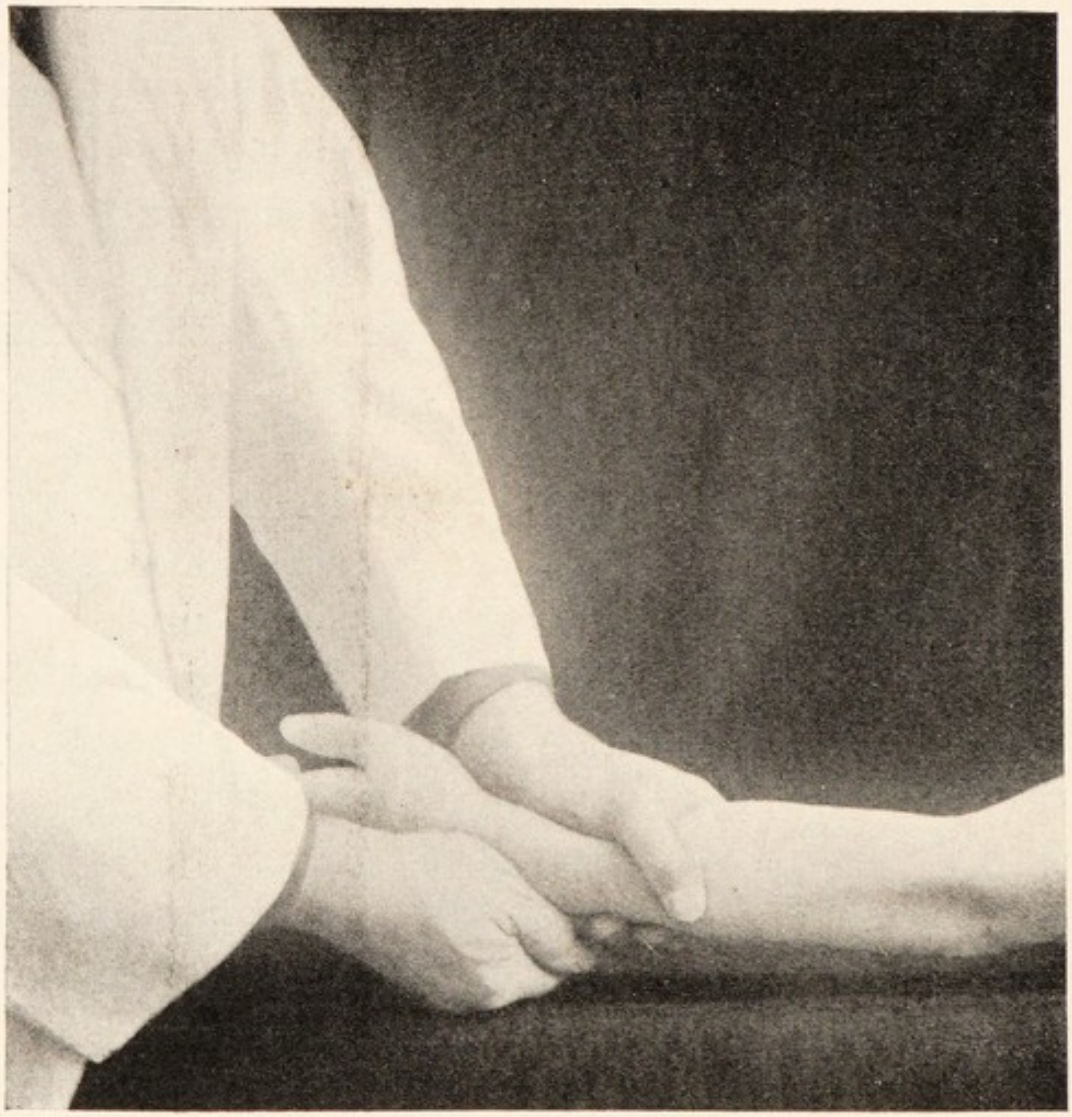

FIG. 10. COLLES'S FRACTURE, MANUAL REDUCTION OF DEFORMITY.

(Fig. 10). To reduce a left Colles's fracture, the surgeon takes the patient's arm in his left hand, with his own scaphoid tubercle against the projecting lower end of the shaft ; he then places his right hand

on the dorsum of the patient's wrist with his own scaphoid on the projecting lower fragment. A firm grip with a slight traction and twist of the wrist completely reduces the deformity. It requires knack rather than strength.

The anterior aspect of the radius has a distinct concavity at its lower end, and the inferior anterior margin projects considerably. If this curve is reproduced reduction is complete.

The fragments can be retained in position by slight pressure of the finger and thumb, one on the upper fragment just above the seat of fracture, and the other on the dorsum of the wrist-joint and styloid process to prevent it from rotating backwards and outwards.

The tendency for the deformity to recur is not great if the reduction is complete, therefore the fracture is put up by placing a pad of wool on each of these two points, and retaining the pads in place with splints (Fig. 11).

The splints the writer uses are made of thin sheet metal. A slight twist is put on these to make them wrap spirally round the limb, keeping the wrist pronated (Fig. 9).

The **Posterior Splint** extends from the external condyle of the humerus to about the middle of the metacarpals, and runs spirally from the ulnar side at the elbow to the radial side below.

The **Anterior Splint** on the palmar aspect of the forearm has the twist in the opposite direction, and must stop short of the thenar eminence.

A firm band of strapping holds these together at the carpus, keeping the wool pads in place ; another

at the upper end of the forearm holds the splints on. The spiral twist of the posterior splint is *against* the direction of rotatory deformity (Fig. 12). The fingers are left free: the play of the finger tendons over the seat of the fracture cannot do any harm when

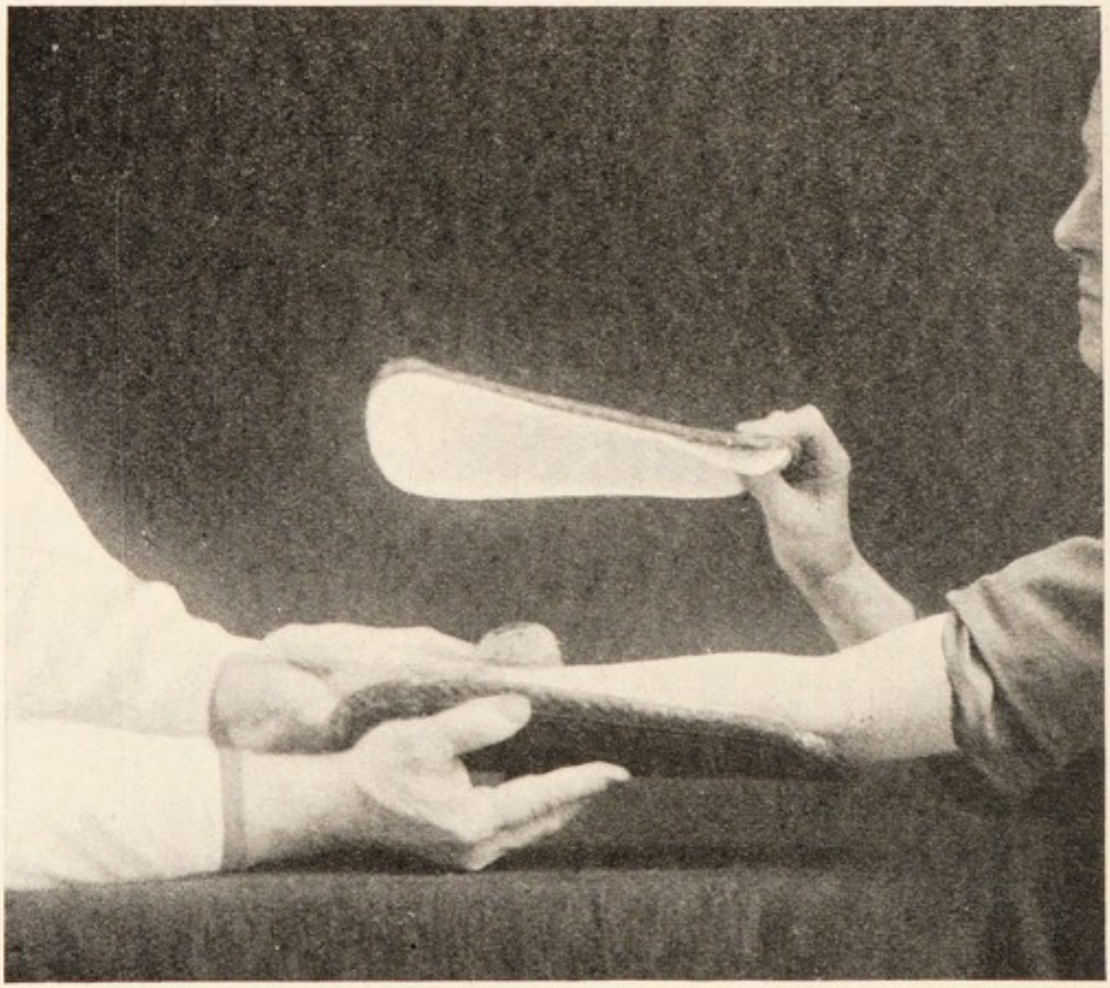

FIG. 11. COLLES'S FRACTURE, APPLICATION OF PADS AND SPLINTS.

reduction has been complete. The forearm is slung at a right angle. A Colles's fracture properly reduced never gives trouble.

After-treatment.—No movement which can strain the newly formed callus should be allowed for three or four weeks. It is not uncommon for patients to

complain of stiffness and disability for weeks after they have sustained a Colles's fracture. This condition occurs only when reduction has been incomplete.

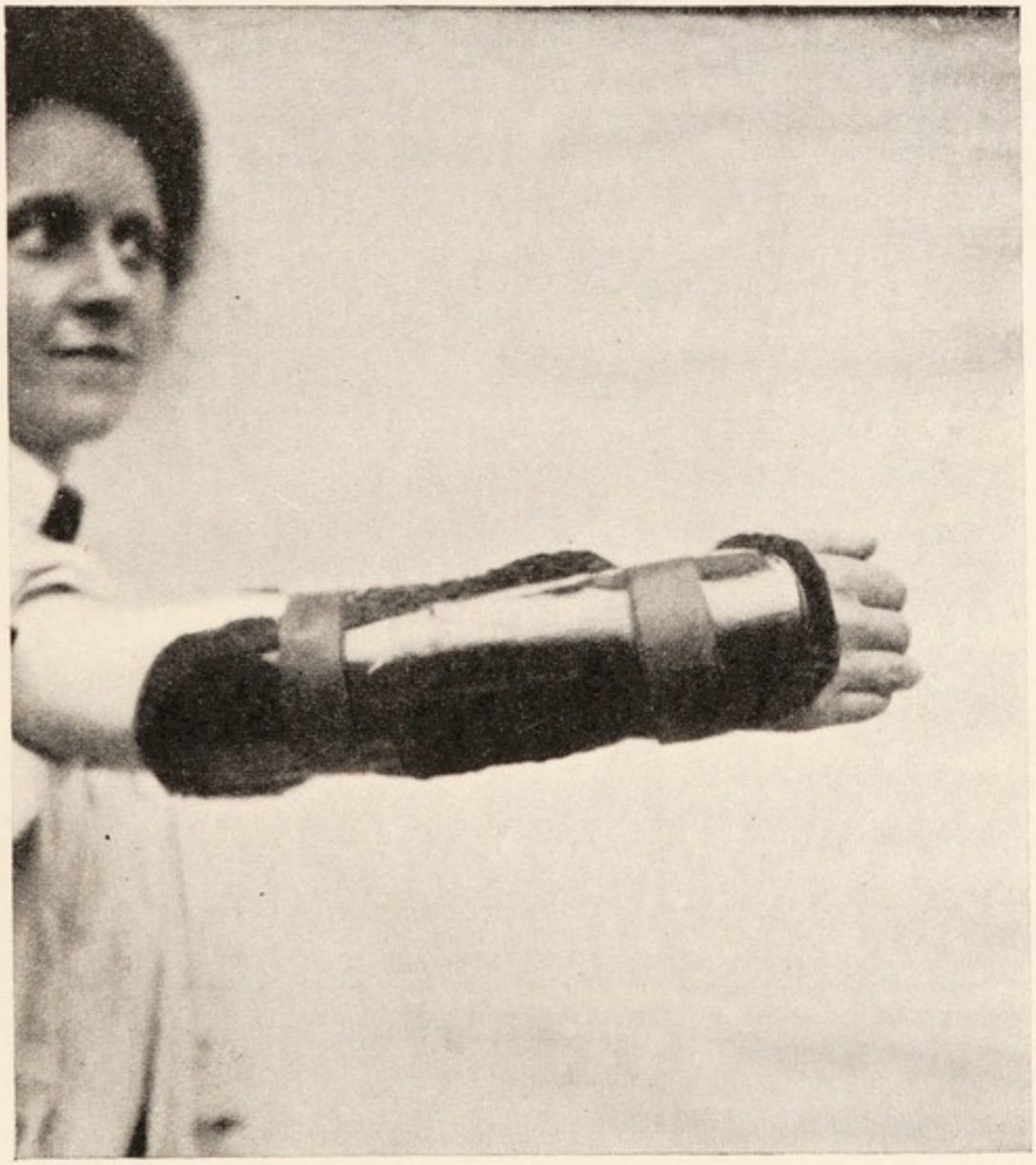

FIG. 12. COLLES'S FRACTURE PUT UP.

Mal-union is unfortunately still far too common. The usual faults are imperfect reduction, and strain of the newly formed callus by injudicious passive movement or too strenuous use.

It is true that in a well reduced case the patient can use his wrist at the end of the fortnight, but there is a penalty attached to this, for any rough movement may strain the callus, when the whole wrist will become stiff and painful. If the mistake is made of trying to overcome this by rough movement, the condition will probably get worse instead of better.

The author's practice is to keep the splints on for

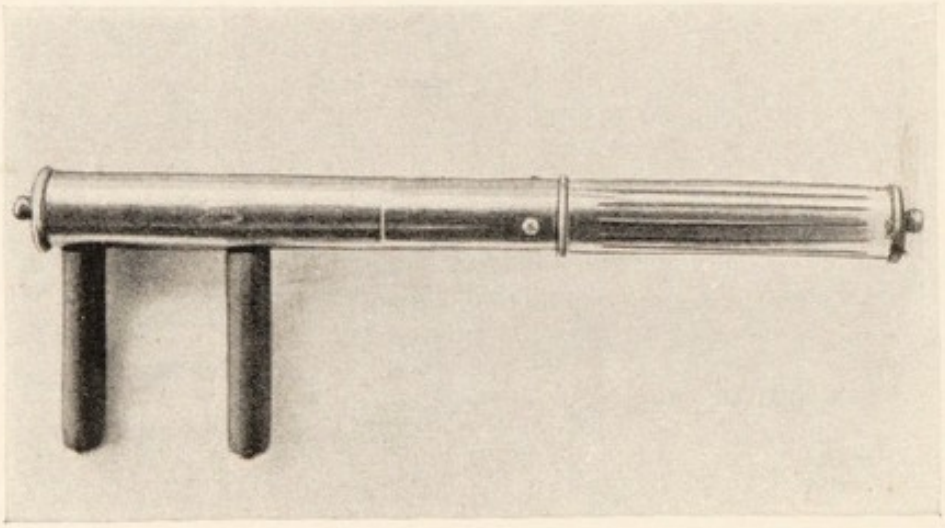

FIG. 13. THOMAS'S WRENCH.

three weeks, allowing light use of the fingers as soon as the patient likes. After that the anterior splint should be retained, while the patient gradually accustoms the wrist to ordinary work.

Massage is most effective when the fracture has thoroughly united.

Mal-united Colles's fractures of many weeks' standing can be reduced under an anæsthetic by manipulation, or by a Thomas wrench (Figs. 13, 14).

