Original Articles

SKELETAL TRACTION BY MEANS OF KIRSCHNER'S WIRE IN THE TREATMENT OF LOWER LIMB FRACTURES

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THE evolution of fracture treatment may be divided into three periods :—

The primitive, from the dawn of history to the end of last century

In all countries and in all ages fractures were treated by tying a piece of wood or metal to the fractured limb, with the idea of holding the fragments in position, after the surgeon had 'set' it by traction and manipulation to bring the broken ends into apposition. As this manœuvre was usually attempted without anæsthesia it frequently failed and, even if it was successful at the time, the retraction of the muscles reproduced the deformity in a few days, so that shortening often accompanied by angular deformity was the usual result. The value of traction in lower limb fractures was beginning to be recognized towards the end of this period, but as it was applied without suspension its efficiency was impaired; the only exception was Hodgen's splint for fractures of the upper end of the femur, a piece of apparatus based on sound principles which is still occasionally used. The introduction of plaster-of-Paris splints was a great advance, as, if the fragments were properly reduced under anæsthesia and the splint was skilfully made without too much padding, it could be relied on to hold the fragments in position long enough to permit of callus formation advancing far enough to fix the fragments. This is still the best method for superficially-placed bones such as the tibia and fibula, when the shortening can be readily reduced, but repeated checking of the position by *x*-rays after the plaster has been applied is essential, as there is a tendency to recurrence of the deformity when the limb wastes and the plaster loosens. Prolonged fixation in plaster is apt to lead to troublesome adhesions in neighbouring joints and hence much attention has recently been paid to the use of ambulatory methods, which permit of early use of the limb whilst still encased in plaster. Böhler employs an unpadded plaster splint, the accurate fitting of which allows of early weight-bearing without risk of angulation or lateral deviation of the fragments, but it must be admitted that the fitting of a non-padded plaster cast requires great skill and involves more risk to the skin in a tropical country.

The second or operative period initiated by Arbuthnot Lane

Dissatisfied with the results of fracture treatment as then practised, he advocated the treatment by open operation of all fractures which could not be easily reduced, the levering of fractured ends into position and fixing them by steel plates screwed on to the bones. Lane was a great surgeon and in his skilful hands many excellent results were obtained, far in advance of those usual in that day; all his followers, however, had not his technique and the supervention of sepsis was a grave disaster that usually left the patient much worse off than if the fracture had been treated on orthodox lines, and this after a long and grave illness. As time went on it became apparent that the absolute immobility of the fractured ends led to delay in callus formation, that minor grades of sepsis often led to a rarefying osteitis around the screws which necessitated the removal of the plate at a later date and that, even if asepsis was perfect, fibrosis and adhesions amongst the muscles and tendons followed the wide opening up of the parts, so that the functional result was less perfect than the exact anatomical reposition would lead one to expect. The method was never applicable to compound fractures, as the introduction of a foreign body into a potentially or actually septic wound violated all recognized principles of surgery.

Certain recent fractures are still treated by open operation, where there is some intervening soft tissue which absolutely prevents reduction in any other manner, but plates are rarely used nowadays, the wound is closed and skeletal traction is applied exactly as in a closed fracture. Fractures of the patella and the olecranon will always remain suitable cases for operative treatment. Old mal-united fractures for many years furnished an ideal field for this method, and the writer has had a long series of successful results, but latterly better results have been attained with less sacrifice of bone length by the application of skeletal traction after removal of callus and freshening the bone ends.

The third period, opening soon after the beginning of the Great War

It was quickly recognized that any form of fixed splint interfered with the dressing of the severe compound fractures then met with, that traction was essential to correct shortening, and that the traction to be efficient must be combined with suspension, for choice in a skeleton splint of iron which would permit of ready access to the wound. With the development of the treatment of compound fractures by excision of the wound we are not here concerned. The Thomas' splint which had long been used in the Liverpool school for the treatment of fractures of the femur at last came into

