

In my opinion, the only satisfactory way of draining the pouch of Haller is by making an opening in the left lateral wall of the pericardium opposite the mouth of the pouch. In order to do this there are obvious advantages in the adoption of the Spangaro operation.

In most cases the tube will lie inside the pleura in its course to the surface and should be packed round with gauze, but if the pleura and lung are not wounded it might be possible to strip back the pleura and push back the lung from the lateral boundary of the pericardium, making the incision in the proper place in the pericardium without opening the pleura.

In reading the records of cases of suppurative pericarditis one is struck with the almost universal difficulty experienced in maintaining drainage. Take, for example, the case of Hilsmann<sup>12</sup> that recovered. A free incision into the pericardium was made in the fourth space. Two pints of pus came out, and much more escaped during the next few hours. During the after-treatment the patient had to bend over, so that his chest was in the position it would have been if he had been standing on his head, in order to empty the pericardium. This manœuvre would cause the ventricles to move forward, and thus the mouth of the cul-de-sac of Haller would be opened.

Again, a fatal case<sup>13</sup> is recorded in which, though a half-pint of thin greenish pus was evacuated through an anterior pericardiotomy, yet at the post-mortem an abscess cavity was found behind and to the left of the heart within the pericardium.

Lastly, cases of purulent pericarditis with left empyema, in which the pericardial wall has been incised through the empyema opening, seem to have a better chance of recovery than those drained through an anterior pericardiotomy. The presence of pus pent up in the cul-de-sac of Haller, quite independently of the effect of sepsis, must interfere seriously with the function of the left auricle.

#### CONCLUSION.

I am well aware that the suggestion I have made that in certain cases of purulent infection of the pericardium the cul-de-sac of Haller should be drained is not founded on the actual successful performance of the operation, but I venture to maintain that such an operation is justified on the anatomical and pathological considerations which I have endeavoured to set before you.

I do not doubt that the surgery of the heart will occupy in the coming time a conspicuous place in surgical practice. The reward of success will attend our efforts in so far as the heart is treated as one of the ordinary tissues of the body and the method of operation conforms to the fundamental principles of surgery.

What developments in this field of surgery may take place we cannot know. It is best to be content with the present splendour and not to be impatient to paint yet more glorious triumphs on the cloud curtain of the future.

<sup>12</sup> Ueber die Paracentese des Pericardiums, Kiel, 1875, Inaug. Dissert. This is one of the 51 cases described by Porter in the Annals of Surgery, 1900.

<sup>13</sup> Coutts and Rowlands: Brit. Med. Jour., Jan. 2nd, 1904. Pericardium exposed by removing the left fifth cartilage and nibbling away a bit of the adjoining cartilaginous sternum. Half a pint of thin greenish pus escaped on incising pericardium. Death three months later. Autopsy: Besides other lesions an encapsuled abscess containing 3 oz. of pus was found. The cavity lay behind and to the left of the heart and within the pericardial sac. The original anterior pericardial wound was not quite closed. It led to a small pocket of pus in front of the heart.

## TREATMENT OF MALUNION IN FRACTURES OF THE FEMUR.

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### Introduction by

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SOON after the armistice was signed in November, 1918, British soldiers who had been wounded and taken prisoners to Germany began to arrive at our base hospitals in France. Amongst them were a considerable number of fractures of the femur, many of which I saw and examined. Without exception the condition of all these fractures was so extremely bad that they excited universal comment and condemnation, and caused me to inquire into the method or methods of treatment which they obtained behind the German lines.

I had long been aware that many of the Germans had looked upon a soldier with a fractured thigh as a useless encumbrance and hardly worth treating; as long ago as November, 1914, they had deliberately left such a man to die in Ploegsteert Wood, and on three other separate occasions I had personally known men brought by our soldiers into our "C.C.S.'s" who had been refused removal by German stretcher-bearers, stripped of their tunics and equipment, and left on the ground in their shirts. I had also seen some of our prisoners exchanged two years ago as useless on account of fractures of the thigh with gross deformity and shortening, who were returned to England because German surgeons looked upon them as too bad for any surgeon to cure. Yet a large percentage of them recovered with good limbs after appropriate surgical treatment in England. I was therefore quite prepared to find that the results obtained by German surgeons in general were very bad, and, I must add, that, as far as I could ascertain, their own soldiers and ours were treated by the same methods.

The ignorance of the essential principles of treatment must have been very widely spread if one may judge from the similarity of the results from different parts of Germany.

The following was the routine method:—

When picked up the patient was placed upon a stretcher without any extemporised splint, such as a rifle, and was then transferred to an evacuation hospital 10 to 20 miles to the rear. No attempt was made here to operate under an anæsthetic, and dressings often remained unchanged for several days at a time.

In most of the cases the limb was splinted at this stage, but the only splint usually employed was a trough-shaped wire splint without a foot-piece. I have seen many of these, and they were so frail as to be of little use. As no extension was applied, the limb rolled out with the weight of the foot and shortened to a variable extent.