Bennett's stave of the thumb or fracture of the base of the metacarpal is the 'sprained' thumb of

the prize-fighter of former days. The fracture consists of an oblique split of the base, the corner next the index-finger being broken off.

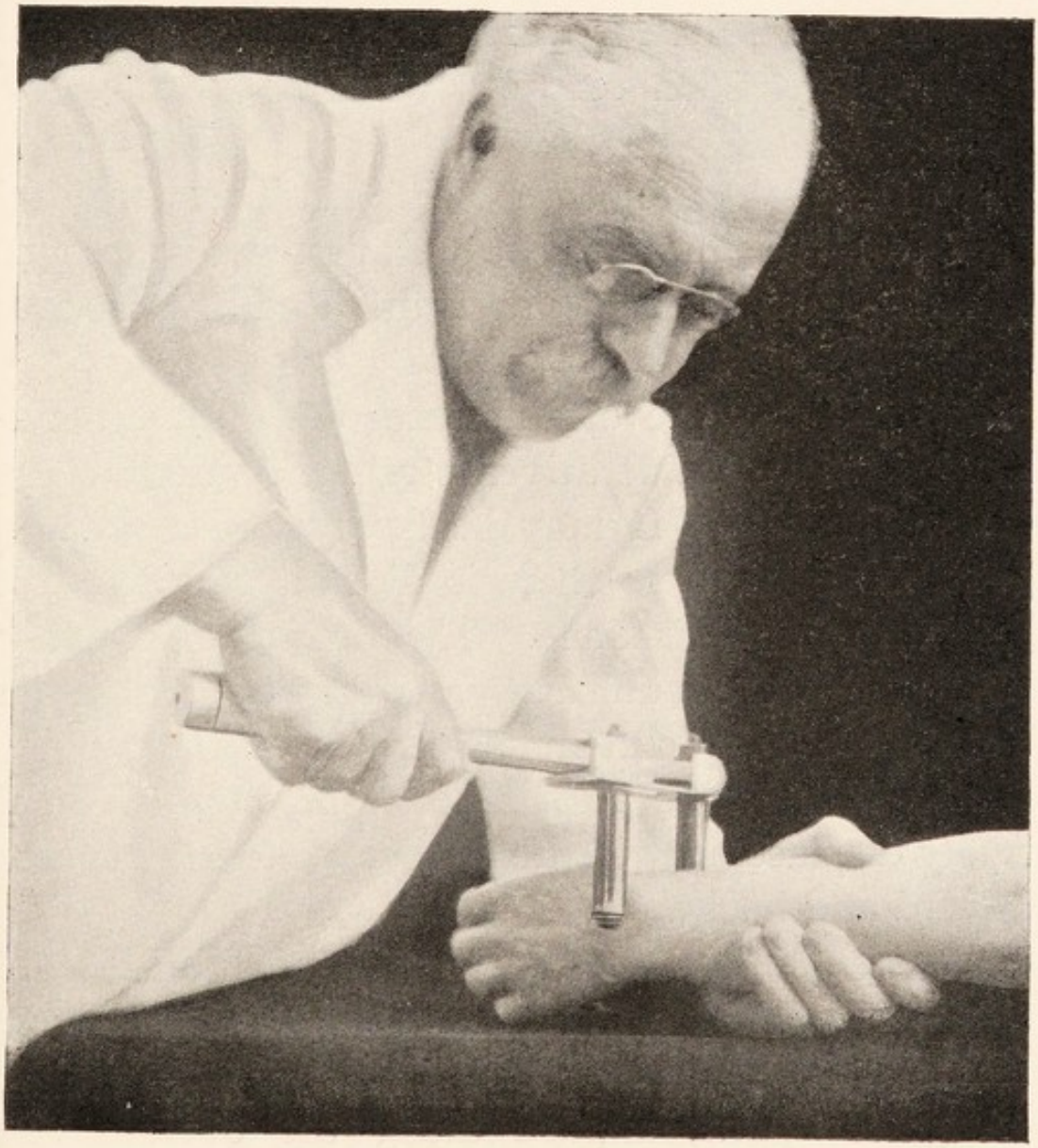

FIG. 14. COLLES'S FRACTURE, THOMAS'S WRENCH APPLIED.

Diagnosis.—It is diagnosed by a complaint of a 'sprained' thumb, which on examination is found to be specially tender just at the angle between the first and second metacarpals, with irregularity of the

base of the first metacarpal and perhaps crepitus. The diagnosis is completed by a radiograph. The disability which follows is impaired mobility, especially difficulty in abducting and adducting the thumb.

The best position for treatment is with the thumb held in the position occupied when holding a glass of water.

A shoehorn-shaped gutter-splint of thin sheet metal with two strips of strapping, one at the wrist and one at the interphalangeal joint of the thumb, suffices to fix it.

Impacted fracture of the base of the first metacarpal, with the shaft driven straight down into the base, also occurs. It may be firmly bandaged, and left to repair *in situ*; there is distinct shortening of the thumb if this is done. The functional result is satisfactory after a sufficient period of rest to let repair be complete before putting any strain on the thumb.

Dislocation of the First Metacarpal at its base is usually displacement of the metacarpal on the carpus outward and backward.

Diagnosis and reduction present no special difficulty, but retention of the bones in position is more difficult unless a suitable splint is used.

A gutter-splint, applied along the dorsum and outer side of the thumb, will meet the case.

Retention should be continued for three weeks, for the action of the flexor muscles tends to lever the base out of position again.

Dislocation of the Metacarpo-phalangeal Joint of the Thumb.—The typical dislocation is displacement

of the phalanx backwards on the head of the first metacarpal. The injury is caused by hyperextension of the thumb, and is associated with tearing of the anterior part of the capsule. According to the classical description there are two degrees of dislocation. In the first degree the phalanx remains balanced on the dorsum of the head of the metacarpal, the two bones being at a right angle to each other. The second degree is produced by an attempt to reduce by traction where the anterior lip of the base of the phalanx slips back over the head and the two bones overlap.

Undue prominence has been given in books to the difficulties caused by entanglement of the head of the metacarpal between the flexors of the thumb.

Recent cases can usually be reduced in the first instance. Some unreduced cases can only be reduced by open operation.

Treatment.—Reduction is effected by hyperextending the thumb and pushing and levering the phalanx **base first** over the head of the metacarpal. Traction is absolutely useless.

The joint is placed in the shoehorn-shaped splint already described, and with ordinary care there is little tendency to recurrence.

Old unreduced cases often require operation. The writer uses a lever, which is introduced from the dorsal aspect under the phalanx and over the metacarpal, and in this way the metacarpal head is brought into position.

CHAPTER VII

INJURIES TO THE SPINAL COLUMN

It is impossible to deal fully with the large subject of injuries to the spinal column here. It must suffice to give some general advice on diagnosis and treatment.

The vertebræ articulate in three ways: by their bodies, by their articular processes, and by the ligaments connecting the spines and the transverse processes of adjacent vertebræ, and are further intimately bound together by a very complicated series of spinal muscles.

In making a diagnosis of an injury of the back it is desirable to examine the patient as soon as possible before complications arise to mask the symptoms.

The surgeon must endeavour to apply the principles already laid down for guidance in diagnosing injuries of other less complicated joints.

Setting aside the question of injuries of the spinal cord, graver injuries of the vertebræ correspond to essential injuries of joints, and movement will be restricted in every direction by the guarding action of muscles. It must be remembered that fracture right across the body of a vertebra frequently occurs in the lumbar, and sometimes even in the cervical region, without displacement of the fragments and without

compression or injury of the spinal cord. In such cases the absence of paralytic symptoms may lead the surgeon to overlook the gravity of the case.

Such injuries are produced by heavy falls and blows. If the patient is able to sit or stand, which is rarely the case, the weight of the trunk on the injured vertebræ causes a dull aching pain, which becomes acute on any attempt at moving. Examination will show that forward flexion, lateral flexion, and backward flexion are all guarded, the injured region of the back being held rigid by the muscles in every movement.

On the other hand, if the injury is merely bruising or strain of the muscles of the back, the patient will resent forward flexion because it puts tension on injured muscles and ligaments, while if the surgeon places his hand on the back and asks the patient to lean back over it, passively, not actively, he will flex backwards with comparative freedom.

This backward flexion is purely passive. If, however, the patient lies down and is asked to arch his back, he cannot do it without pain, for he is actively using the injured muscles. It is very important to distinguish clearly between flexions which are passive and those which are active.

Similarly, when the injury to muscles or ligaments is unilateral, one side flexion may hurt and not the other, thus enabling an approximate diagnosis to be made.

The Position of Rest for Spinal Cases.—Should deformity follow an injury of the spinal column, it

is always angular flexion (kyphosis) with or without lateral curvature (scoliosis).

The weight of the head and shoulders helps to produce the deformity, and once produced tends to aggravate it. It may be laid down as a rule that a bowed back is mechanically weak.

All grave and doubtful injuries of the spinal column should therefore be put at rest in a slightly dorsiflexed position. A double Thomas frame with a head-piece secures this and gives complete control; the patient can be carried about on it and easily nursed with a minimum of disturbance.

Localization by Tenderness.—The great groups of muscles of the back lie on either side of the vertebral spines. Therefore, when a muscle is strained or torn, by forcible flexion or by an effort of lifting, or by a direct blow, tenderness will be found to one side or other, not in the middle line. Tenderness on percussion or pressure in the middle line on a vertebral spine is indicative rather of injury to the spinous processes.

Crepitus and mobility and pain near the surface on manipulating a spinous process is a positive sign of a fracture of the spinous process.

In cases of injury of a vertebral body or intervertebral disc, it is rarely possible to obtain definitely localized tenderness by pressure on a spinous process.

The diagnosis of stiff backs, due to adhesions and those due to graver lesions, will be given below. All doubtful cases, cases which for the moment do not allow of accurate diagnosis, and cases associated with

injuries of limbs, can be treated on the Thomas frame with head-piece, in the first instance, with perfect safety.

Fractures.

Cervical Vertebræ.

1. Fractures of the spines are rare; the spines are short and deeply embedded in muscles.

2. Fractures of the body and dislocations of the cervical vertebræ are not uncommon, but are so often fatal that cases which come under active treatment are comparatively rare.

The cases which survive are those of partial dislocation and fracture of the body with only a partial slip of one fragment.

(*a*) Dislocation of the atlas forwards on the axis is sometimes not fatal, particularly if it is associated with a fracture of the axis allowing the odontoid process to go forward with the anterior arch of the atlas.

Diagnosis.—The chin is depressed on the neck and the spine of the axis is felt as a prominence behind. In the normal neck it is too deeply situated among the muscles to be easily felt. The only cervical spine which can normally be felt is that of the seventh vertebræ.

Treatment.—An anæsthetic should be given; the surgeon draws the patient's head up over the end of the table, and extends and hyperextends gently to reduce the displacement. The hyperextension should be maintained after reduction.

Fixation of Neck Injuries.—A most efficient

emergency splint can be made out of a newspaper and a triangular bandage.

The whole newspaper should be folded and refolded; its length when folded should be just long enough nearly to encircle the neck.

The middle should be as wide as the distance from the top of the sternum to the chin, with the head held up.

The ends should taper a little to fit under the occiput. This is rolled up in the triangular bandage; when put round the neck the ends of the bandage cross behind and are brought round and tied in front.

The top of the collar supports the jaw and the tips of the mastoid processes, and is a great comfort to the patient in all cases of injury to the cervical spine or its musculature.

(*b*) Partial dislocation and fracture of the body also occurs commonly by a fall from a horse. The third and fourth cervical vertebræ are usually injured.

Sometimes only one side of the upper vertebræ or fragment is displaced forwards.

Diagnosis.—The patient holds his head rigidly in a flexed and wry-necked position, but accurate diagnosis cannot be made without the aid of radiography.

Treatment.—Reduction should be attempted under an anæsthetic as above, the traction being accompanied by lateral flexion to disengage the displaced side of the vertebræ.

Fixation after Reduction.—In dislocation and fractures of the bodies of the vertebræ the spinal cord is usually injured against the upper edge of the body of the vertebræ below the displacement, therefore flexion of the neck must be studiously avoided, both in manipulation and in after-treatment. When reduction has been effected, the head and neck must be fixed at once in hyperextension. The most efficient means is plaster of Paris fitting close up to the jaw and mastoid processes and including the upper part of the trunk.

It is difficult to say what should be done in the field. To remove a patient with a broken neck may destroy his only chance of recovery. If the muscles are relaxed it would be sound practice to hyperextend and reduce at once, slipping a folded coat under the shoulders and back of the neck. To prevent sudden flexion of the neck in a jolting ambulance, a collar should be improvised to hold the jaw up. The newspaper collar described above should be taken as a pattern, a broad strip of bark, leather cut from a saddle, or any other available material being used for stiffening, and the sides of the head should be steadied on the stretcher with sand-bags.

Dorsal Region.—The dorsal region of the vertebral column is so well buttressed by the ribs that fracture of the bodies is practically unknown, except in severe crushing injuries, which are usually fatal from rupture of internal organs.

Fractures of the spines of the vertebræ, however, are here comparatively common. They are not

important, apart from the rare occurrence of fragments being driven in and pressing on the cord (*vide infra*).

The Lumbar Region.—In the lumbar region, as in the neck, heavy falls with the body curled up are liable to produce fractures of the bodies of the vertebræ. Owing to the interlocking between the articular processes dislocation without fracture is almost impossible ; but by reason of the great strength of the anterior and posterior common ligaments, and the strong psoas and erector spinæ muscles supporting the vertebræ, fracture frequently takes place without serious displacement.

Further, as the spinal canal only contains the cauda equina and not spinal cord, it naturally follows that cases of fracture of the vertebral bodies which survive to receive surgical treatment are relatively common.

The injury is often overlooked, for it is often accompanied by other injuries and so the graver spinal lesion escapes immediate notice. If the diagnosis is missed and the patient allowed up at the end of three or four weeks, the continuance and increase of pain in the back with the loss of the natural lumbar lordosis, and the appearance of a slight lumbar kyphosis, should rouse suspicion, and the patient should be immediately put on his back on a Thomas frame well arched to restore the lumbar curve before the fracture is too firmly set.

Duration of Treatment.—So far as the bone lesion is concerned, cervical fractures, if promptly treated, should be firmly united in a month, and if there is

no paralysis there is no reason why the patient should not go about with the head supported.

Mid-dorsal lesions require more time, as they have to bear more body weight, but the spinal support carries the shoulders on the pelvis sufficiently well for the patient to get about fairly early.

In the case of lower dorsal and lumbar regions it is practically impossible to carry the weight of the head and shoulders from the pelvis without letting some strain fall on the seat of fracture, and strain means deformity afterwards. Therefore these cases must be kept recumbent for at least ten weeks before any liberty of movement is allowed them.

Poroplastic supports are unsatisfactory in children, and quite inefficient in adults.

Stiff Back following Injuries

In patients who have recovered from the immediate effects of an injury to the back, the diagnosis of the cause and the subsequent treatment adopted depend on being able to differentiate between various lesions. They fall under three types :

1. Stiffness due to adhesions among the muscles of the back, due to cicatrization following tears and strains of muscles.

2. Stiffness, pain, and local deformity due to a fracture of vertebræ which has been overlooked.

3. Stiffness due to an osteo-arthritis of many of the joints of the vertebral column.

1. **Cicatricial Adhesions among Muscles.** The patient is able to go about, but generally complains

that he cannot stoop, or when he has stooped can only get up again with difficulty and some pain.

On examining the back, the spinal column is rigid to forward flexion, but the patient can bend back passively over the surgeon's hand to a much greater extent, while lateral flexion may be fairly free. Some localized points of tenderness may be discovered among the muscles, not in the middle line.