its own, thanks to the influence of Sir Robert Jones and the band of workers he gathered round him, and throughout the war it was used with great success in all the British theatres of war. Traction was ordinarily applied by strapping extension, but in the case of fractures of the tibia and fibula the surface of skin available for applying the strapping was insufficient, so that devices, such as Sinclair's skate, gauze affixed by glue or a stirrup passed beneath the tendo Achillis above the os calcis, were utilized. In the case of low fractures of the femur Pearson's modification of Besley's ice-tongs caliper enabled traction to be applied directly to the bone. This latter appliance was a great advance which enabled shortening to be completely corrected in cases where extensive wounds rendered it impossible to obtain sufficient undamaged skin for the application of strapping extensions, but it had several grave drawbacks. Pressure atrophy of the bone was liable to occur, the calipers unless carefully watched might 'creep' and set up infection in the structures of the knee joint and occasionally the supervention of sepsis led to a low form of osteomyelitis of the femur or even arthritis of the knee joint, with delayed convalescence and troublesome stiffness of the joint. In spite of all these drawbacks however the method was much used during the war, both for the femur and applied to the malleoli for fractures of the tibia and the results were so much superior to those obtained by other methods in dealing with the terrible injuries then met with that its drawbacks were condoned. After the war these drawbacks began to appear more important, especially when they occurred in cases of simple fracture and gradually this method of extension lost its popularity. Steinman's pin, a straight steel pin sharpened at one end, which was driven through the bone was an improvement, but its introduction was laborious for the surgeon and the hole left in the bone was large, so that sepsis sometimes followed. This method, always very popular on the Continent, never had much vogue in England.

The position remained stationary until the introduction by Kirschner of Tübingen of the 'piano-wire' method of extension which, almost universally adopted in Germany and in Vienna for the past few years, has only recently begun to be generally used in England.

This is an ideally simple method of obtaining skeletal traction with the minimum of trauma. A wire of rustless steel of one millimetre or two millimetres in diameter according to the weight to be applied (2 mm. is generally preferable) sharpened at one end is driven through the bone. This may be accomplished either by a hand or electrically driven drill, but in any case the slender wire needs to be supported or it would buckle up under the pressure necessary to force it through the bone. There are various devices to accomplish this, but the cheapest and most efficient apparatus is that illustrated in figure 1, designed by Soutar. It is an ordinary Colt's bone drill worked by hand, with an extension piece of three metal cylinders which telescope into each other. The wire shown in the figure is clamped into the drill chuck and the extension is drawn out as far as necessary to enclose

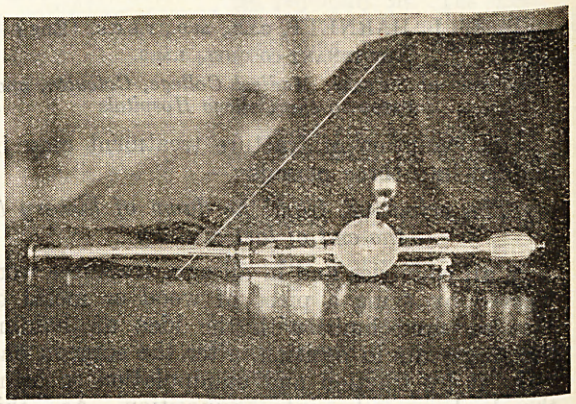


Fig. 1.—Drill with telescopic extension and Kirschner wire.

the wire, leaving about one inch protruding. This is pressed against the part to be drilled and the crown wheel is revolved. As the drill penetrates the tubes telescope into each other until the wire has passed through the bone and appeared on the other side, the drilling is continued until the tubes are completely telescoped into each other. The chuck is then unscrewed and the apparatus disconnected, leaving the wire in the bone. The next step is to put the wire under tension sufficient to stand the pull without buckling. Figure 2 illustrates the stirrup of elastic steel