In this splint the patient remained and was transported farther back. The wounds were generally dressed every second day. After the lapse of about two or three weeks the wire splint was commonly removed and the injured limb was enclosed in plaster-of-Paris, which was taken up over the pelvis as far as the nipples. During these two or three weeks more and more shortening had taken place, and the malposition was now rendered permanent by the plaster case. The wound was still dressed every two or three days through

a "window" cut in the splint. After a further period of about two months the plaster case was removed and no other splint treatment was adopted. Sores caused by splint pressure and by vermin were the rule. After this stage had been reached the patient was either left in bed, if too ill to move, or was allowed to get about on crutches. If union of the fracture was materially delayed amputation was frequently resorted to.

Such is a bare outline of the methods adopted in the case of British prisoners who have been restored to our hospitals, and such, I believe, was the routine treatment of German wounded also. No improvement of methods was discoverable even at the end of the war.

I think that perhaps the most remarkable fact is that "extension," which has been the routine method in most countries for over 40 years, was practically never employed, but I should add that at Cologne one "professor" did employ it in the most primitive and barbarous manner in the chief hospital for prisoners in that town. This method was as follows:—

First, an incision was made two inches behind the anterior superior iliac spine, and then the bone was perforated and a steel hook put through the ilium and brought out above the iliac crest. To this hook a cord was attached, and at the other end of the cord two bricks were slung over the head of the bed. Another steel hook was fixed to the tibia below the tubercle, and to this a cord was attached and two other bricks were slung over the foot of the bed. A whole ward of 30 British patients were thus treated in Cologne until the "professor" died and his colleagues abandoned the method. All hook wounds suppurated and were, as a rule, still suppurating when the survivors arrived in France.

How many of the British prisoners with fractured thighs lost their limbs by amputation and how many died we have no means of knowing, but the evidence of the survivors shows that both these results were of frequent occurrence. The whole story is very discreditable as far as the German surgeon is concerned, but, fortunately, the results obtained in England by operations on the shortened and deformed limbs go a long way to make amends.

#### *Treatment of Malunion in Fractures of the Femur.*

By W. ETHERINGTON WILSON.

Repatriated prisoners of war from Germany have supplied most of the cases of our series in which osteotomy has been done. Other sources have also produced their quota of crooked thighs. These cases are interesting, for they show the results of the ignorant and vicious methods practised by the German, causing hideous and awful crippling which by present-day methods are avoidable. Major M. Sinclair, in THE LANCET of March 29th, 1919, drew attention to these facts.

The results following osteotomy as done by Mr. Harold Wilson, M.S., F.R.C.S., have been excellent and amply justify the operative technique employed.

The after-treatment of the cases in the femur wards follows the teaching of Major Sinclair, whose inventive and mechanical mind has turned the fractured femur into an interesting study. The treatment of fractures has received an impetus during the war which cannot be lost sight of, and it is hoped that the wage-earning capacity and the standard of efficiency required by a man's work will not be lowered in the future to the extent described in 1908 by Mr. Clinton T. Dent in his annual oration on the "After-effects of Injuries,"

in connexion with the Metropolitan Police, read before the Medical Society of London.

#### *Actual Conditions Present in Malunion.*

(1) *Shortening* from 2 in. to 7 in. caused by overlapping of the fragments and bowing of the union in one or other direction. The pull of the rectus femoris and hamstrings are chiefly responsible.

(2) *Bad alignment*.—This varies according to the site of fracture.

(a) *Backward sagging* of the lower fragments with union at an angle directed backwards is a common deformity present in these cases. It is one of the worst deformities of the femur, and one of the most prone to occur, especially in lower third fractures in which this deformity eventually produces genu recurvatum, resulting in disorganisation of the knee-joint and crippling. The chief factor producing this, apart from gravity, is the backward pull of the gastrocnemius.

(b) *Outward bowing*, caused either by union at an angle outwards, or by using the limb too early without support in cases of soft or frail union, is common. In some cases of soft union, when all apparatus has been removed, the thigh will bend outwards by muscular action only. When this bowing occurs in lower third fractures the knee-joint is thrown out of line, and an unequal strain on some parts of the joint follows, resulting in crippling. The muscles concerned in the bending of the thigh outwards are those causing abduction of the upper fragment, assisted by muscles attached to the pelvis and the femur, which lie in a vertical plane internal to the bone itself, forming, as it were, the strings of a bow.

(c) *Forward or inward bowing* of the femur is not common.

(d) *Flexion, abduction, and external rotation* of the upper fragment, particularly in upper third cases, is a common deformity, these three conditions coexisting. The amount of external rotation is judged by the appearance of the lesser trochanter in an antero-posterior skiagram; the greater the external rotation, the more of the trochanter is visible. The unopposed pull of the external rotators, glutei, and ilio-psoas, and the slackening of the strap-like ilio-tibial band all help in the production of this malposition of the upper fragment. The results of inefficient treatment in these cases are shortening, T-shaped union of the fragments, and an unsightly thigh, the end of the upper fragment often making its way through the skin.