The X-ray photograph should exclude a gross lesion of the vertebræ. The bones will be found clear in outline but rather thin in texture from disuse atrophy.

Treatment.—The adhesions should be thoroughly broken down, and the patient exercised afterwards. To break down adhesions in the back the patient should be anæsthetized, the thighs fully flexed on the trunk with the knees extended to stretch the hamstrings and buttock muscles, then the movement should be continued, rolling up the trunk very much as a hedgehog rolls up.

Half-hearted attempts only lead to recurrence; thorough manipulation is followed by most gratifying recovery. Next day the patient is made to touch his toes with his hands, and is exercised and massaged, and the adhesions not allowed to recur.

2. **Fracture of a Vertebræ** which has been masked by other injuries soon makes itself apparent if the patient is allowed up four or five weeks after the injury. He will definitely complain of increasing pain and stiffness, and the tenderness becomes

localized. A section of the spinal column is found to be rigid in every direction, for some two or three vertebræ above and below the point of maximum tenderness. A kyphosis is sometimes found in the suspected region. Treatment is that for fractured vertebræ.

3. **Traumatic Spondylitis** is an osteo-arthritis with rarefaction of the bone, due to opening out of the Haversian spaces to allow of increased vascularity, and corresponds to the changes which occur in a contused shoulder-joint when the articular cartilage is injured and must be vascularized before it can be repaired.

Diagnosis.—The back is stiff and painful. There is a long slight kyphotic bowing, which is quite different from the sharp angular kyphos of collapse of the body of a vertebræ found in tuberculous spondylitis, or the sharp localized kyphos due to fracture. The lesion here is probably a bruising of intervertebral disks and articular cartilages by a heavy fall which has forced the vertebræ against each other. The general tenderness and signs of rarefaction are due to the increased vascularization incidental to repair of fibro-cartilage. Whether this explanation is strictly applicable to any particular case does not matter: it suggests the nature of the histological changes and provides a guide to the line of treatment in this type of stiff back.

The X-ray photograph shows the bone less dense than normal, but the outlines at the edges of the vertebrae and about the articular processes are hazy,

not sharply outlined—evidence of the general osteo-arthritis, and is very similar to that which occurs in rheumatoid osteo-arthritis of septic origin, only in this case it is definitely associated with an injury.

Treatment.—Rest on a proper spinal support, to allow all repair to be completed before the tender vertebræ are required to carry any weight, is all that is required. The patient next gets up in a spinal support which steadies the spine while it learns to carry weight. The support is next removed for massage, and full recovery may take place if care be taken and hurry avoided.

Paralyses associated with Injuries of the Spinal Column.—The spinal cord may suffer injury in connexion with injuries of the spinal column.

1. Hæmorrhages may occur in and about the cord as the result of violent flexions even when there is no fracture or dislocation. If the hæmorrhage is in the cord there may be disturbances of sensations to heat and cold as in syringo-myelia. Hæmorrhages about the cord cause paralysis by pressure (both motor and sensory, more or less complete); the paralysis tends to pass off as the blood-clot is absorbed. In these as in other partial lesions the later stages of paralysis tend to be spastic in type, due to pyramideal track interference. These can usually be treated by massage and assiduous education in voluntary movement.

2. In fracture of the body, as in dislocations, the upper part tends to slip forward over the lower and the

cord is nipped against the posterior and upper border of the vertebræ below the displacement.

When partial injury of the cord occurs, motor palsy is generally more marked than sensory, and the result is a spastic paralysis with flexion deformities of the lower limbs, as in spastic paraplegia. The prognosis is not as good as in cases of mere interception by pressure of blood-clot, for some of the nerve tracks may be torn and permanently interrupted.

3. Total severance of the cord means complete immediate motor palsy of the flaccid type with complete sensory paralysis below the lesion and a hyperæsthetic girdle above it. In the cervical region this is fatal; in lower regions it may not immediately endanger life, but there are the usual risks of bladder infection and atony.

There is not space here to go into detail regarding the segmental supply of the body and accurate localization, but merely to indicate broad lines of distinction.

Gunshot Injuries.—In gunshot injuries the bullet or splinters of the hard bone of the neural arches may lodge in the cord or press against it. The associated palsy helps to localize the offending bullet or fragment of bone. Signs of direct pressure on the cord call for operation to remove the bullet or splinter of bone. Sepsis about the track of a wound with a bullet lodged near the canal, is an indication for operation to remove the bullet and drain and disinfect the wound.

The wound should not be probed merely to find out where the bullet is: it involves a risk of introducing

sepsis, and is of much less value than an X-ray photograph.

The use of a probe as a guide when operating is quite a different thing, for then the wound is to be opened up and drained. The bodies of vertebræ are generally perforated by bullets without much splintering; it is the hard bone of the various processes which splinters on injury.

CHAPTER VIII

JOINTS OF THE LOWER LIMB

The Hip-joint

THE integrity of the hip-joint depends on the deep ball-and-socket arrangement of the head of the femur and the acetabulum, and on muscular action more than on ligaments. The only ligament of any importance is the ilio-femoral, the so-called ' Y-shaped ligament of Bigelow '.

The landmarks of the joint are :

1. The head of the femur, which can be felt in the groin with the femoral artery pulsating in front of it, below the middle of Poupart's ligament.
2. The great trochanter.
3. The anterior superior spine of the ilium.
4. The tuberosity of the ischium.

Nélaton's line is drawn from the tuberosity of the ischium to the anterior superior spine. It is most easily demonstrated by fixing an end of a tape on the tuberosity with the finger, then bringing the tape across the outer side of the limb to the anterior superior spine, with a free sweep of the hand. The top of the great trochanter just touches this line in the normal limb.

Another simple method is that suggested by Bryant. It consists of dropping a metal tape from the anterior

superior spine to the table upon which the patient rests. The distance from the great trochanter to this vertical line is contrasted with that on the normal side. No matter how experienced the surgeon may be, he should never fail to take precise measurements in all injuries about the hip-joint.

Strains of muscles or bursitis about the insertion of the psoas muscle, or the great trochanter, ought to be diagnosed by the methods of elimination described in the introductory chapter.

If all movements of the joint, including rotation, are limited there is an inflammatory condition present, or some serious lesion. If some movements are free but others limited, the obstruction is probably mechanical or due to injury of some structure outside the joint.

Dislocation of the Hip.—The head of the femur almost invariably leaves the acetabulum and tears through the capsule at the lower part of the joint in this condition. Rotation of the femur plays a prominent part in twisting the head out of the joint.

The Y-shaped ligament of Bigelow generally remains intact and provides a fulcrum which helps in the process of dislocation, and is utilized in the process of reduction. The dislocation is backward or forward according to the direction of the thrust along the femur at the moment of dislocation. Backward dislocation is much the more common form.

Posterior Dislocation.—This dislocation seems generally to be produced with the thigh adducted, rotated inwards, and flexed, the patient being in a stooping position. Generally something heavy falls on the

patient's back, or he is carrying a heavy object on his shoulder and makes a false step.

With the thigh rotated inwards the head is twisted out of the lower and back part of the joint, and then the thrust in the line of the femur makes it travel round the back of the acetabulum to some posterior position.

Diagnosis.

1. The limb is rotated inwards, and slightly adducted and flexed, so that the foot rests on the dorsum of the other foot.
2. On pressing a finger in the groin the resistance of the rounded head of the femur is absent.
3. The head is felt as an abnormal prominence behind, and moves with the trochanter when the limb is moved.
4. Mobility is markedly lessened.
5. By measurement from anterior superior spine to internal malleolus the limb is shorter than its fellow and the trochanter is above Nélaton's line.

Treatment.—Methods of reduction have passed through various stages; the ancient method of reduction by forcible direct traction was displaced by Bigelow's circumduction method, which recognized the value of the Y-shaped ilio-femoral ligament as a fulcrum for levering the head into the acetabulum.

Modern methods eliminate the unnecessary parts of Bigelow's sweeping movement. **Bigelow's method :** The patient is placed on his back, while the surgeon by a sweeping adduction flexion and internal rotatory movement of the thigh makes the head travel down

the back of the acetabulum to the point at which it left it. Next by a slight lift and abduction the Y-shaped ligament is tightened and the head levered into position as the thigh is extended. If skilfully done in one continuous movement, it is a very effective manœuvre.

The objections are that the sweeping movement may cause unnecessary injury of soft parts, and if the head is not lifted over the edge of the acetabulum, it may travel forwards into the position of anterior dislocation, doing still more injury to soft parts.

The **modern method** of reduction depends on bringing the head down to the lower and back part of the acetabulum and lifting it over the edge, and consists in gently reversing the mechanism by which the displacement was produced.

While the patient lies on his back,

1. Flex the thigh ; this brings the head down near the point of exit.
2. Lift, as if trying to lift the patient ; if any obstruction is experienced, rotate inwards and lift again. If still obstructed, rotate outwards and lift.

The dislocation may usually be reduced by this method, but sometimes the surgeon feels that the head comes up to the edge of the acetabulum, but fails to slip over ; if so, he should gently extend as well as lift the limb, when the reduction will take place. To do this, it may be necessary to strap the pelvis to the table by a couple of groin straps, or the patient may be laid on the floor while the surgeon places his unbooted

foot on the perineum to steady the pelvis while he lifts. After a week in bed the patient should be allowed to go about with a plaster of Paris spica bandage round the hip, which includes both pelvis and thigh.

Anterior Dislocation.—The mechanism is not so distinct, but apparently it generally occurs in abduction; the great trochanter engages on the top of the acetabulum and thus tends to lever the head out through the lower part of the capsule. Outward rotation of the thigh twists the head of the femur forward and sets it travelling round the front of the acetabulum into some anterior position.

Diagnosis.—The limb is rotated outwards and usually a little abducted; the head is prominent in the groin and is internal to its proper position, which is behind the artery and below the middle of Poupart's ligament.

Treatment. Reduction: slight flexion and pronounced abduction with traction of the limb bring the head down towards the point of its exit. An assistant now places his hand on the head in the groin and presses it outwards and backwards.

Adduction now makes the assistant's hands a fulcrum and levers the head into position. This manœuvre was suggested by Allis, and is most effective.

The more usual routine is a modification of the circumduction method. It consists of flexing the thigh to a little short of a right angle, and both lifting and rotating it. Flexion brings the head down round the outside of the acetabulum into position near the

rent in the capsule. Rotation, sometimes outwards, sometimes inwards, with a little lift will usually guide the head over the edge of the acetabulum.

Rotatory movements are particularly useful in clearing the head of any entanglement in muscles, nerves, or the capsule.

The free circumduction movements of Bigelow sometimes led to the head hooking itself in some band of muscle or even in injuring the sciatic nerve. If the manipulation is rough or prolonged, the danger to the sciatic nerve is a real one, therefore all manipulation must be gentle.

Where the head has travelled far from the acetabulum, gentle traction on the limb is of course first necessary to bring the head down towards the acetabulum before the manipulation is practised.

The very rare injuries such as central luxation, where the head is driven through the acetabulum into the pelvis, or anterior dislocations, where the head travels up over the ilium and pubic ramus into the abdomen, are very serious and fortunately very rare injuries, for which no routine manipulation can be described.

Fractures about the Neck of the Femur.—The deformity or mal-union which is likely to occur in all injuries of the bone above the small trochanter is determined to a large extent by the shape of the bone and the direction of traction of the muscles crossing the hip-joint.

With the body standing in the erect position the axis of the neck of the femur is inwards, upwards, and

forwards, while the shaft sweeps in a curve downwards and slightly inwards to the knee.

In the standing position, with the feet a couple of inches apart, a vertical line from the middle of the head of the femur passes down nearly through the middle of the knee-joint and then through the middle of the ankle-joint.

A glance at the diagram shows that in the case of a lesion about the neck of the femur, the tendency of muscular contraction will be to cause diminution of the natural angle of the neck and shaft (i. e. a coxa-varoid deformity), while the adductor muscles tend to adduct the shaft of the femur (Fig. 15).

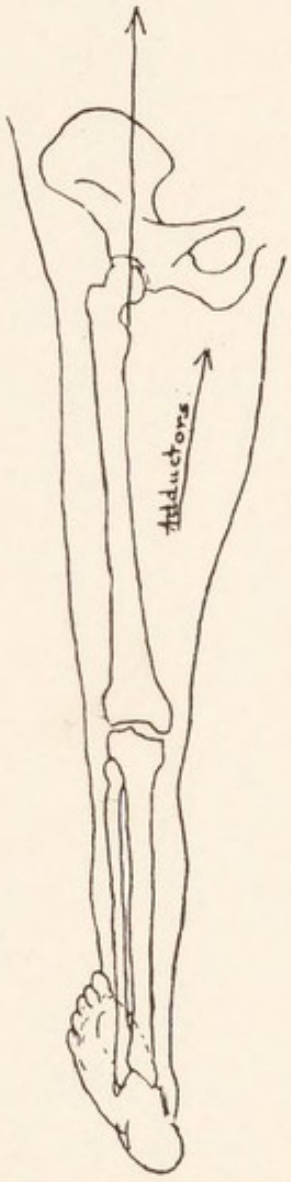

FIG. 15. Diagram showing how in abduction the line of action of the psoas and adductors is normally in the line of the femur.

Experience has shown that the most effective way of disarming this oblique action of the muscles is to apply extension in the abducted position.

The author's experience is that weight and pulley extension is wholly inefficient as a means of fixing fractures, because every time the patient moves his body in bed he alters the tension on the muscles crossing the site of fracture, and this immediately excites

a reflex contraction which means disturbance of the fracture and starting pains. The muscles therefore never come to rest. Fixed extension, with counter

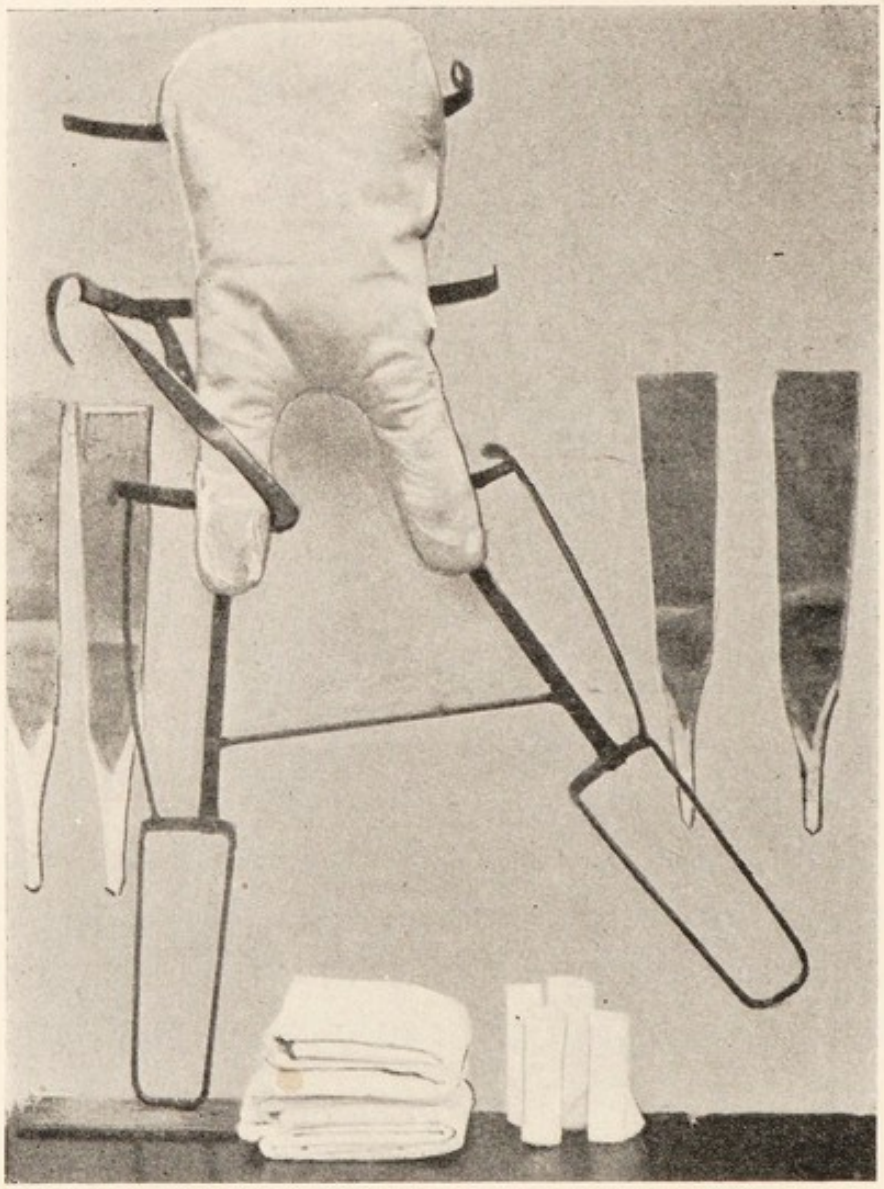

FIG. 16. ABDUCTION FRAME.

extension from the tuber ischii of the same or the opposite side as shown in the diagram, permits no contraction of muscles, and they soon become quiescent when this extension is applied (Figs. 16 and 17).