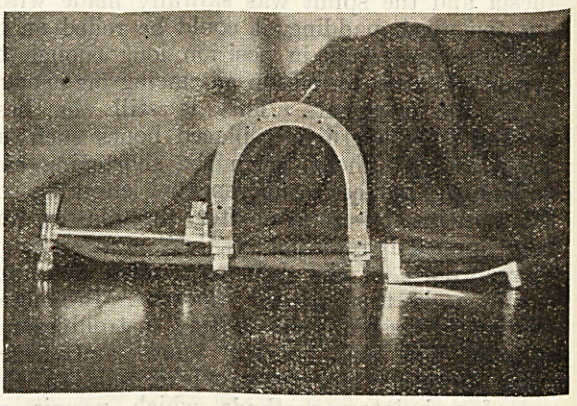


Fig. 2.—Stirrup, tension apparatus and spanner.

used for this purpose. The wire is clamped into the far side of the stirrup, leaving the near-side clamp loose, the screw tension appliance illustrated is then fitted and tightly clamped to the wire. The screw is turned until the wire is under sufficient tension to stand a pull of 15 to 20 pounds, the near-side clamp of the stirrup is

then tightened by the spanner, the clamp on the tension apparatus is released, and it is disconnected, when the stirrup springs apart and holds the wire under tension sufficient to enable it to carry the needed weight. For the femur the best place for the wire is the tubercle of the tibia about half an inch from the surface where the bone is very dense. The limb is put up in a bent Thomas' splint with knee flexed, slung

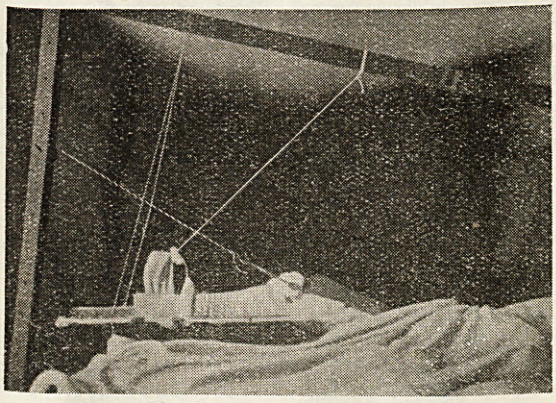


Fig. 3.—Fractured femur with Kirschner wire extension, Thomas' splint and Balkan frame.

to a Balkan beam, and 15 to 18 pounds weight, according to the build of the patient, is attached to the stirrup. Extension is maintained for about five weeks, by which time the fracture should be united. The wire is then found to be quite loose and may be cut off and removed without causing pain. A strapping extension is applied for another two or three weeks if there is any doubt as to the firmness of the union, after which a walking caliper splint may be fitted. In many cases union is so perfect that after a further rest of two or three weeks with massage and exercises the patient is able to get up and walk out of the hospital (*see* figures 3 and 4).

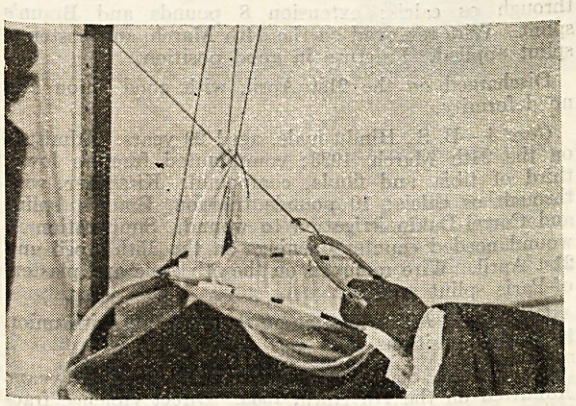


Fig. 4.—Near view of figure 3.

For a tibia-fibula fracture the wire is passed through the os calcis, the point for drilling the bone being two finger-breadths below and behind the medial malleolus. The limb is placed in a Braun's splint (figure 5) and the arrangement of

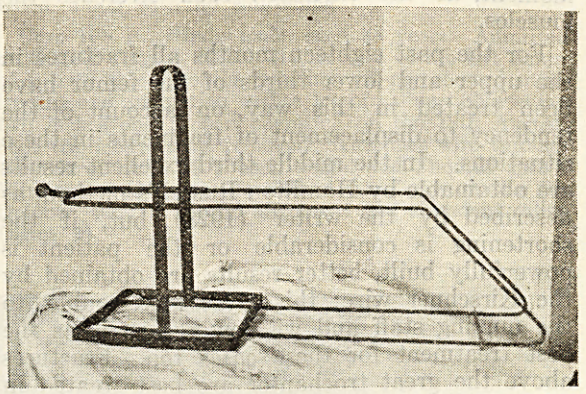


Fig. 5.—Braun's splint.