(e) *Internal rotation of the lower fragment* is caused by the rest of the limb below the fracture being allowed to roll inwards, chiefly through lack of support. Union in such a position results in the toes being turned in to a varying degree, and this, combined with other deformities present, makes progression exceedingly awkward. The result of union of a fracture in which the upper fragment is very much rotated out and the lower rotated inwards, leaves a condition in which the patient has little or no power to turn his toes out voluntarily.

(f) *Traumatic coxa vara*, present in some cases of fracture of the neck of the femur, resulting in shortening and adduction. Osteotomy at the site of fracture was not done in these cases owing to the risk of suppuration in the hip-joint.

(3) *Impaired movement of knee-joint*.—The range of possible flexion was very poor in most of the German cases, as, apparently, no attempt was made by them to deal with the knee question. In one case in which good movement was present it was only got at the cost of increased deformity due to the man being allowed to walk very early and without any walking appliance.

#### *Causes of Undue Stiffness of the Knee in Fractured Femurs.*

(a) Suppuration among the thigh muscles, particularly the quadriceps extensors, resulting in scarring and fixation to the bone. This scarring of the quadriceps, especially when near the knee, is the most important cause of a stiff joint. (b) Inflammation and injuries about the joint, in some cases caused by the use of

callipers, transfixing pins, &c. (c) Prolonged immobilisation, with no efforts at massage and movement.

Extension through the knee-joint is not of itself responsible for stiff joints. Instructive examples of this fact were seen amongst some of the prisoners of war, of which the following case may be regarded as typical.

Pte. M. had an almost immovable knee-joint before osteotomy. When a knee-flexing splint came to be fitted after 10 weeks' extension in a straight Thomas, 20° of flexion at the knee-joint was found possible.


#### *General Principles in the Treatment of Malunion.*

In the cases requiring osteotomy the bone was divided at the site and in the plane of union of the original fracture. The further treatment of these cases was carried out in the femur wards, and the stages may be very briefly mentioned and summarised as follows:—

*First position.*—Application of a well-fitting Thomas's splint, &c., the thigh being kept in position by an extension, for which purpose Sinclair glue or two screws in the upper third of the tibia were utilised; I prefer the tibial screw extension to any other form and this was chiefly used. Callipers to the knee were not used. The limb is supported by slings clipped in position in the usual way and the foot controlled by Sinclair's foot-piece. Extension is obtained by "body-weight," the amount being regulated by the height of the foot of the bed.

*Extension by screws into the tibia.* (Fig. 1.)—These were largely used in the cases of osteotomy for malunion where a heavy pull was required in the first position. Method of application: The leg is shaved in the area of operation and the strictest aseptic precautions are necessary. The patient is anaesthetised.

*Inner screw.* A horizontal incision  $\frac{1}{2}$  in. long is made down to the bone on the inner side mid-way between the anterior and the postero-internal borders of the subcutaneous surface of the tibia, 1 in. below the tubercle. A hole is bored slightly downwards, backwards, and outwards through the compact bone, passing across the medullary cavity, and striking off the compact tissue of the opposite side. The diameter of the boring instrument should be less than that of the screw. The latter is driven home, and it is most important that a firm grip should be obtained into the compact tissue of the opposite side. The screw is 2 in. long.

The outer screw,  $2\frac{1}{2}$  in. long, has to pass through the anterior tibio-fibular compartment of the leg before reaching the antero-external surface of the shaft. The skin incision is made in the same way, but at a lower level, so that the screws do not foul each other, and the knife is then carried in a plane at right angles to the original incision so as to do the minimum amount of damage to muscle. The screw is fixed in position in the same way as described above, but it is rather more difficult than in the case of the inner one. About  $\frac{1}{2}$  in. or more of each screw remains unburied, and over each of these a metal ring-shaped  is applied, one of the loops having 3 ft. of strong tape firmly tied on to it. Dressings soaked in a 5 per cent. solution of picric acid are applied, and the whole field of operation is concealed by a sterile gauze roll. This dressing is never removed unless occasion arises.

The two tapes are tied round a square extension support of metal fixed to the end of the Thomas, the ring of the splint having been pushed up the thigh previously as far as the tuber ischii. The width of the extension support keeps the tapes clear of the malleoli.

*Advantages of screws.*—(1) They are absolutely painless if properly inserted. Those cases which have experienced both glue and screws infinitely prefer the latter. A patient upon whom osteotomy had been performed was not aware that screw extension was being used until he was questioned about them four weeks later. (2) In certain cases when the skin will not

stand a pull by glue, screws will save much trouble both to the patient and the surgeon. (Screws must not be applied to blistered parts.) (3) Once inserted, the screws last throughout the treatment of a case. (4) Unlike the wounds produced by many callipers, they do not cause a zone of inflammation, and the wound heals in a few days when the screw has been removed. (5) A greater amount of pull can be obtained than with glue, sufficing for all practical purposes.

*Disadvantages.*—(1) The possibility of sepsis, depending entirely on the precautions taken. Our results have been excellent, and nothing untoward has occurred. (2) An anaesthetic is needed for their insertion, but in cases in which the femur is being put up under an anaesthetic or an operation done in the theatre the screws are done at the same sitting.