The common deformity in mal-united or indifferently treated fractures about the neck of the femur,

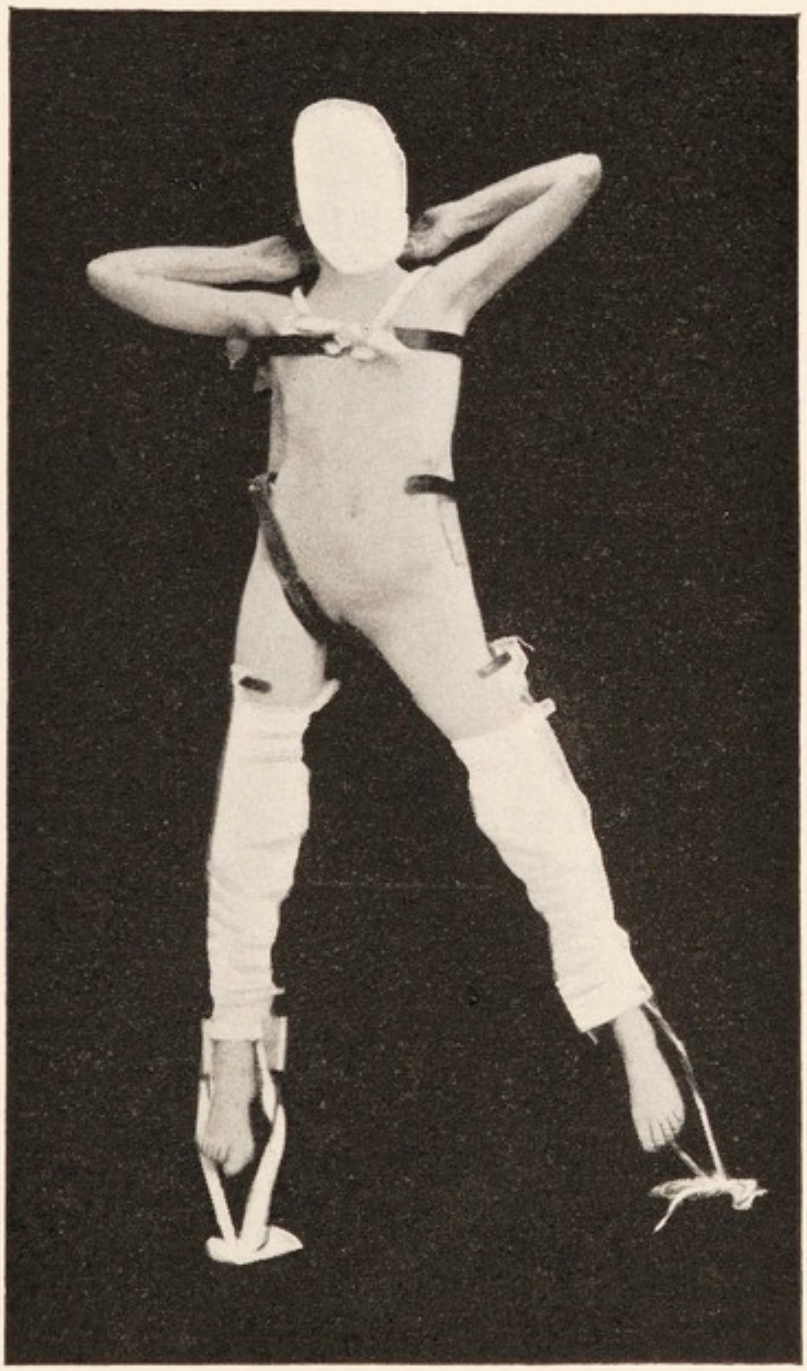

FIG. 17. ABDUCTION FRAME APPLIED.

as also in the case of tuberculous or rheumatoid arthritis, is flexion and adduction.

Rule.—The lesson is clear that all lesions in this

neighbourhood should be treated in an abducted position, the limb being rotated inwards without any flexion. Experience has shown that the results are good. If the surgeon is in doubt or difficulty about a fracture of the acetabulum, he is perfectly safe if he follows this rule.

A partial separation of the head of the femur occurs in young adolescents, and the course of the affection is often insidious. This condition is known as traumatic coxa vara. It consists of a partial or complete separation at the epiphysis of the head, a fracture through the neck, or a fracture involving both neck and epiphysis. It is the most often overlooked of all hip injuries even by extremely good surgeons; it is furthermore often a serious matter for both the patient and surgeon if an early diagnosis be not made. It frequently occurs when turning suddenly; a sharp pain and disability in the hip follows, but the patient is able to walk a little after a rest. The surgeon finds the movements fairly free in the direction of flexion, extension, and adduction; the rotations are distinctly painful, and abduction beyond a short range is not tolerated. The measurements of the limb are normal. Ten days' or a fortnight's enforced idleness, and the patient returns to a normal life. In days or weeks another strain occurs and further disability, with symptoms no more diagnostic than before. After, perhaps, a further strain, the hip becomes painful and the patient lame, and, on examination, the limb has slightly shortened, and a separation of the epiphysis, partial or complete, will be found. The head of the

femur is in the acetabulum, but the femoral neck has travelled upwards.

The injury is much more severe in another type, the disability more pronounced and lasting, and we find we are dealing either with a fracture of the neck, or with a complete separation of the head. There is a third type which completes the clinical group. A youth slightly injures his hip, and is incommoded, hardly disabled, for a day or two. As the weeks pass he complains of an increasing lameness and stiffness at the hip, and his symptoms are very much those of a starting hip affection ; there is limitation of movement in all directions, shortening of the limb, elevation of the trochanter above Nélaton's line. A skiagram shows a coxa vara of the epiphyseal type. The slight injury has partly torn the periosteum and separated the epiphysis, and under the strain of body weight the characteristic deformity occurs.

(*a*) The author would suggest that a single strain or a succession of strains of the hip-joint in adolescents, if followed by disability and pain on abduction, denotes an epiphyseal separation.

(*b*) If strain completely disables the patient, and is accompanied by elevation of the trochanter, a fracture of the neck is to be diagnosed.

(*c*) If a slight injury be followed by a limp, rigidity, and shortening of the limb, we are probably dealing with a coxa vara following a partial epiphyseal separation, exhibiting the signs of epiphysitis.

We must remember that a neglected traumatic coxa vara results in a stiff, adducted, and slightly

flexed hip. The treatment should consist of immediate fixation under an anæsthetic. With the pelvis fixed while the limb is abducted the upper border of the acetabulum acts as a fulcrum ; the limb is secured in extreme abduction and extension by means of plaster of Paris, or preferably an abduction frame, for six weeks until consolidation has occurred.

The sliding head or fractured neck is placed in proper relation with the shaft by this method.

'Extra-capsular' Fracture of the neck of the femur occurs typically in active adults up to later middle age. The fracture is usually caused by a blow or fall on the trochanter major. The neck of the femur is driven into the trochanter and may be impacted or may break free.

We should realize that occasionally the patient can walk if the fracture is firmly impacted. The diagnosis can be easily made if the following points are noted :

1. The trochanter major when grasped between the finger and thumb is usually broader than its fellow.

2. Shortening is not great if the fracture is impacted, but may be one and a half inches or more if free.

3. The trochanter is felt to rotate on a shortened radius.

4. Some eversion is usually present.

Treatment.—The hip should be well extended in the abducted position. The functional result should be satisfactory, and the shortening not more than three-quarters of an inch.

The old treatment in a long ' Liston ' splint is very apt to be associated with some shortening, a good deal of callus which interferes with free movement, and generally some adduction (i. e. coxa - varoid deformity) is often found even in cases which have been carefully treated by this method.

If an abduction frame is not available a Thomas knee-splint is better than a Liston, for the ring of the splint gives good counter-extension from the tuber ischii, and the abduction can be arranged by means of sand-bags ; but it should only be a temporary measure.

The essential aim in all fractures of the neck of the femur is to secure correct alinement. This is not possible in any position but that of abduction. The limb should be extended, abducted to about forty-five degrees, and rotated inwards. Whitman strongly advocates the use of plaster of Paris to maintain the position, and although the author generally employs his abduction frame, he is convinced of the admirable results to be obtained by fixation in plaster of Paris.

In impacted cases it is advantageous to disimpact in every case where there is considerable shortening or external rotation of the limb, leaving only those cases where the shortening is trivial and where there is no rotation. The results are better than when the old practice was followed of leaving all the impacted cases to unite as they were.

' Intra-capsular ' Fracture of the neck of the femur occurs typically in elderly people. The fracture is

almost always produced by a sudden twist, then the patient falls.

Diagnosis.

1. Mobility and crepitus between the trochanter major and the head of the femur.

2. Shortening is not as great as in the extra-capsular variety, as the fracture is largely, not entirely, within the capsule.

Broadening of the trochanter does not occur in a typical case.

Treatment.—Treatment and its result depends on whether the patient is fit to be kept in bed without risking a ' hypostatic pneumonia '.

If possible, treat in an abduction frame, and a reasonably good result may be expected. If the patient is old and is likely to develop lung trouble if too much restricted, it is better to put on a Thomas knee-splint to prevent shortening, and let the patient sit up.

The case should be treated in the same manner as the so-called ' extra-capsular ' fracture. Where hypostatic troubles may be expected, plaster of Paris has advantages over any kind of splint, for the patient need not be confined to his bed. The extension and rotation can be maintained by including the foot in the plaster. In cases where the bone has failed to unite, a well-applied Thomas calliper knee-splint (Fig. 19) enables the patient to walk with comfort. The ring of the splint lying against the tuber ischii supports the body weight.

Plaster of Paris should never be used in compound

fractures about the hip. Where suppuration has occurred, it becomes a filthy method. Despite every precaution for the exposure of the wound, the plaster mops up discharges like blotting-paper, becomes

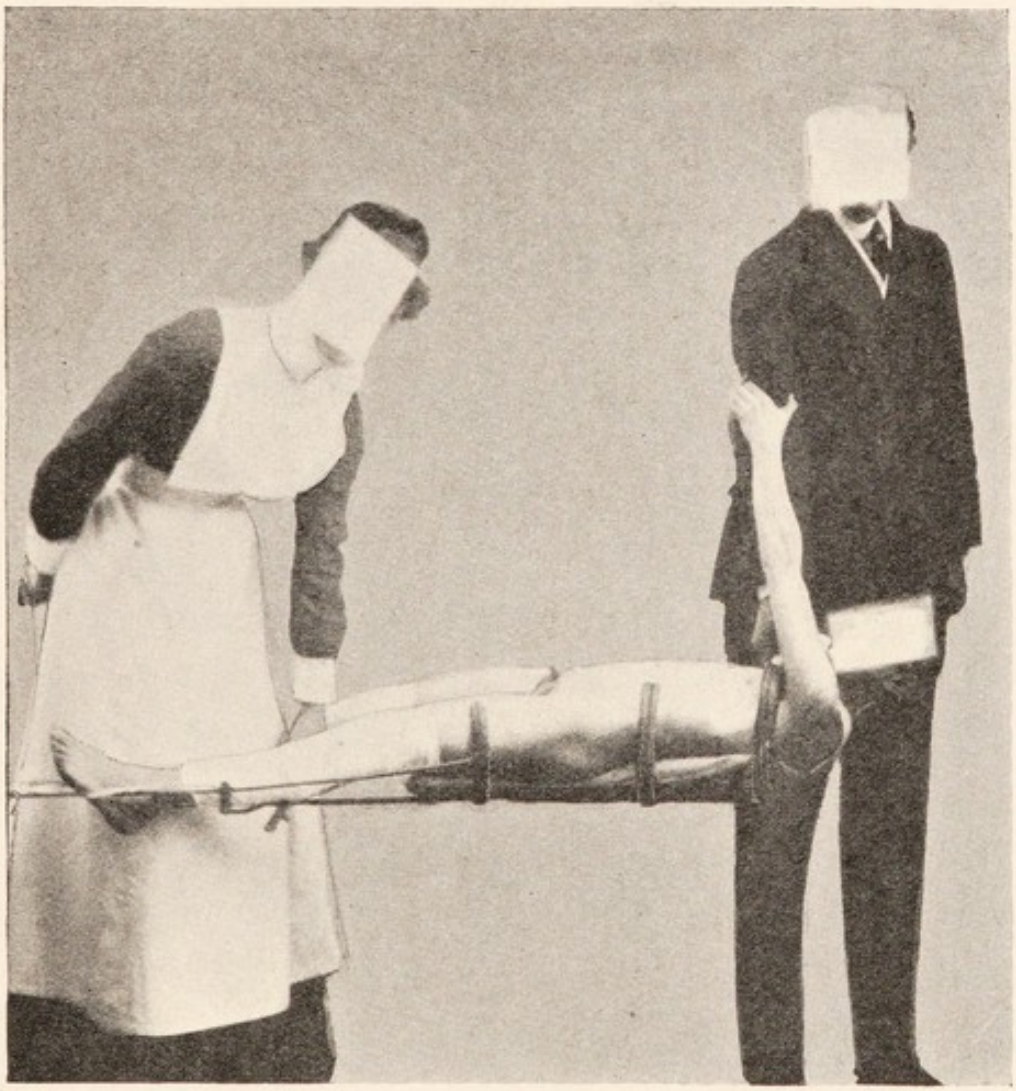

FIG. 18. ABDUCTION FRAME APPLIED: CARRIED.

horribly offensive, and adds to the infection of the wound.

The patient who lies on an 'abduction frame' can be lifted and moved without pain, without disturbing the fracture or relaxing the extension, and the dressing can be changed without interfering with the mechanism

of fixation (Fig. 18). If the wound is through the buttock and the discharge takes place there, the splint can be suitably modified. The abduction frame can be applied in a few minutes.

The Knee-joint

The integrity of the knee-joint depends entirely on its ligaments and muscles, and consequently it is the seat of many derangements caused by injuries to these structures. The joint is further complicated by the semilunar cartilages and by abundant fatty synovial fringes.

Strains of muscular attachments about the knee may occur at the insertions of the semi-membranosus, at the inner side and back of the internal tuberosity of the biceps, at the head of the fibula, which may be diagnosed by local tenderness on pressure and pain on resistance to voluntary flexion.