the apparatus is shown in figure 6. Ten to twelve pounds weight is ample—less often suffices—the general principle always being to use only the minimum weight which will suffice to correct shortening without drawing the ends apart. In all cases a sling must be applied to the foot to prevent foot-drop. For tibia and fibula fractures extension may be maintained for much longer; bad compound fractures may need extension for two or three months. In the case of the femur the effect of long-continued traction on the knee joint has to be considered and five weeks is about the limit if the knee joint is not to be rendered unstable by stretching of its ligaments.

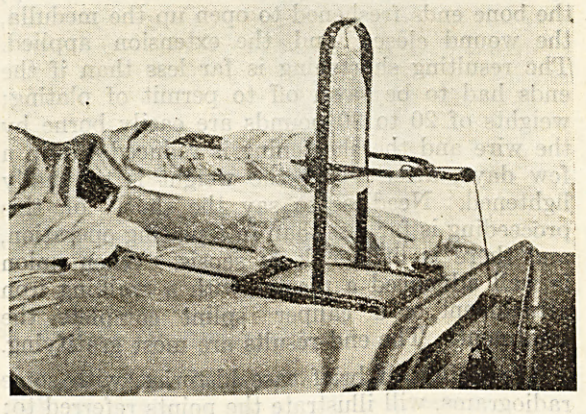


Fig. 6.—Arrangements for extension of a tibia-fibula fracture.

Extension may be applied to the humerus by passing the wire through the olecranon and to the radius and ulna by passing it through the lower ends of the bones, but of these methods the writer has no personal experience.

On the Continent the wire is always passed under local anæsthesia, but we find general anæsthesia by evipan sodium very convenient;

it gives 15 to 20 minutes' unconsciousness, quite sufficient to get the limb arranged in the splints. The imperfect relaxation obtained is of no moment, as the extension soon stretches the muscles.

For the past eighteen months all fractures in the upper and lower thirds of the femur have been treated in this way, on account of the tendency to displacement of fragments in these situations. In the middle third excellent results are obtainable by Hamilton Russell's method, as described by the writer (1928), but, if the shortening is considerable or the patient is powerfully built, better results are obtained by the Kirschner wire; this gives less trouble to the nursing staff and we now regard it as the best treatment for these cases too. Fractures above the great trochanter are best treated in Whitman's plaster splint.

Simple fractures of the tibia and fibula may be put up in plaster and treated thus, provided the *x*-ray shows that the fragments are in satisfactory apposition, but if not the plaster is cut off and a Kirschner wire is put through the os calcis and the limb is placed on a Braun's splint, the method which is used as a routine in all cases of compound fracture after the usual excision of the wound.