No anaesthesia is necessary for their extraction; the process is not so painful as pulling glue or adhesive plaster off a hairy leg. X rays show an area of atrophy around the thread of the screw, and this makes extraction of the screw easy.

The first position is, therefore, one of extension and of manipulation of the fragments, the deformity being corrected and an additional length given to the limb. The attainment of the latter is accomplished in two to three weeks by continued and steady traction on the soft parts of the thigh, the supporting slings controlling the fragments as desired. Enough callus is, as a rule, formed in eight weeks to hold the fragments in the desired position, and the first stage is thus terminated.

*Second position.*—In the second position the body-weight extension is no longer allowed, so that the limb lies passively in the splint. A knee-flexing arm is applied to the Thomas and movements begun. The second stage is, therefore, one of passive hardening of the newly formed callus, and is utilised also for movements of the knee.

*Third position.*—After three to four weeks a walking calliper is applied and used for two to four months. This period is one of active hardening of the junction of the fragments, and prepares for the time when the patient can discard all appliances with safety.

All the upper third malunited fractures were treated on Sinclair's net-bed, and it is impossible to over-praise this excellent means of double abduction and extension in the first stage. Frequent skiagrams must be taken, especially in the first stage of the treatment, anterior and lateral views being necessary. Massage of the knee and patella and muscles of the thigh is begun early, as is also electrical stimulation of the quadriceps.

#### *Type of Suppuration after Osteotomy.*

The outstanding feature in the majority of cases in which osteotomy was done for malunion was the occurrence of suppuration, and this of a peculiar and apparently characteristic type. It will be seen from the table appended that all but two of the cases operated on had been healed for periods varying from two to ten months, and the greater number of these suppurated after osteotomy was performed. This fact suggests that the organisms concerned remained latent in the tissues, either in the soft or bony parts or in both. It has been demonstrated by other observers that organisms do exist, and remain latent in scar tissue and in and around foreign material in wounds which have been healed for some time. It is a common experience to see a "flare up" nowadays in a stump or limb many weeks after complete healing, causing sometimes a transient inflammation, sometimes suppuration, with the "melting away" of an old scar. The presence of a sequestrum is also a

common cause of the above state of affairs, and it is possible that dead bone may not reveal its presence for many months and then show itself in the way mentioned. Skiagrams occasionally show opacities in some of the long-standing cases, suggesting dead bone, and yet the wounds healed up without operation. How long and how many of these cases will continue healed remains to be seen in the future. In some of the cases to be described the infection following the operation was undoubtedly derived from the bone, for cavities containing purulent material were seen during the operation in the newly formed bony parts.

#### *Results of Examination of Pus and Bacteriological Report.*

The pus is thick, dirty yellow, abundant, and has a most characteristic foul, strong, faecal-like odour, making the vicinity of the patient most offensive. The pus from a number of these cases was examined with a view to demonstrating the presence of spore-bearing anaerobes. No spore-bearers, however, were shown. The pus contained abundant organisms of the proteus and coliform types which produced very foul cultures. Staphylococci were constantly present; streptococci also in most cases. On one occasion cultivation of a small piece of scar tissue removed at the time of operation grew *Staphylococcus aureus* only.

#### *Course of Events following Osteotomy.*

Drainage is provided in all cases, as for two or three days the oozing of blood derived from the raw bony surfaces is considerable. The amount of shock was small in those cases in which the operation did not prove very difficult, where little blood was lost, and where gas and oxygen with ether was the anæsthetic used. Some shock would seem to be produced by hammering upwards against the hip-joint. It is odd that even after six and eight months, suppuration, so profuse in amount and clinically so alarming, should occur. The thigh swells up, becoming tense, shiny, and tender. Two to three days after operation the oozing blood becomes purulent and offensive. The next day or so a profuse discharge of pus is obtained. The temperature reaches  $101^{\circ}$ – $103^{\circ}$  (see Chart 2) about the fifth day and a corresponding rapid pulse is obtained (100–120). If the draining proves adequate the temperature begins to fall step-ladder fashion, becoming normal about the tenth day. Improvement is first detected by wrinkling of the skin taking the place of the glossiness, and appears first when the temperature is beginning to come down. The progress of the case depends on the efficiency of the drainage. The stitches of the 8-in. incision do not attempt to give, and there is often no redness of this part, or, indeed, of the thigh as a whole, due to the fact that the pus is among the muscles and deep to the strong limiting fascia lata of the thigh.

The attenuated organisms are not of a virulent character, for after the natural forces of the body are mobilised and brought into the field of action, a matter of some five days, the enemy is soon overcome. A profuse foul discharge may be kept up for some time, but the temperature and pulse keep down. A subsequent rise of temperature indicates the collection of a pouch of pus requiring an outlet. (See Chart 3.)