Strain of the attachment of the ligamentum patellæ is more important. The tubercle of the tibia is sometimes developed as a separate epiphysis, and the local inflammation then may be of the nature of epiphysitis. Commonly, however, it is a local periostitis which is kept active by the continued action of the quadriceps extensor cruris.

Treatment.—If the inflammatory condition is at all severe, a back-splint should be applied to prevent flexion and strain on the painful attachment. In less severe cases a firm band of sticking-plaster applied around the thigh above the patella may suffice to

relieve the part sufficiently to allow recovery to take place.

Sprains and Rupture of Ligaments.

The external lateral ligament is not often sprained and does not often give trouble unless the injury is severe.

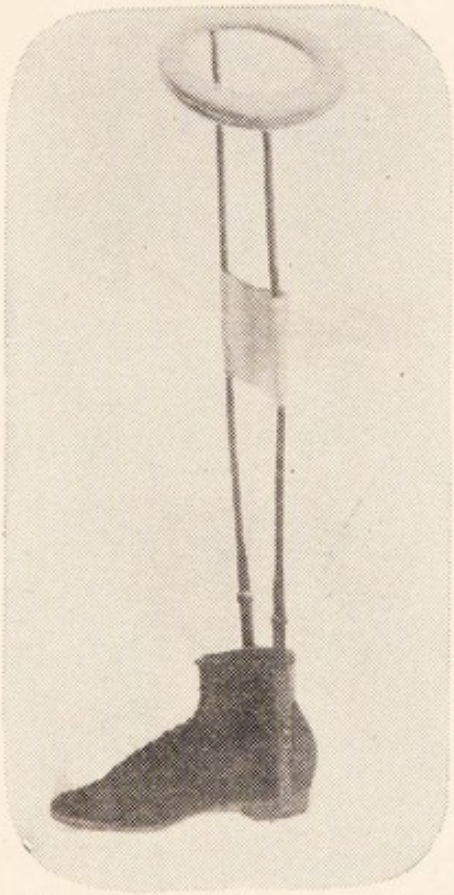

FIG. 19. CALLIPER.

The internal lateral ligament, on the other hand, is very frequently sprained. The force which puts strain on this ligament is eversion of the foot and abduction of the leg in slight flexion. One is apt to think of this ligament as a long strap attached above to the internal condyle of the femur and below to the inner aspect of the shaft of the tibia, and to forget that the deep fibres have a very short course from the condyle to

the adjacent part of the inner tuberosity of the tibia, and are intimately connected with the capsule. It is these deep fibres which are usually injured in a 'sprained knee', and the injury is most commonly at their attachment to the margin of the tibia.

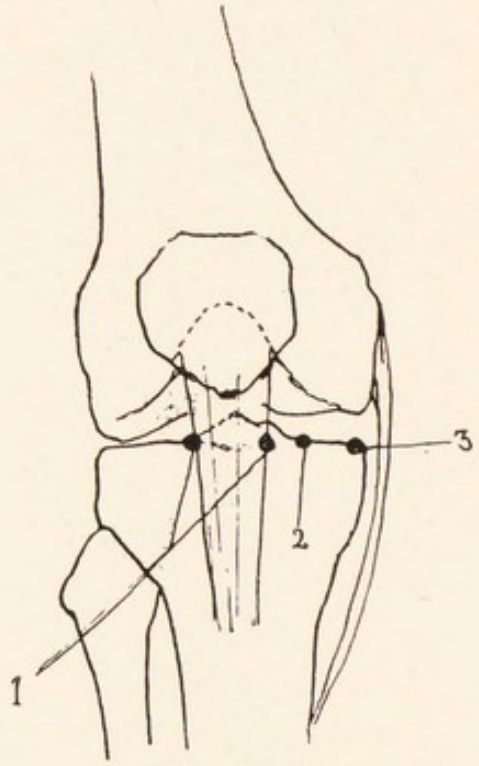

FIG. 20. DIAGNOSTIC POINTS OF TENDERNESS ABOUT KNEE. 1. Tenderness on full passive extension with swelling each side of the ligamentum patellæ suggests a tender post-patellar pad. 2. Tenderness on pressure suggests injury to anterior portion of internal semilunar. 3. Usual point of tenderness in sprain of internal lateral ligament.

Diagnosis.

1. The patient complains of pain at the inner side of the knee, particularly when he twists his foot outwards.

2. Pain is caused by passively stretching the internal lateral ligament.

3. There is tenderness on pressure confined to the line of the ligament, not over the anterior end of the cartilage which lies nearer the front of the knee.

4. There is no history of locking of the knee, or of something slipping inside the knee, which would suggest an injured cartilage.

Treatment.

1. Apply a splint until union is complete; this usually takes a fortnight.

2. The patient should deviate body weight from the ligament by walking with his toe turned in.

3. Strain is relieved by making the inner side of the heel of the boot a quarter of an inch thicker than the outer.

Internal Derangements.—The post-patellar pad of fat is frequently bruised; this injury is often not clearly understood, and is frequently diagnosed as 'rheumatic'. The material fact is that the pad of fat which fills up the space in front of the knee behind the patellar ligament is a little too large owing to hyperæmia, possibly due to a slight bruise.

Diagnosis.

1. Patient complains of pain in the front of the knee.

2. There is a slight fullness at the sides of the ligamentum patellæ which on palpation is not fluid but elastic, being congested fat.

3. Flexion of the knee is painless.

4. Passive extension causes pain, definitely located in the front of the knee behind the ligament.

5. There are often recurrent effusions into the joint.

In cases of long duration which may have been diagnosed as ' rheumatic ' or ' arthritis ' the thickened pad may cast a faint blurred shadow in an X-ray photograph in a lateral view, due to excess of fibrous tissue. A knee-cage limiting full extension may have to be worn for many months before the thickened tissue all disappears.

Treatment.—Prevent repeated pinching of the fatty pad by making the patient wear a jointed knee-cage which allows full flexion but stops twenty-five to thirty degrees short of full extension. This allows the congestion of the pad to disappear without laying up the patient, and then the knee can be extended without causing pain.

Injuries of Semilunar Cartilages.

The internal cartilage on account of its shape and attachment is more frequently injured than the external.

The mechanism of the injury is nearly always the same. The foot is fixed in eversion. The body suddenly swings inwards with the knee bent inwards.

(*a*) *First,* the internal lateral ligament usually gives way.

(*b*) *Second,* the knee-joint opens on its inner side and the semilunar cartilage, which is strongly attached to the ligament, is pulled out of its place; it may merely bend or one of its end attachments may give way, most often the anterior end.

(*c*) *Third,* as soon as the patient falls and the strain on the knee is relieved, the joint shuts with a snap and pinches the cartilage.

1. The cartilage may be merely bruised and slip back into its place.
2. In the typical case it is split or broken, or the end is doubled over and nipped so that some part of the cartilage fails to get back to its proper place.

When this happens we have the characteristic symptom of ' locking ', i. e. owing to the obstruction nipped between the bones the leg cannot be fully extended at the knee.

Diagnosis is made

1. By ' locking ' when present, or the history of the knee having been locked.

2. By tenderness over the injured internal lateral ligament.

3. Tenderness on the upper edge of the tibia half an inch to the inner side of the patellar ligament.

Treatment.—Complete reduction of the displaced portion of cartilage is essential. The surgeon should not be content till he has the knee *fully* extended. Mere partial reduction means constant bruising of the nipped portion, with symptoms similar to those of a bruised post-patellar pad, only the pain is situated more to the inner side of the joint, and is usually more acute.

Reduction.—With the patient lying on the back, flex the thigh on the trunk, flex the leg on the thigh, rotate outwards and abduct the leg to open the inner side of the knee-joint and clear the cartilage. Then very rapidly rotate inwards and extend. The cartilage will often slip in during the inward rotation.

If reduction is complete, the knee is fully extended with ease, and the patient feels the cartilage is 'in'. If the patient does not know that the cartilage is 'in' the reduction is not complete.

When working without an anæsthetic the author asks the patient to kick his leg into full extension, counting one, two, three, *kick*! On the word 'kick' the patient violently extends thigh and leg, while at the same instant the surgeon rotates inwards and helps the extension by pulling on the foot. With a little practice this manœuvre seldom fails.

Cases that have remained incompletely reduced for any length of time generally require an anæsthetic. Often when the surgeon has failed to reduce the displacement, the patient suddenly makes some unconscious movement, relaxes his muscles, and reduction occurs spontaneously, which proves that reduction is not a matter of force, but rather of knack.

After-treatment.—There is always a good deal of effusion in and about the joint. When full reduction has been attained, the knee should be firmly bandaged on a back-splint for a few days till all effusion has disappeared.

The patient may then walk about with the posterior splint on, to let repair of torn structures take place. If the torn or displaced portion of cartilage gets fixed down, no further trouble may occur.

Then a pad may be placed on the inner side of the knee, and the joint firmly bandaged or strapped and the patient allowed to walk under certain restrictions.

He must carefully avoid everting his foot for fear of stretching the internal lateral ligament and allowing the cartilage to slip again. To enforce this position, the inner side of the heel should be made a third of an inch higher than the outer side ; this makes the patient

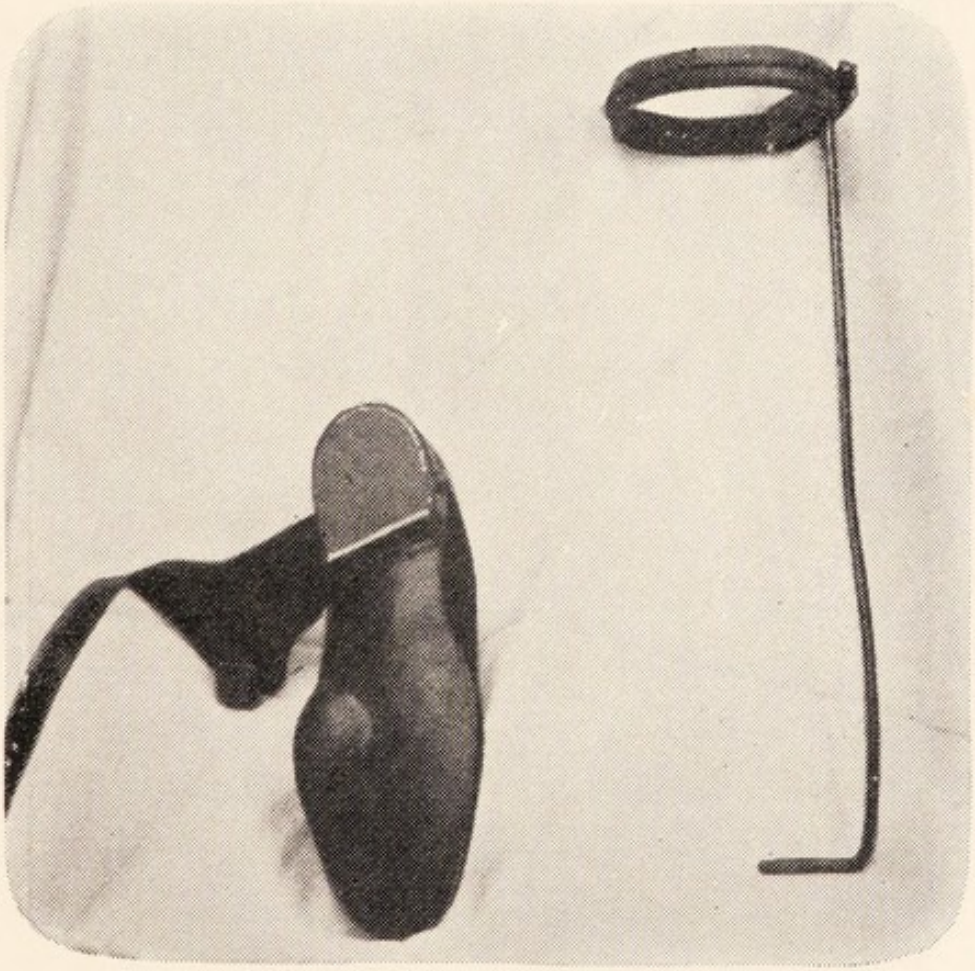

FIG. 21. BOOT AND IRON.

turn his toe in, and by throwing his weight on the outer side of the foot tends to give him a bow-knee rather than a knock-knee, so keeping the inner side of his knee shut (Fig. 21).

The External Semilunar Cartilage.—Injuries of the external semilunar cartilage are rarer. The signs and

symptoms are less distinct, and the mechanism is not so obvious.

The patient complains of something slipping in the knee and may state definitely that the sensation is in

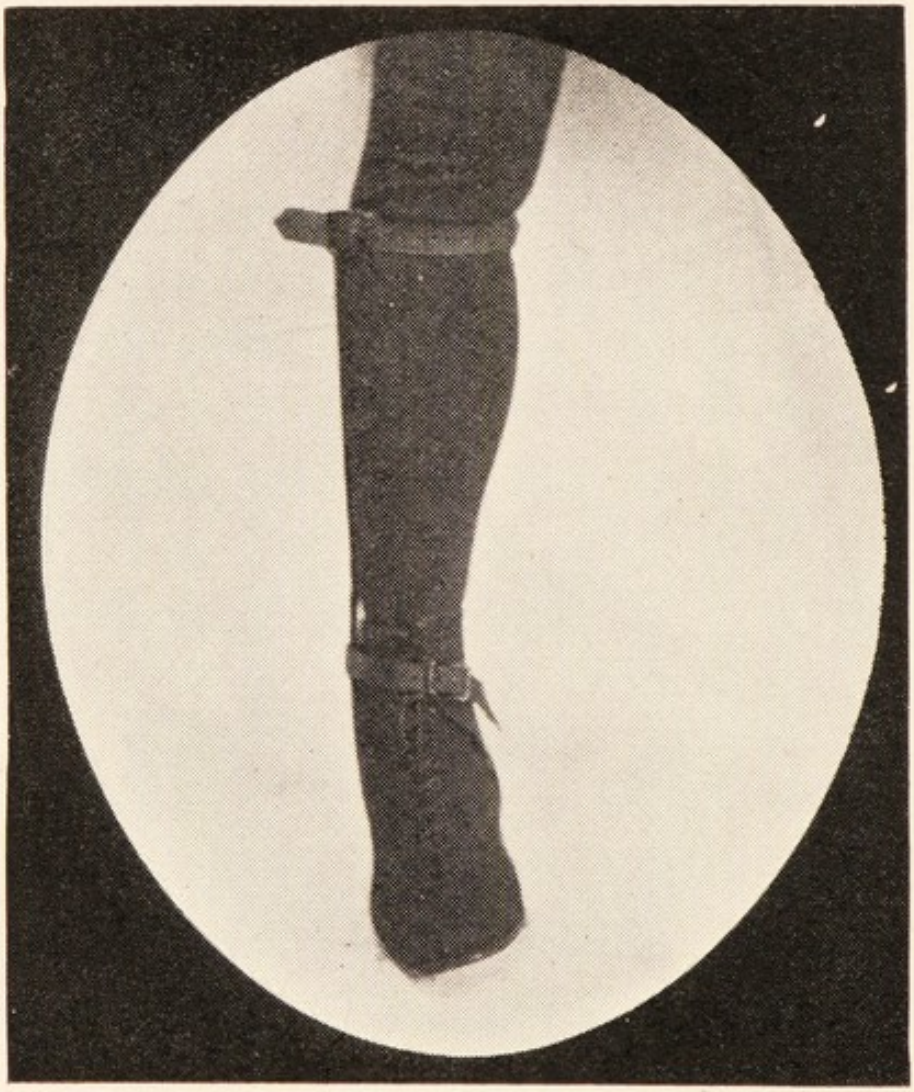

FIG. 21 A. BOOT AND IRON APPLIED.

the outer side of the joint. Pain is usually referred to the outer and posterior sides of the joint, pain on pressure is not pronounced, effusion is not so common, and a loose external cartilage often gives rise to the 'clicking' knee.