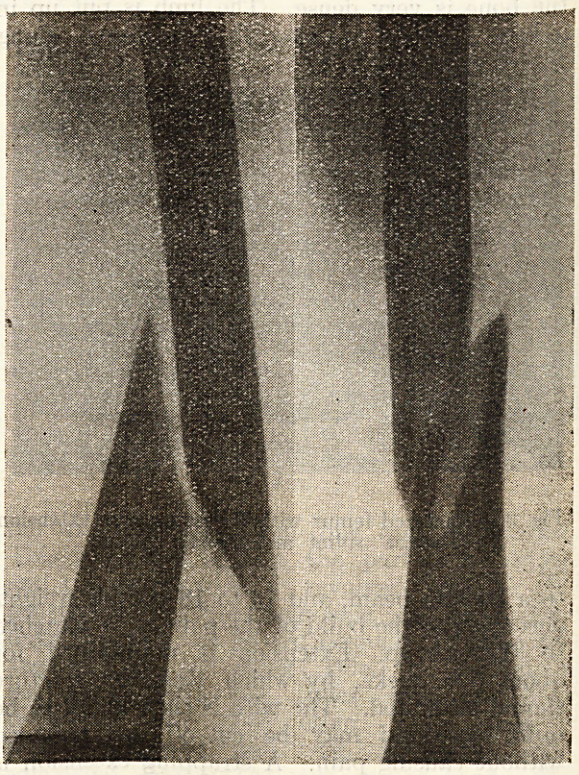
In mal-united fractures of the femur or leg bones the method gives results far surpassing those obtainable by plating. If the fracture is not more than two months old it is refractured under full anæsthesia and then treated by extension exactly as a simple fracture, if of longer standing with radio-opaque callus, an open operation is performed, the callus chiselled away, the bone ends freshened to open up the medulla, the wound closed and the extension applied. The resulting shortening is far less than if the ends had to be sawn off to permit of plating; weights of 20 to 30 pounds are easily borne by the wire and the shortening is reduced within a few days, after which the weight is gradually lightened. Needless to say the shock of this proceeding is far less than in a plating operation, and there is little risk of sepsis. When union is well advanced a plaster with a walking iron attachment or a caliper splint complete the treatment. The end-results are most gratifying.

A selection of brief case histories, with some radiograms, will illustrate the points referred to:

Case 1.—S. S. B., Hindu female, aged 58 years. Admitted 8th November, 1932. Old fracture of upper third of right femur four months ago. Shortening 1¾ inches. *X*-ray showed sub-trochanteric fracture with adduction of lower fragment and acute angulation. Refractured on the 20th November and extension 15 pounds applied by Kirschner wire through tubercle of tibia; put up in extreme abduction. Wire removed on the 17th December; discharged on the 5th January, 1933, in plaster-of-Paris splint; subsequently fitted with caliper walking splint.

Final shortening ¾ inch; some adduction recurred owing to breaking up of plaster, but walking well in the splint and satisfactory clinical result.

Case 2.—N., Hindu male, aged 15 years. Admitted on the 6th January, 1933. Recent oblique fracture of lower third of left femur. Shortening one and a half inches (figure 7*a*). Kirschner wire through tubercle of tibia. Wire removed on the 7th February; extension by strapping for two weeks more. *X*-ray on the 25th February (figure 7*b*); discharged 3rd April.



(*a*) (*b*)

Fig. 7.—Case 2. (*a*) Before extension, and (*b*) six weeks later.

No shortening and patient able to walk. No caliper necessary.

Case 3.—B. R., Hindu male, aged 30 years. Admitted on the 3rd February, 1933; comminuted fracture of tibia and fibula, half inch shortening. Kirschner wire through os calcis; extension 8 pounds and Braun's splint. Wire removed on the 14th March, and posterior splint applied. Fracture in good position.

Discharged on the 21st April, with good union and no deformity.

Case 4.—B. S., Hindu male, aged 20 years. Admitted on the 24th March, 1933; comminuted fracture lower third of tibia and fibula, compound. Kirschner wire through os calcis; 10 pounds traction, Braun's splint and Carrel-Dakin irrigation to wound. Suppuration in wound needed counter openings on the 15th April and 21st April. Wire removed on the 5th June and plaster-of-Paris splint applied.

Discharged still in plaster on the 21st July with union in perfect position.