Necrosis following suppuration after osteotomy necessitated sequestrotomy in five cases. In doing the operation of sequestrotomy the old scar is used, a sinus being present here as a rule. A 4-in.

incision is usually made down to and through the periosteum. The latter is raised and the bone chipped away around the cloaca until the cavity in the femur is exposed and can be thoroughly explored for the removal of the sequestra. At the same time the cavity is converted into a pond with sloping edges to hasten its obliteration and healing of the case. Sequestrotomy was not done early in the cases mentioned. The operation should be

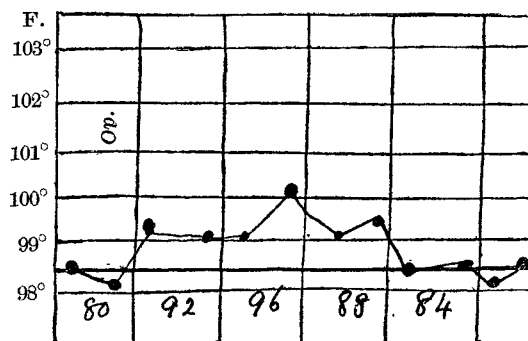


CHART 1.—Osteotomy without sepsis.

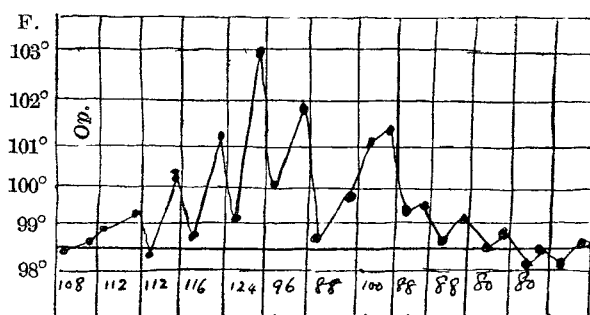


CHART 2.—Osteotomy complicated by sepsis.

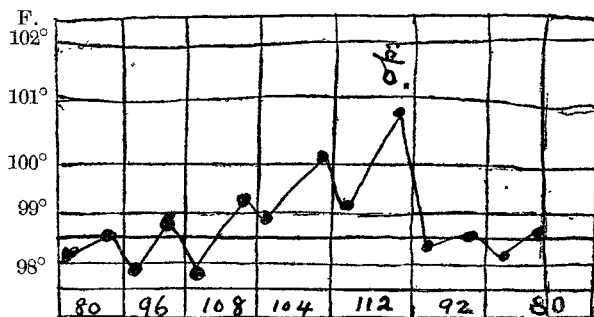


CHART 3.—Pocketing occurring later, after osteotomy and sepsis.

left until it is time for the patient to walk or until he actually has walked about in a calliper for three weeks or so. Obviously, with firm union such an operation can be more safely and thoroughly done.

#### *The Operation of Choice and the Prevention of Bad Results.*

It may be argued that it would be better, in view of the suppuration occurring, to divide the femur some distance away from the site of fracture in a fresh field free from lurking organisms. The results obtained, however, by the operation as done by Mr. Harold Wilson leave no doubts as to the method of choice. The only disadvantage, suppuration, has not proved dangerous when properly provided for.

The advantages of this operation are:—

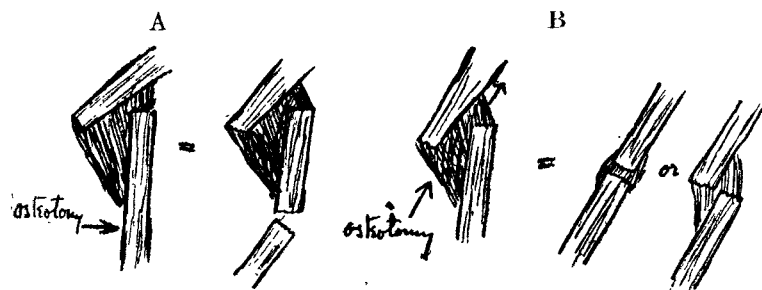
(1) *Increased length*—an important factor when 2 in. or more (see Table of results) may be added to the length of the limb.

(2) *Improvement of alignment and correction of deformity*.—In cases where there is angulation it is most important that in the corrected position the fragments, if not in end-to-end apposition, should at least lie parallel to one another and so produce a straight thigh. The importance of this cannot



be exaggerated, especially in the deformity resulting from the backward sag of the lower femoral fragment.

The two methods may be represented as shown in Diagrams A and B.



Result.—Correction of alignment to a large extent, but shortening still remains.

Method of choice.—Result: Better correction of alignment and correction of shortening.

The causes of angulation and bending of the femur are:—

(a) *Want of care in the first position.*—Mere plating of a femur and treatment without a slight extension on the limb to keep the muscles occupied leads to union, often in a bowed position; indeed, the strong plate bends also if the screws hold.

(b) *Assuming the third position too early or discarding the calliper too soon.*

(c) *Walking when angulation is already present to a greater or less degree.*

(d) *Frail union*, as when only half the broken surface of the femur throws out callus; when loss of bone results in a large gap made good by callus; when there is partial union only, through the loss of fragments; if end-to-end apposition is obtained with little visible or palpable callus.

(e) *Sepsis.*—When a sequestrum is present sepsis does not prevent formation of callus, but occasionally seems to hinder proper calcification, with the result that bowing occurs on walking, or even by the traction of muscles while the limb lies in bed between sand-bags.