The Indications for Operation.—Recurrent derange-

ments demand operation, more especially those cases often accompanied by acute symptoms. Where a strenuous athletic life is a means of livelihood, a physical necessity, or where the subject works in dangerous places, there should be no hesitation in urging an operation. No soldier, the subject of a slipping cartilage, should be passed for service until the defect has been put right. Already many have returned from the front because of this disability.

A first attack efficiently treated may result in a cure without recurrence in a large number of cases; therefore, unless there are special reasons, operation is not to be urged where the knee has only once given way.

The Operation for exposing the Internal Semilunar Cartilage.

Incision.—The J-shaped incision frequently employed is open to objection, for by carrying the lower end of the incision backwards, it is easy to cut part of the internal lateral ligament, with lasting impairment of its efficiency.

The incision the writer employs is made as follows: The patient's leg is allowed to hang over the end of the table with the knee bent at a right angle. The incision, about one and a half to two inches long, crosses the joint over the anterior end of the cartilage, following the margin of the articular surface of the condyle of the femur.

The knife used for the skin incision should not be used for opening the joint, for fear of infecting with Staphylococcus albus from the skin, if with no more

virulent organism. In the flexed position an excellent view is obtained, the internal lateral ligament is well back out of danger, and there is really no excuse for encroaching on it. The offending object, cartilage or fringe, should be cut clean away with a thin-bladed knife without dragging on it. If a tourniquet is first applied, there is no bleeding to obscure the view. The tourniquet should not be removed until the operation is ended and the knee bandaged.

The surgeon who operates upon a healthy knee-joint should be clean beyond reproach. He should have an antiseptic conscience. His finger should never enter the wound however scrubbed or thickly gloved, as an infection would prove a tragedy.

The synovial membrane and capsule should be carefully sutured with a reliable catgut handled and tied by forceps, and the skin then separately stitched so that there is no immediate connexion between the skin wound and the joint.

The after-treatment is the same as for a successfully reduced cartilage. The patient may walk in a back-splint ten days after the operation. A week later he may be promoted to a firm bandage and a crooked heel, and begin to bend the knee. In six weeks he may play games and do what he likes.

Dislocation of the Knee.—Fortunately dislocation of the knee is very rare ; the nature of the displacement is too obvious for any error in diagnosis to take place.

The interesting fact is that in spite of the extensive rupture of ligaments, including the crucial ligaments, the functional results in recorded cases have been so

good. The explanation of this is that the lesion is so formidable that prolonged fixation is absolutely necessary; early use and movement is impossible without displacement occurring. Hence torn structures are usually given time to unite firmly, and with exercise and use, considerable freedom of movement is recovered in time. No surgeon sees many cases in a lifetime, so that it is necessary to deduce clinical lessons from recorded cases.

The great lesson seems to be that if the displacement is reduced and the limb fixed in a straight position, nature will do surprisingly well.

Rupture of the Crucial Ligaments and Fracture of the Spine of the Tibia.—These accidents occur as the result of forcible twisting of the knee without sufficient displacement occurring for the case to be diagnosed as a dislocation of the knee.

The pain and effusion at the time is so great that the practitioner necessarily does the correct thing by fixing the limb on a posterior splint.

Patients are generally seen by the consulting surgeon at a later time and complain of preternatural mobility and insecurity in the knee.

The **diagnosis** of rupture of the crucials is not difficult if we remember their anatomical functions.

1. The anterior crucial ligament is tense when the knee is fully extended and prevents the tibia from being displaced forwards on the femur.

2. The posterior crucial ligament is tense in complete flexion and prevents the tibia from being displaced backwards on the femur.

3. Both ligaments check inward rotation of the tibia.

Hence, when it is found that after an injury to the knee the tibia can be displaced backwards or forwards, or rotated inwards in the extended position, an injury of one or both crucial ligaments may be diagnosed.

When in the extended position the tibia cannot be displaced forwards, it may be assumed that the anterior crucial is not torn across.

If in full flexion the tibia cannot be displaced backwards, the post-crucial is not ruptured.

Treatment.— Fixation of the knee in the straight position to allow the stretched structures to shorten, followed by the use of a knee-cage to steady the knee when walking, will generally lead to a satisfactory result.

Operation in the author's experience does not achieve much. The torn tissues may be drawn together with sutures, but the ends cannot be accurately approximated with the knee bent so as to expose the intercondylar space. With the knee-joint closed it is not possible to get in to tie the knot. The good results therefore must be more due to the after-treatment, which allows of sufficient rest to permit the repair tissue to consolidate and shorten.

Fractures of the Spine of the Tibia.—Passing next to fractures of the spine of the tibia, the injury is generally associated with rupture of one or both crucial ligaments. The fracture is probably produced by a combined slide and twist of the condyles on the

tibia so that the intercondylar margin sheers off the spine.

Diagnosis between ruptured crucial ligaments and fractured spine is easily made by the X-ray photograph.

Treatment.—It is essential to get the knee straight ; if there is bone lodged in the front part of the joint it must be got out of the way.

Manipulation of the knee and forcible extension may succeed in driving the obstruction up between the condyles, where it will be out of the way and can do no great harm. The knee can then be fixed on a back-splint and left to recover. There will be some limitation of flexion in many cases, but as a rule the functional result is gratifying.

When the obstructing fragment cannot be dislodged by manipulation, there is no choice left but to operate.

Operation.—The incision is determined to some extent by the location of the fragment. It may be possible to remove it by an incision to the side of the patellar ligament, but in order to obtain a ready access and a good view, the patella should be split vertically as well as the quadriceps and patellar ligament. After the joint is explored the ligamentum patellae, the quadriceps, and the aponeurosis are stitched. No wiring or plating is needed.

Fractures about the Knee-joint.—All fractures about the knee-joint can be fixed efficiently on a Thomas knee-splint (Fig. 22), and the patient can be moved in this splint with less discomfort than in any other known to the writer.

Fracture of the Femur above the Condyles.—The traditional method of treating this fracture is with the knee flexed, because the gastrocnemius muscle is expected to tilt the short lower fragment backwards, and by this means pressure would be put on the popliteal vessels, endangering the vitality of the leg and foot. This fear is entirely without foundation, provided the limb is so securely fixed that reflex muscle-spasm is not excited.

Reflex muscle-spasms and the resulting starting-pains are excited by alterations in tension of the

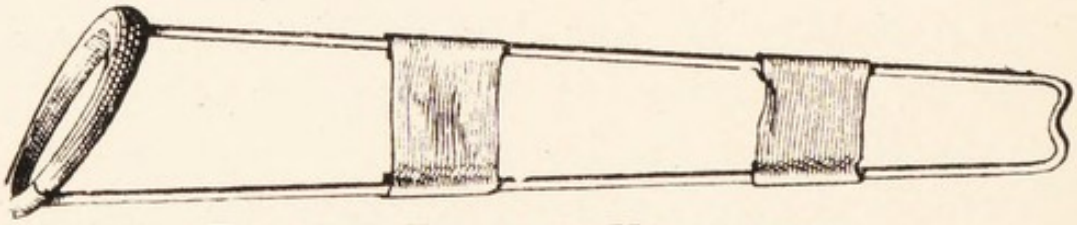

FIG. 22. THOMAS'S KNEE-SPLINT.

muscles crossing the site of fracture, and can only occur if it is possible for the muscle to contract.

If extension straps of adhesive plaster are applied in the usual way, and firmly fixed to the bottom of the splint, and the ring is firmly up on the perineum and tuber ischii, it is mechanically impossible for the muscle to shorten. The consequence is that no reflex action occurs, and all the muscles of the part become relaxed and restful within twenty-four hours.

The extension plasters should be of strong linen-backed sticking-plaster—one on each side of the leg, with stout webbing stitched on to the lower ends.

They are applied to the limb in the usual way, taking as high a grip as the wounds may permit. The malleoli are protected from pressure.

When fastening the lower end, one band is taken over the side-bar, the other under, and the two knotted over the U-shaped bend at the bottom of the splint, which is purposely made to prevent the knot from slipping off (Fig. 23).

The limb is slung from the side-bars as shown in the diagram, or the method modified to leave access to wounds which have to be dressed.

Fractures of the Condyles.—One or both condyles may be knocked off. The tibia then has a tendency to slip to one side or other.

It is very rarely necessary to resort to operative interference.

Extension strapping is applied up to the knee, the Thomas splint is slipped over the limb, and an assistant applies extension; if he puts his knee against the end of the splint, he gets his own counter-extension from the perineum.

The surgeon grasps the condyles between his two palms, and generally will get the broken fragments to slip together. A firm bandage or, if there is no wound, a few turns of sticking-plaster will hold them together. So long as the tibia is not allowed to bump up against them, they will not be again displaced, and the limb can be fixed as shown in the diagram (Fig. 23).

If the fragments do not slip into place, apply firm extension for a few hours, and try again; the muscles

may have relaxed by that time. Often when left alone overnight a displaced fragment is found to have slipped into place by morning.

If in any difficulty an anæsthetic should be given, but this is by no means a routine necessity. Last of all, operation should follow failure of manipulation.

Setting a limb in this way without an anæsthetic

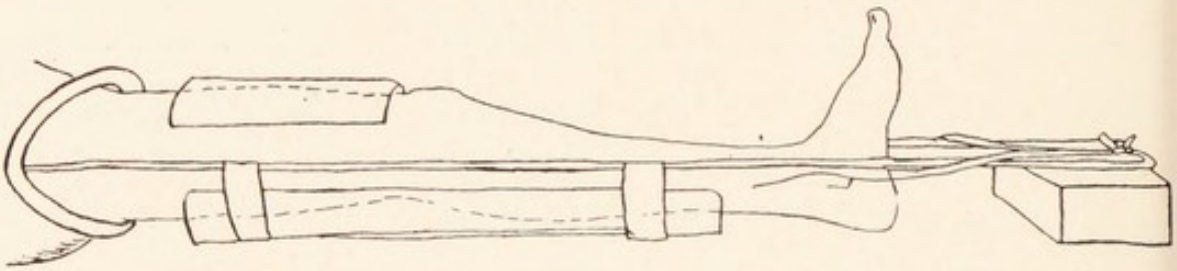

FIG. 23. DIAGRAM SHOWING THOMAS'S KNEE-SPLINT AS USED FOR FRACTURE OF THE FEMUR BELOW THE SMALL TROCHANTER, ABOUT THE KNEE AND UPPER PART OF THE LEG. Arthritis of knee, compound fracture of patella, &c. The gutter-splint behind is slung from the side-bars.

If necessary to get free access to a wound about the knee, leg and thigh would be separately slung. To avoid confusion, only the lower end of the extension plaster is shown ; also all bandages and padding are omitted.

The anterior splint is such as would be used for fracture of the shaft of the femur. The block supporting the end of the splint keeps the heel off the bed and protects the heel.

does not hurt the patient any more than the usual preliminaries to an anæsthetic.

Fractures of the Tuberosities of the Tibia are dealt with in precisely the same way. Once the limb is extended and the fragments have been coaxed into position and bandaged there is no tendency to displacement.

One of the great advantages of the Thomas knee-

splint in all these cases is that splint and limb are all in one piece, and no movement of the patient's body or other limb can have any material effect on the seat of fracture.

The foot, of course, is fixed at right angles with a figure-of-eight bandage in the usual way.

Fractures of the Patella

Recent investigations have shown that fractures of the patella are much more often due to direct violence than formerly believed. Amongst those undoubtedly due to falls or blows, we must include nearly all fractures of the oblique, stellate, and longitudinal varieties. A very large proportion of the transverse type are the result of a combination of a muscular contraction and of indirect violence. The middle portion of the patella remains in contact with the femur, and this may be snapped by a strain exercised by the quadriceps.

Prognosis.—Bony union nearly always occurs in the longitudinal, oblique, and stellate varieties, but only occasionally in the transverse. Excellent function may follow recovery with wide separation of fragments, and not infrequently excellent union may be accompanied by faulty function. The tearing and faulty union of the aponeurosis is a common cause of atrophy and weakness of the quadriceps. The author has seen several cases where secondary fracture has occurred in the original site many months after operative treatment, and it is common experience

that if fracture occurs after a good fibrous union, it is not often in the same place.

Treatment.—The non-operative treatment must always be employed unless an operation can be performed with the most rigid aseptic precautions, and this should only be undertaken by scrupulously clean surgeons. The introduction of fingers into the wound and the rough handling of fragments play havoc with the patient's chances.

The calliper splint can be applied at once in simple fractures, and as soon as the effusion has gone the patient may be allowed to walk; this generally happens about the end of the first week. The splint is admirably adapted for fixing the upper and lower fragments without circular compression (Fig. 24). The fragments are approximated with the fingers, and a loop of bandage slung round the bars and arranged so as to press upon the quadriceps just above the patella, while another loop is fixed below the lower fragment. Any tilting can then quite easily be remedied by a pressure pad over the riding end. The calliper should remain on for two months, when a small stop-cage brace can be applied, first allowing twenty-five degrees of flexion, and this is gradually increased. The use of the cage gives the quadriceps time to recover without stretching the bond of union, a very important clinical point if the loss of function is largely due to a lax and lengthened quadriceps. While the effusion is being absorbed the limb should be elevated; in this way the quadriceps is kept relaxed.

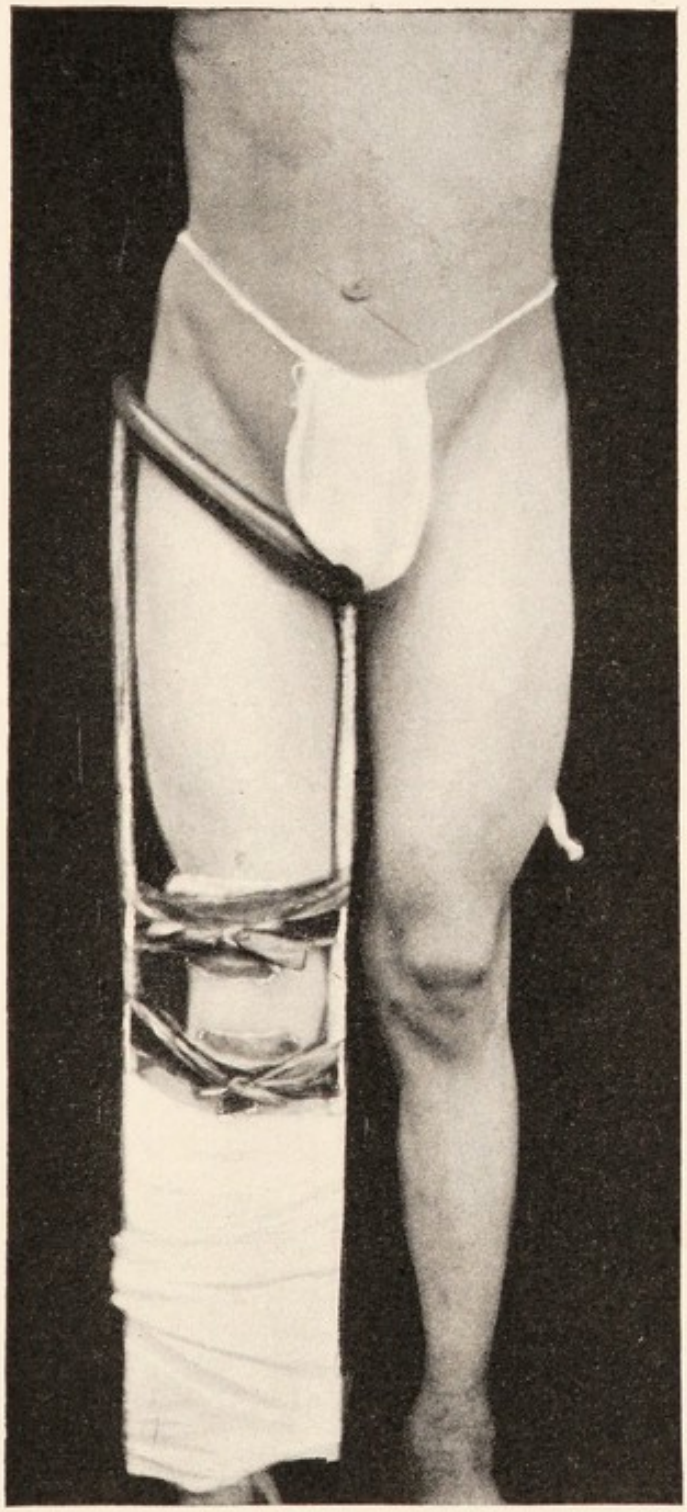

FIG. 24. THOMAS'S KNEE-SPLINT APPLIED FOR FRACTURED PATELLA.