As already mentioned, premature walking is not the only cause of bowing of the thigh; it can occur by muscular action alone while the limb lies passively in bed. The commonest direction of bowing in these cases is outwards, and seems to be due largely to the pull of the adductor muscles on the lower fragment in some cases. The upper third fracture, or osteotomy, particularly offends in this way, the bowing outwards being primarily due to the extraordinary tendency to abduction of the upper fragment.

Such cases are treated by being put up again into the first position of extension at once, and no difficulty is experienced in getting good alignment again in a few hours or days. A fortnight in this position and a further three to four weeks in the second position warrants a further trial with the walking calliper. The case that has once "bent" needs to be watched, for it may recur, and a further period of treatment, as just described, may be necessary. Bowing of the thigh is often the cause of a surprisingly large amount of shortening,  $1\frac{1}{2}$  and 2 in. being common in the slightly curved cases, and this is especially true of upper-third fractures.

#### Methods for the Correction of Bowing.

(1) *Re-fracture by breaking, without open operation.*—The site of fracture is snapped across and the corrected alignment maintained by treatment in the first position with the help of slings pulling the fragments into position. This method, of course, would apply only to recent cases where there was no great overlap, or to cases of frail union

which would not mould into position, but would crack across the narrow bridge of callus instead. Simple fractures are safer to deal with in this way than compound, owing to the risk of suppuration ensuing in the latter.

(2) *Active moulding by manipulation*, with or without an anæsthetic, depending on the case and resistance expected. This is done by trying to bend the femur back gently into the straight position over one's arm. This, as a rule, requires to be done within three months of the original fracture, but the amount and density of the callus, as shown in a skiagram and the history of the case, must determine whether moulding is possible. Upper-third cases are difficult to treat by this method, especially when the upper fragment is a mere stump. The case is then treated in the first

position, &c., as just described for recent bowing of the thigh.

(3) *Passive moulding* by treatment in the first position—i.e., continuous pulling and the help of slings or pressure pads, which help to push the bent thigh straight. This method often, in combination with active moulding, is the method to be preferred. For upper-third cases the net-bed is most successful. This method, again, depends for its success on the time since the fracture and the amount and quality of the new bone formation.

Pte. R., admitted 13 weeks after simple fracture of upper third. Firm union. Much outward bowing due to abduction of upper fragment. (Fig. 3.) Shortening  $1\frac{1}{2}$  in. Treated on net-bed with 24 in. drop. Skiagram three days later showed no improvement. Ten days later some alteration in position had taken place quite distinctly. After 14 days' continuous pulling, the alignment as shown in Figs. 11 and 12 was obtained. Shortening now  $\frac{1}{2}$  in. Bowing absolutely corrected. Treatment, before walking in a calliper, lasted nine weeks.

Pte. Y. Compound fracture, mid-third, of several months' standing. Wound healed. No overlap of fragments, firm union. Net-bed had to be used owing to the outward bowing of the femur being too great to allow of the application of a Thomas splint. Shortening 5 in. Ten days later a flush appeared around the scarring. T.  $103^{\circ}$ . The flush spread up and down the thigh in the usual way, then subsided in three days. X rays showed the femur straightening out, and four weeks' pulling produced the desired result. The second position was maintained for three weeks. Deformity corrected; shortening 2 in. To prevent the tendency to bowing the thigh was put in plaster, over which a walking calliper was worn. Suppuration would probably have ensued in this case if osteotomy, or cracking the femur across, had been done. A similar result might have followed forcible moulding, so the method of passive moulding was probably the shortest and the safest in the long run.

(4) *Osteotomy.*—Cases of bowing with a great deal of overlap should be treated by osteotomy through the plane of union, as described below.

Pte. C. (Figs. 5 and 6) shows the results of such treatment on a net-bed. Besides the angulation present there was 4 in. of shortening. The result was a perfect thigh with  $1\frac{1}{2}$  in. shortening.

Pte. W. had similar treatment, except that it was thought better to wire the fragments together to hold them in position until union occurred. The overlap was very small, the shortening being due almost entirely to the extreme abduction of the upper fragment. Profuse and long-continued suppuration followed operation. Shortening reduced from  $3\frac{1}{2}$  in. to  $\frac{3}{4}$  in. Deformity corrected.

#### Osteotomy the Operative Technique.

The operative technique, as adopted by Mr. Harold Wilson for the treatment of malunion, is as follows:—

A large incision (6 in. to 8 in.), utilising the excision of a scar or unhealed sinus when these are present, is

made on the outer side of the thigh. The incision is so placed as to enable the lower end of the upper fragment to be freely exposed, for the latter serves as a guide for the insertion of the osteotome into the plane of union. The lower fragment usually lies deep to the other and on its inner side, its upper end lying high up when there is much overlapping. The incision cuts cleanly through the skin, fascia lata, and muscle, down to the bone, incising the periosteum from end-to-end of the wound. Bleeding from several arteries, branches of the external circumflex, is often severe and these require tying. It is better to work without a tourniquet.

The thickened periosteum is elevated completely off the fragments, a scalpel being necessary in places where scarring binds the periosteum down. The periosteum having been raised and a free exposure of the site of union obtained, a broad, slender Albé osteotome 2 in. wide is inserted under the lower end of the upper fragment if possible, and the junction of new bone between the fragments divided carefully in an upward direction. Just how the osteotome is placed depends, of course, on the disposition of the fragments, the aim being to divide the new bony cement and not the original main fragments. The latter are liable to splinter if care is not taken, and one object of the broad osteotome is to try and prevent this.

An assistant now holds the foot and moves the leg as directed, to enable the operator to make sure that division is complete and to give him an idea how the fragments are eventually going to lie in relation to one another when extension is applied. Any scar tissue or props of bone, inhibiting free movement or preventing apposition, are removed. In some cases simple division may be all that is necessary. In others, division of union and shaping of the ends of the bone may be deemed advisable, due allowance being made for the subsequent lengthening which will occur as the result of continuous extension. In others, again, division and the free removal of props of new bone (see Figs. 9 and 10) is necessary before correct alignment by pull is possible, as these bony growths keep the fragments apart. The wound is irrigated with hot saline and tags of tissue removed. The muscle and covering fascia are sewn up with continuous catgut and the skin sutured, drainage being provided by a large tube carried down to the bone at the upper end of the incision. An additional tube is sometimes inserted about the middle of the incision, or posterior drainage is provided, especially when suppuration is expected. The limb is then put up into the first position in a Thomas's splint or a net-bed, as the case requires, and treated as an ordinary fractured femur. In simple malunited fractures, or when no suppuration is expected, the drainage-tubes are removed in 48 hours.

*Further treatment.*—Most of the further treatment has been described above. An X ray is taken three or four days after the operation, and any adjustment required is made then. Large quantities of callus are usually throw out in these cases of osteotomy, and there is little fear of non-union provided the suppuration problem is dealt with effectively. Thirteen weeks usually sees the patient on his feet in a walking calliper, although a small sinus may still be present and the case may require a sequestrotomy at a later date. The skiagrams shown are typical examples of the results obtained.

Summary of Methods of Treatment for Malunion.

- (1) Deformity with much overlapping (i.e., shortening): Osteotomy through plane of union.
- (2) No deformity but much overlapping (2 in. or more): Osteotomy through plane of union.
- (3) Deformity with little or no overlapping (recent case): (a) Moulding into position; (b) or actually cracking the bone across and treatment by splinting and extension.
- (4) Deformity with little or no overlapping (old case with firm union): (a) Re-fracture if possible without an open operation; (b) open osteotomy.

In conclusion, I desire to express my thanks to Sir Anthony Bowlby for the introduction. To Mr. Harold Wilson, who initiated the femur work in this hospital and was until recently in charge of

the femur wards, I am deeply grateful for kind and useful guidance. Lieutenant-Colonel R. J. W. Oswald, O.B.E., R.A.M.C.T., commanding the 1st London General Hospital, has kindly consented to allow the publication of these cases.

Showing Results following Osteotomy.

Case No.	Region of fracture.	Condition of wound at operation.	Suppuration after operation.	Shortening before and after operation.		Knee flexion before and after operation.	
				Bef.	Af.	Bef.	Af.
1	Upper third. (Sinclair net-bed.)	Healed 2 mos.	Moderate.	4½ in.	2¼ in.	0°	20°
2		" 3 "	"	4¼ "	1¼ "	5°	15°
3		" 10 "	Slight.	3½ "	1½ "	90°	90°
4		" 4 "	Severe and prolonged.	3½ "	¾ "	30°	Uf.
5	Middle third.	Simple fracture.	—	1¼ "	¼ "	5°	30°
6		Unhealed.	Slight.	3 "	1 "	0°	30°
7		Healed 5 mos.	Nil.	2¾ "	½ "	10°	45°
8		" 4 "	Moderate.	3¼ "	1¾ "	10°	45°
9*	Lower third.	Unhealed.	Severe.	4 "	1½ "	5°	30°
10		Sinus c. sequestra.	Moderate.	4½ "	2 "	5°	20°
11		Healed 5 mos.	Slight.	2¾ "	1½ "	15°	30°
12		" 4 "	Moderate.	5 "	2 "	5°	20°
13†		" 6 "	Nil.	2¾ "	½ "	10°	60°
14‡		Unhealed c. sequestra.	Profuse.	7 "	1½ "	5°	Uf.
15		Simple fracture.	—	3 "	Nil.	15°	Uf.
16		" "	—	2½ "	1¼ in.	35°	35°
17		Healed 2½ mos.	Moderate.	4¾ "	4 "	0°	Uf.
18		" 8 "	"	3¼ "	¾ "	90°	60°
19		" 3 "	Severe.	3½ "	1¼ "	10°	30°
20		" 3½ "	Nil.	2 "	Nil.	10°	Uf.

\* See Figs. 5 and 6. † See Figs. 9 and 10. ‡ See Figs. 3 and 4. Uf. = Unfinished.

Showing Results following Moulding (see Figs. 11, 12).