The author would recommend an operation in all young folk, provided asepsis is guaranteed, but the types of operation suitable to varieties of fractures cannot be discussed in this short book.

Compound fractures of the patella as they occur at the seat of war should not be treated by operation.

CHAPTER IX

THE ANKLE-JOINT AND JOINTS OF THE TARSUS

In fractures of the ankle-joint we must remember, whether the joint be stiff or not, that the patient will want to walk on his foot, and that he should be able to get both the heel and sole to the ground, and a dropped foot or equinus deformity must be prevented.

Whatever the injury, the surgeon must keep the **foot at right angles to the leg**; if he fails in this he has failed in his treatment orthopædically, no matter how skilful or scientific his treatment of the actual lesion may have been.

Strain of the tendo Achillis and sometimes inflammation of the bursa under the tendon are not rare. The condition is really very disabling, especially to men on the march.

A simple device to relieve strain consists in raising the heel of the boot on the affected side half an inch. The patient thus unconsciously does more work with the other leg and avoids strain of the tender tendon. It is obviously of no use to raise both heels, for then the work thrown on both feet would be equal, and the desired effect would not be produced.

It is really practising a species of deception on the

patient's sense of balance, but it is very effective in many cases.

Sprains of Ligaments.—Reference has already been made in the introductory chapter to the means of localizing an injury of a ligament about the ankle and to the appropriate means of keeping down effusion by pressure, and of relieving strain by tilting the heel of the boot, and it is not necessary to refer to them again.

Dislocations of the Ankle-joint.—Dislocation of the ankle is so often associated with some fracture, that the reader must be asked to refer also to the complications of Pott's Fracture.

Uncomplicated Dislocations practically only occur forwards or backwards; upward and lateral dislocations of the astragalus are nearly always associated with some fracture of bone, and all the types occur in association with Pott's fracture.

Backward Dislocation must be fully reduced if a satisfactory functional result is to be obtained, otherwise the anterior edge of the tibia will block dorsiflexion.

To reduce a posterior dislocation when working single handed, let the foot project over a stool or chair. A roller towel or strong bandage loop is drawn over the lower end of the upper part of the tibia, and traction applied with the surgeon's foot in the other end of the loop, while the patient's heel is drawn forward (Fig. 25).

Diagnosis is not difficult, as an undue prominence of the anterior edge of the tibia will be observed and

differences on the two sides in the measurements from the malleoli to the heel and the great toe.

Anterior Dislocation of the Ankle.—Care must be taken to determine the relative position of the various parts of the foot, for the astragalus alone may be projected forwards, or it may be fractured and half of it

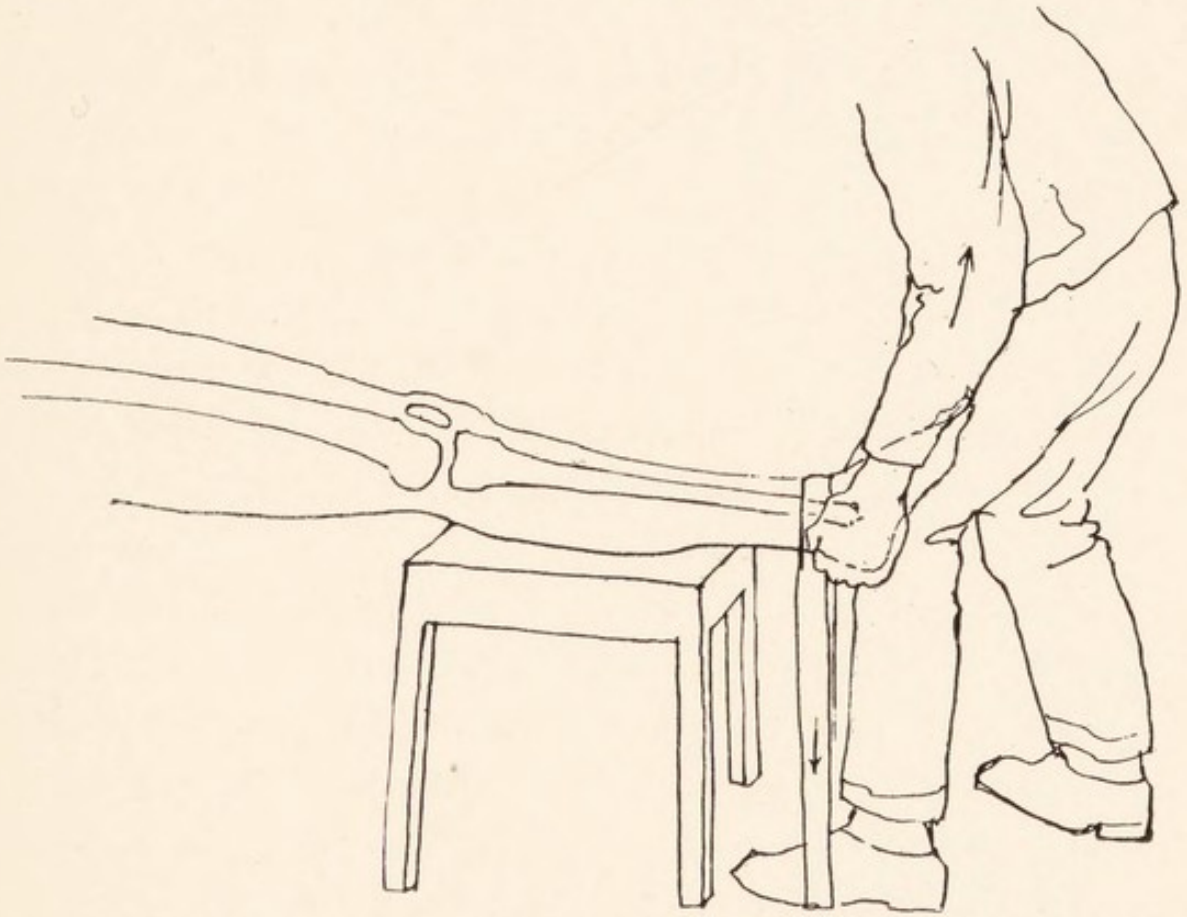

FIG. 25. Diagram showing Foot in Loop when lifting Ankle forward.

projected forwards, producing a hump on the dorsum of the foot. A simple dislocation of the ankle forwards should be reduced, but, as will be seen below, fractures of the astragalus with displacements often call for prompt operative attack.

The foot must be brought to a right angle with the leg, and a good functional result may be predicted.

Inversion of the Foot.—It may be correctly stated that an adducted foot is associated with strength, and that an abducted foot will be weak and become associated with flat-foot and strain of the longitudinal arches.

If the foot is slightly adducted at the ankle the body weight will fall on its outer edge, and the astragalus will be forced on to the bony angle formed by the internal malleolus and the under surface of the tibia.

If the foot is in the valgus position, the upward force is against the external malleolus, tending to spread the fibula from the tibia and producing a strain of ligaments and a painful ankle, which is often falsely diagnosed as 'rheumatic' when the whole trouble is mechanical.

Rule.—In all fractures about the ankle, the foot should be placed at right angles to the leg and slightly in the varus position. If this be done, whether ultimately mobile or stiff, the foot will carry weight well.

After-treatment.—After all such injuries of the ankle and after Pott's fracture, the heel of the boot should be 'crooked' on the inside, by making it a third of an inch higher on the inside than on the outside. If there is any tenderness or liability to strain, an outside iron and brace will often make all the difference between a man being able to do his work or not (Fig. 21).

Pott's Fracture.—The importance of Pott's fracture lies not so much in the break of the fibula as in

the disturbance of the axis of the ankle-joint which is liable to follow.

The deformities commonly associated with the injury are eversion of the ankle and posterior displacement of the astragalus. The former, if not fully corrected, leaves the patient with a valgus deformity of the ankle. The upward thrust of the astragalus falls on the space between the fibula and the tibia instead of fairly on the tibia (Fig. 26).

FIG. 26. POTT'S FRACTURE. Showing typical deformity and weak position of ankle.

Backward displacement, when not fully corrected, means that when the patient tries to dorsiflex his foot in walking, the dorsum of the neck of the astragalus will impinge on the anterior edge of the tibia.

The Mechanism of the Fracture is always violent eversion of the foot. The patient falls to the side of the injury with the foot caught. The thrust of the astragalus comes on the external malleolus, the strong tibio-fibular ligaments hold fast and form a fulcrum, and the thin part of the shaft breaks by leverage two or three inches higher.

Diagnosis.

1. The everted position of the foot.

2. Tenderness at the site of the fracture elicited by running the finger down the fibula.

3. Tenderness at the same point, when the upper third of the tibia and fibula are squeezed towards each other.

4. The foot is often in a slight equinus position, and displaced backwards, the outer and lower border of the tibia presenting prominently.

Treatment.

1. The knee should be flexed and counter-extended.

2. The posterior displacement of the foot should be corrected by pulling the heel forwards and pushing the tibia backwards.

3. The foot should be inverted slightly to over-correct the valgus and dorsiflexed to a right angle (Fig. 27).

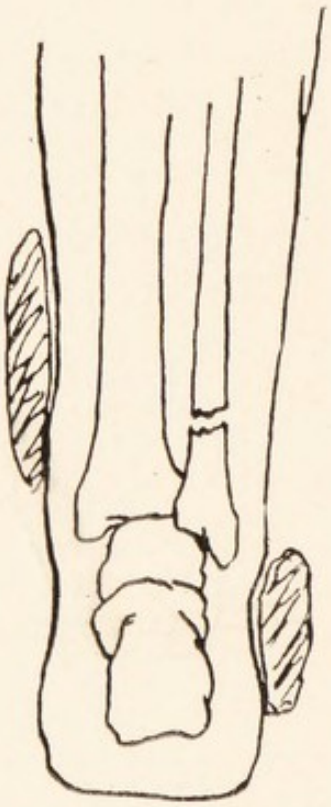

FIG. 27. POTT'S FRACTURE. Showing position of pads to restore curve of fibula and balance of ankle.

After-treatment.—Pott's fracture has been generally looked upon as a most disabling accident, and many surgeons of experience complain that perfect function is rarely restored to the ankle. The sources of failure are twofold: incomplete reduction and inefficient after-treatment. To secure good reduction the correction should be immediate in spite of swelling or bruising, and conducted on the lines indicated above.

The after-treatment is often inefficient in spite of good reduction, the deformity of eversion and abduction resulting. The fracture has united with the foot and ankle in good position, but under the strain of weight-carrying the callus begins to yield and the

astragalus is allowed to thrust the external malleolus outwards, and so a painful traumatic flat-foot is produced. To prevent this it is necessary that walking should be abstained from until the union is firm, and when it does take place, that body-weight should not be erroneously deflected upon the ankle. It is wise to maintain fixation of the fracture for about six weeks, and when the time for walking comes, the boot of the patient should be altered in order to keep the foot inverted, and in heavy folk a light steel brace should be applied to help the action of the boot. The toes should be kept turned in during walking from the first (Fig. 21).

In old cases where either eversion, backward displacement, or both exist, a well-planned operation will restore function.

Common Complications.—The following series of complications are common to cases of Pott's fracture, dislocations, and some so-called bad sprains :

1. The tip of the internal malleolus is generally torn off by the accident—treatment in full inversion meets this.

2. Where the accident is caused by a fall or jump from some height, the astragalus may be forced up between the tibia and fibula, driving before it a wedge-shaped portion of the tibia. Strong traction on the foot and inversion will get the astragalus down between the malleoli, and generally the wedge will follow it, for some fibres of the ligamentous attachments between it and the astragalus will remain.

3. Fracture of the anterior edge of the tibia is very

important, because it is frequently overlooked. The separated fragment slips down in front of the joint and blocks dorsiflexion, a disability which is very crippling to the patient. This disability ought never to occur, for the surgeon ought always to dorsiflex the foot when readjusting an injury about the ankle, to ensure free right of way (Fig. 28).

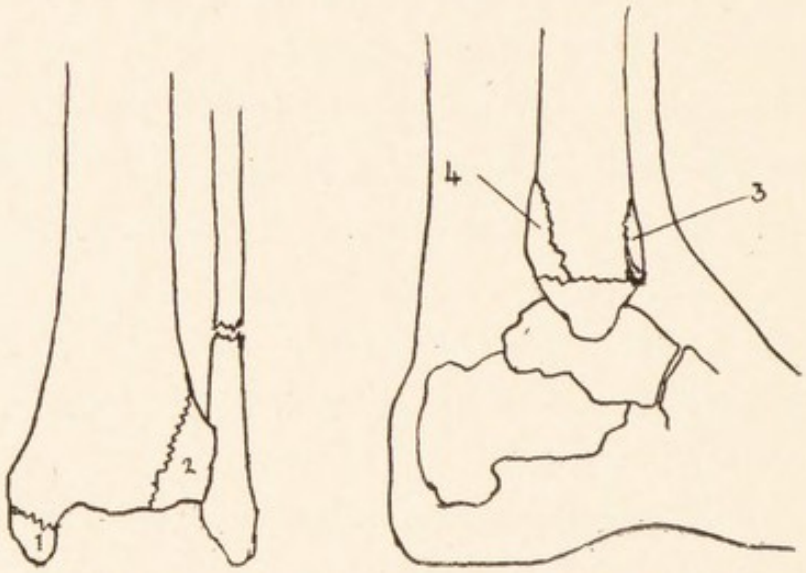

FIG. 28. POTT'S FRACTURE. COMMON COMPLICATIONS. 1. Fracture of internal malleolus. 2. Fracture of anterior wedge of tibia associated with upward displacement of astragalus. 3. Fracture of anterior edge of tibia. In a large proportion of cases the foot and astragalus are dislocated backwards and outwards.

If diagnosed, the foot should be first extended and the fragment pushed into place, then the foot is dorsiflexed. If the fracture is not discovered until the union is firm, it will be necessary to operate. The projecting end of bone should be sufficiently chiselled off to admit of dorsiflexion.

Dislocations and Fractures of the Astragalus.— Dislocation of the entire astragalus forwards is

produced by violent plantar flexion of the foot. The injury is frequently compound.

The diagnosis is obviously made by the hump on the dorsum of the foot, by altered relations of the bony points.

Associated fractures of the malleoli or of the astragalus may be detected by manipulation and will be recognized in the X-ray photograph, which should never be omitted.

Fractures of the astragalus occur most commonly in heavy falls on the feet, when the astragalus may give way instead of the lower ends of the tibia and fibula. The fracture may be transverse, most usually where the body joins the neck, or the line of the fracture may be antero-posterior, splitting the body into two lateral portions.