Case No.	Kind of fracture.	Time between date of fracture and moulding.	Shortening before and after operation.	
			Before.	After.
21	Upper third shaft. Gunshot wound.	4 weeks.	1 in.	¼ in.
22	"	1 year.	2 "	½ "
23	Pulping of trochanters. Gunshot wound.	18 weeks.	2½ "	1½ "
24	"	12 "	2½ "	¾ "
25	Pulping of upper third shaft. Gunshot wound.	7 "	1½ "	0
26	Upper third shaft. Simple fracture.	8 "	1½ "	½ "
27	"	4 "	1 "	0
28*	"	14 "	1¾ "	¾ "
29	Middle third shaft. Gunshot wound.	30 "	5 "	2¼ "
30	"	14 "	8 "	1½ "

\* See Figs. 11 and 12. The upper third cases were all treated on a net-bed, for periods varying from 6 to 12 weeks. In all cases the deformity present was corrected, and thereby the limb considerably lengthened.

DESCRIPTIONS OF ILLUSTRATIONS.

- FIG. 1.—Method of extension by screws in tibia.
- FIG. 2 (Case 14 in table).—Showing extreme flexion and abduction of upper fragment. Union firm. Sinuses c. sequestra present. Treated by wedge-shaped osteotomy from outer side; sequestra removed at the same time. (Screw extension to tibia.)
- FIGS. 3 and 4.—X ray of Case 14. Before operation and three weeks after operation. Result shown in table.
- FIGS. 5 and 6.—Before and after osteotomy. Showing upper fragment abducted, flexed, and externally rotated. (See Case 5 for result.)
- FIGS. 7 and 8.—Before and after operation. Lateral views. Shows great overlap of fragments, and then reduction in the finished result. (Case 8.)
- FIGS. 9 and 10.—Shows necessity of removing the "bony props" during operation. Also shows cavity in femur c. debris. (Case 13.)
- FIGS. 11 and 12.—Before and after "moulding" on a net-bed. (Case 28.)

FIG. 1.



FIG. 2.



FIG. 3.

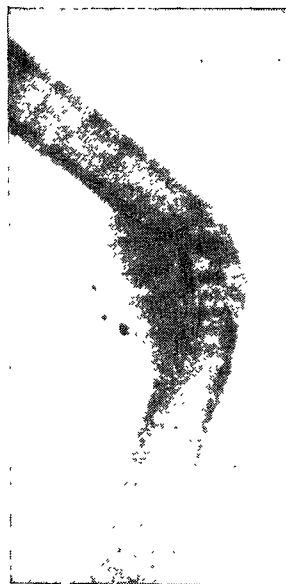


FIG. 4.

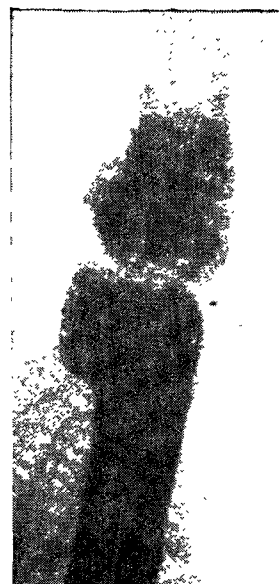


FIG. 5.



FIG. 6.



FIG. 7.

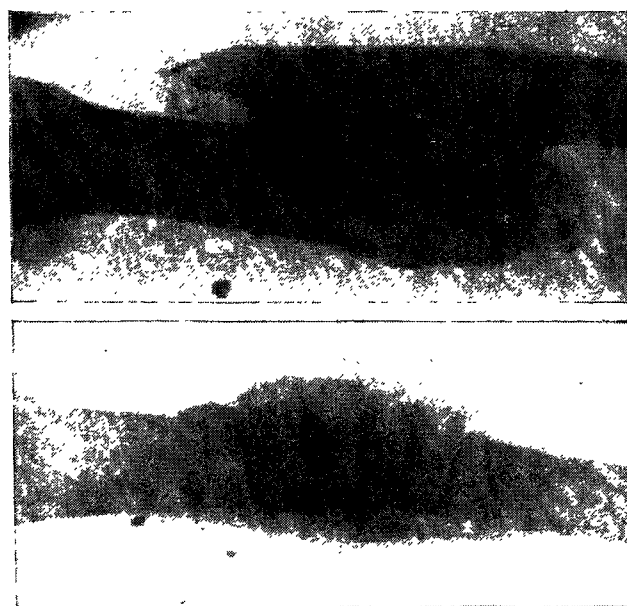


FIG. 8.

FIG. 9.



FIG. 10.

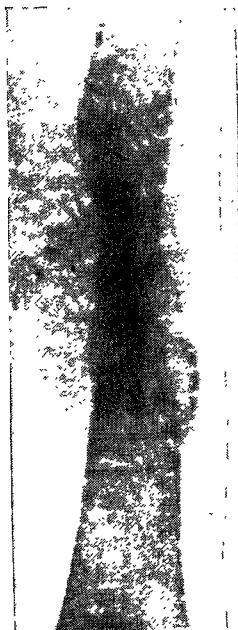


FIG. 11.



FIG. 12.