At one time teachers of surgery laid great stress on the blood supply of bone, and pointed out that once the astragalus was torn from its connexions with the os calcis, necrosis might be expected. This ancient teaching is false. Bone cells have extraordinary vitality, and can survive if only some of the natural fluid effusions of the body can percolate to them. This is amply proved by modern osteoplastic surgery. Bone cells, however, die rapidly in the presence of poisonous products of bacilli, for the osteoclasts cannot open up the Haversian canals rapidly enough to establish a protective hyperæmia. Hence the conjunction of an impaired blood supply and toxic products are fatal to bone, and the only chance of saving it is drainage, sufficiently prompt to

prevent the toxic products from collecting, and so allowing the processes of repair to establish themselves.

Bearing these facts in mind, we may assume that if the astragalus can be got back into good position, a good result may be expected in the absence of sepsis, and is worth an attempt if the septic processes can be kept under control.

Forward dislocation of the whole or of part of a fractured astragalus may be reduced. While an assistant presses the displaced bone backwards, the surgeon exerts traction on the foot to separate the os calcis and tibia. There should be no hesitation about dividing the tendo Achillis to get more room. If the astragalus can be got to engage between the os calcis and tibia, dorsiflexion of the foot may cause it to shoot back into place. If the foot can then be put easily at a right angle to the leg, all will be well.

In cases of transverse or longitudinal fracture, the same line of treatment is to be followed. Once the bone can be got into position between the malleoli, all the surgeon needs to consider is the future usefulness of the foot for carrying weight, and important factors in connexion with flat-foot must have due regard paid to them.

In many cases of displacement of part of the astragalus and in some cases of dislocation of the whole bone, the displaced bone gets turned round in such a way that no manipulation will again twist it into position, when it should be removed.

In transverse fractures of the astragalus the

posterior portion is generally displaced backwards and interferes with the tendo Achillis. This portion may be removed, leaving the anterior part *in situ*, with the foot fixed at a right angle. Effusion takes place into the vacant space, which becomes to some extent organized, and a very serviceable ankle results if the part is protected from strain till repair is well advanced.

Fracture of the Neck of the Astragalus.—The after-treatment of a fracture of the neck of the astragalus, as distinct from a fracture of the body, depends on a proper grasp of the architecture of the arches of the foot, and the distribution of the body weight on these arches. The human foot consists of two portions :

(*a*) A posterior portion, consisting of the astragalus and os calcis, which we shall call the hind part, and is situated behind the mid-tarsal joint, or so-called Chopart's joint.

(*b*) An anterior portion consisting of the rest of the tarsus, the metatarsus, and toes, which we shall call the fore part of the foot, and is in front of the mid-tarsal joint.

The hind part is quite capable of bearing body weight, as is proved by the excellent results of Chopart's amputation through the mid-tarsal joint.

The fore part gives the foot its spring and plays an important part in balancing. The foot is a tripod resting on three points: the heel, the ball of the great toe under the head of the first metatarsal, and the heads of the fourth and fifth metatarsals.

It has a transverse arch, with which we are not here concerned, and two longitudinal arches.

The outer longitudinal, which is less arched than the inner, consists of the os calcis, cuboid, and the fourth and fifth metatarsals, and is not particularly liable to strain—in fact, with any weight on the foot the whole of the outer edge of the foot is on the ground.

The inner component of the longitudinal arch is much higher, and strain of this arch constitutes flat-foot. It rests behind on the os calcis and springs upwards and forwards through the astragalus to its summit, and then downwards, forwards, and **inwards** through the scaphoid cuneiform and first metatarsal to the ball of the foot under the great toe.

The true crown of this arch is in the neck of the astragalus, which is set at an angle, downwards and **inwards** from the body. Hence if the neck is fractured, the effect of putting undue strain on the new callus is to strain it exactly as the astragalo-scaphoid joint is strained in a flat foot.

Hence to protect it the patient should have an outside brace with T-strap and a well-crooked heel, to deviate body weight on to the outer side of the foot until the callus is strong enough to carry weight without being strained, just as if the patient suffered from acute flat-foot (Fig. 21).

Flat-foot, everted foot, and **weak foot** have been applied to various degrees and stages of the same mechanical derangement of the foot, though orthopædic surgeons have not arrived at a definite agree-

ment as to what precise meaning is to be attached to each term. The names matter little, the ideas conveyed by the varied nomenclature are important, for they give a general view of the subject.

The foot of the infant is distinctly adducted and inverted at the mid-tarsal joint—really at the neck of the astragalus, but we need not elaborate that point; the child of two or three years walks with his feet parallel. The Red Indian, who wears moccasins, and bare-footed races preserve the plumpness of the infant foot, and walk with the feet parallel. Civilized man—so called—wears pointed boots, turns out his toes, abducts and everts his foot at the mid-tarsal joint, and really strains this joint and so paves the way for the production of flat-foot.

The plumpness of the foot in barefooted races and the infant is due to full development of the small muscles, which act on the 'fore part' of the foot.

The ugly attenuated foot of boot-wearing races is due to atrophy of these muscles, caused by squeezing the fore part of the foot into a boot which allows no play.

The maintenance of the arch depends on the muscles and the ligaments. Ballet-dancers who have strong muscles and can pirouette on their toes are frequently flat-footed because in the positions of extreme eversion of the foot which they practise they stretch the ligaments under the inner arch of the foot. Hence when they rest, relaxing the muscles, the ligaments are too stretched to maintain the arch, and the foot looks and is flat. The joints are free

and the muscles strong, and so the spring of the foot is maintained. The flat-foot of one who stands all day is different: his muscles are weak, the foot has remained flat and has become stiff in the flat position. Ultimately he has a painless, stiff flat-foot and no spring in the arch, but before he reaches this stage he passes through various painful stages of weak foot to his final condition of flat-foot. **Pain** in flat-foot is mainly due to stretching of ligaments. All the ligaments about the tarsus participate, but strain of the inferior calcaneo-scaphoid ligament is characteristic of the foot which is **becoming flat.** At this stage the foot is not actually flat, and footprint records are of little value, for the normal arch varies greatly in different individuals; hence a person with a naturally high arch suffers more than one with a naturally low arch, without any visible flatness to account for it.

Diagnosis.

1. Pain in the instep across the dorsum, or all over the foot, according to how many of the ligaments are suffering strain.

2. When the patient stands to attention his muscles may pick up the arch and the deformity become less evident, but as the muscles relax he stands with feet everted and the tuberosity of the scaphoid descends.

3. On palpation, tenderness is found under the tuberosity of the scaphoid, due to strain of the inferior calcaneo-scaphoid ligament.

4. In cases with severe eversion, pain is com-

plained of on the outer side, due to the os calcis impinging on the tip of the malleolus. It may be due to periostitis, or an adventitious bursa may form.

5. In acute cases the whole foot becomes painful to touch or movement.

Treatment.—Ordinary cases of painful feet due to an unaccustomed amount of walking, or narrow boots which do not leave room in the fore part for the play of the small muscles, will generally be found to have the characteristic tenderness under the tuberosity of the scaphoid. This demands rest of all the structures on the inner side of the foot. This can be obtained by deviating the body weight on to the outer border of the foot.

Boots should be straight on the inner border and roomy in the fore part, but should grip the 'hind part' comfortably to prevent chafing and blistered heels. The heels of the boot should be a third of an inch higher on the inner than on the outer side to tilt the body weight on to the outer edge of the foot. (Fig. 21.)

Instep-plates are radically unsound, as they compress the small muscles of the sole between the plate and the bones of the foot, and so prevent them from exercising themselves and getting strong. They will do this naturally if relieved of undue strain.

The patient should practise movements:

(*a*) Free inversion movements of the foot and all movements of the toes to strengthen the small muscles of the foot and the tibials.

(*b*) Tiptoe exercises, coming down on the outer edge of the foot—never down in the flat-foot position.

Contrast-bathing by plunging the foot rapidly in hot and cold water alternately is a great stimulus to the circulation and will prevent the muscles from getting cramped and stiff.

All these points are of value in training and hardening recruits. In ninety-nine cases out of a hundred pain in the feet is mechanical strain, not 'rheumatism'; and if the recruit's boots were raised on the inner side of the heel he would be very rarely off the parade ground.

The above line of treatment is applicable to all cases in which the patient can voluntarily invert his feet and walk on the outer edge.

In stiff flat-foot he cannot do so for mechanical reasons; in acute flat-foot pain prevents it.

Acute Flat-foot is due to sudden straining of all ligaments about the tarsus; the whole foot and tarsus becomes acutely tender and somewhat swollen. It may come on by injudicious exercise; it is common, for example, in nurses who are sent on duty too soon after an illness.

It may come on after a foot has been crushed or after a sprained ankle.

Here there has been an injury associated with effusion which has softened and loosened ligaments. After a few days' rest the patient feels better—goes for a long walk before his ligaments have hardened up, and develops an acute flat-foot. In cases of unilateral flat-foot there is nearly always a history

of accident to the affected foot, it may be weeks before.

Treatment.

1. Complete rest in bed and massage to get rid of swelling.

2. A week in plaster of Paris with the foot fully inverted to let all stretched structures shorten.

3. Commence exercise and wear boots with crooked heels, walk with feet parallel exactly as has been described above.

Rigid Flat-foot may be—

1. The end stage of an untreated flat-foot of pure static organ.

2. The final stage of a crushed or injured foot which was not bandaged in the inverted position and treated as described above.

3. The final stage of an arthritis or a gonorrhœal periarthritis, where the patient has walked on the foot before the ligaments were strong.

Every general injury of the foot—crushes, fractures, &c.—should be protected against becoming a flat-foot by not letting the patient walk until he has had the heel of the boot crooked to deviate weight to the outer side, and if the injury has been severe, an outside brace as well.

Treatment of Rigid Flat-foot.—The treatment is to convert the foot into an acute case by giving an anæsthetic, breaking down **all** adhesions with Thomas's wrench (Fig. 13). It is no use breaking down only some of them. The foot must be wrenched in every direction, till it is perfectly pliable; then put in

plaster for ten days in the inverted position ; after that the patient starts walking in a boot with crooked heel, and can generally return to light duty in a month after the foot is wrenched.

A common type of flat-foot is due to spasm of the peroneus longus and brevis muscles, probably the result of strain at their insertion. It presents all the appearance of an osseous flat-foot; the foot is quite rigid and voluntary inversion cannot be performed, but under an anæsthetic the deformity disappears. Such cases are troublesome, and are best treated by excision of half an inch of both tendons just above the external malleolus, followed by inversion of the foot with adduction at the mid-tarsal joint and fixation in plaster for a fortnight. The subsequent treatment is the same as that for ordinary flat-foot.

Alteration of boots, with or without braces, are of no avail in rigid forms of flat-foot until the patient's foot has been forcibly inverted.

Hallux Rigidus.—This affection is proving a source of considerable trouble amongst our recruits. It consists, as its name implies, of a stiffness of the big-toe joint accompanied by pain.

The first objective symptom is an obstruction to full extension of the joint, which, as the disease progresses, results in fixed flexion at the metatarso-phalangeal joint. Swelling may not be present, but sometimes there is lipping of the bones, and it is often associated with flat-foot.

It may be produced by 'stubbing' the toe or by a direct blow, but usually comes on gradually, and is

often associated with a strained foot which is becoming flat. In an unconscious effort to save the arch the patient attempts to maintain it by digging his great toe on the sole of his boot. The joint may become very tender, and in old cases quite stiff. When marching the soldier cannot get off his toe as he steps off, because he cannot dorsiflex it.

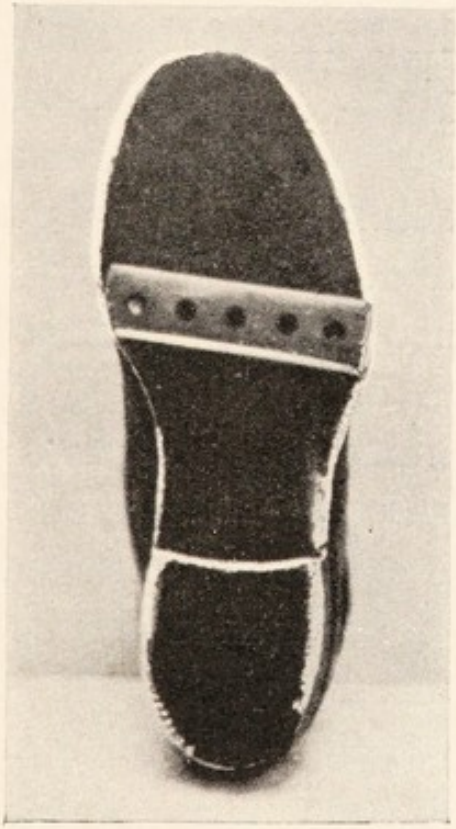

FIG. 29. BAR ACROSS SOLE, BEHIND TREAD.

Treatment.—A bar across the boot about half an inch thick just behind the head of the metatarsal makes the neck of the metatarsal bear the body weight instead of the joint (Fig. 29).

In later stages where the joint is very tender it is more satisfactory to excise the head and form a pseudarthrosis by covering the head of the bone with

subcutaneous fascia or the bursa. Such a false joint restores the function of the foot.

Hallux Valgus.—Hallux valgus is an outward displacement of the great toe. It may give rise to very crippling symptoms, or it may not even be inconvenient. The joint may stand an ordinary amount of strain, but disable the recruit on long marches.

In extreme cases considerable alteration in the relationship of the bones of the metatarso-phalangeal joint may take place. As the phalanx travels to the outer side, the head of the metatarsal becomes partly uncovered and enlarged, with irregular edges due to periosteal irritation. The skin over this prominence becomes thickened, and the bursa inflamed. It is the inflammation of this bursa which gives rise to the painful symptoms sometimes culminating in a cellulitis. This is known as an acute bunion.

The simple case, as in hallux rigidus, can be dealt with by placing a bar across the boot-sole (Fig. 29), but the severe case requires operation, which should not be undertaken until all inflammatory symptoms are in complete abeyance. A pseudarthrosis of the joint should be the aim, when the bursa can be placed over the metatarsal bone after the head and neck are exsected, or a thin slice of the head with its cartilage can be applied to the metatarsal after the removal of the neck ; thus a good weight-bearing joint may be secured.

Excision of the joint is advised by some surgeons. This operation is not a success when performed.

Hammer-toes, which give rise to marked disability

and often prevent the patient from completing route marches, should never be amputated, as this leads to secondary deformities. An elliptical incision should be made over the angulation, and the skin and bursa removed ; then a wedge from the phalanges should be removed sufficiently large to permit of correction of the deformity, and the toe is allowed to ankylose in a straight position.

Metatarsalgia.—This affection is characterized by a cramping pain, more or less spasmodic, situated below the metatarso-phalangeal joint of either the second, third, or fourth metatarsal heads, much more generally the fourth.

It is due to a flattening of the transverse arch and pressure upon the twigs of the external plantar nerve.

The treatment, if radical, is effective—it should consist of removal of the painful metatarsal head.

Palliative treatment should consist in placing a bar of leather across the boot under the tread, just behind the heads of the metatarsals.

Malposition of Joints after Amputation.

During the recovery of stumps after amputation, care should be taken to procure a free range of movement in the neighbouring joints. Otherwise difficulties will arise when the time comes for fitting artificial limbs. This is especially important in the hip and shoulder. Quite a large proportion of cases are returned with flexion at the hip, which can only be accurately detected by flexing the sound limb on the

patient's chest, when it will be found that the stump cannot be fully extended; in other instances there will be limitation in abduction, adduction, or rotation. The shoulder may be similarly handicapped after amputation through the arm. To prevent this, the position of the stump should be frequently changed during healing—a process so often delayed by suppuration—and, in addition, the joint should be put through its full range of movements two or three times a week. Deformities which have been allowed to take place during recovery will require complete correction before an artificial limb can be effectively worn.

If deformity is threatened by contraction of scar tissue, it is imperative that the limb be placed for an extended period in a position opposed to the pull of the scar.

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