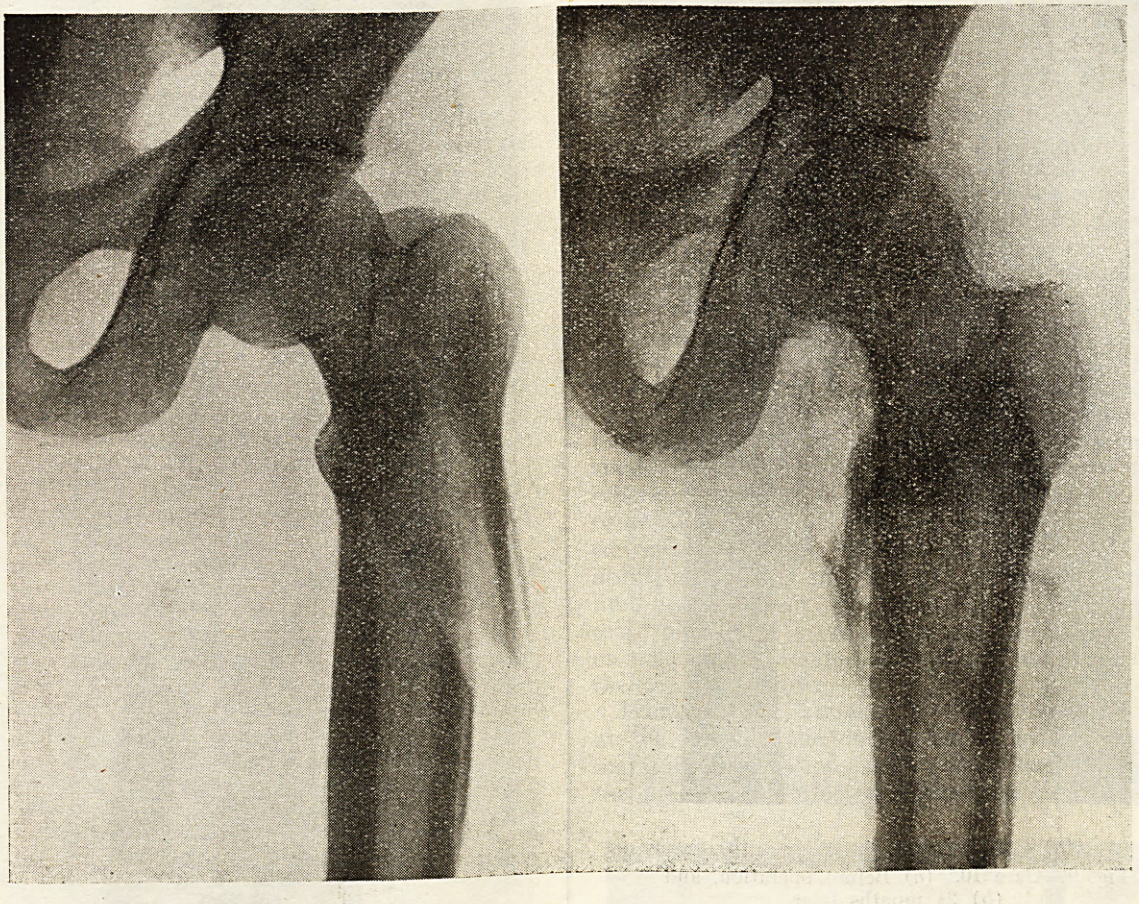
Case 5.—A. S., Mahommedan male, aged 25 years. Admitted on the 7th April, 1933. Direct violence fracture of left femur at junction of upper and middle third (figure 8*a*); showed tendency to adduction of lower fragment, half inch shortening. Kirschner wire through tubercle of tibia, 15 pounds traction and Thomas' splint. Wire removed on the forty-seventh day (the reason for this long retention is not recorded in the notes, probably union was progressing slowly,

but the knee joint was not suffering from the prolonged traction). *X*-ray on the 28th June (figure 8*b*) shows perfect position and abundant callus. No caliper necessary.

Case 6.—R. K., Hindu male, aged 30 years. Admitted on the 14th July, 1933. Compound comminuted fracture of left tibia and fibula. Kirschner wire through os calcis; 10 pounds traction, Braun's splint. Wire removed on the 7th September and plaster-of-Paris splint applied.

Discharged on the 13th November in plaster. Wound healed, firm union in good position.

Case 7.—A. M., Hindu male, aged 35 years. Admitted on the 4th August, 1933. Bad compound comminuted fracture of tibia and fibula. Shortening two inches.



(*a*) (*b*)

Fig. 8.—Case 5. (*a*) Before extension, (*b*) on discharge 2½ months later.

Kirschner wire through os calcis; 8 pounds weight and Braun's splint. Wire removed on the 22nd September, plaster-of-Paris splint with walking piece applied.

Discharged 13th October with good union and no shortening, still wearing plaster.

Case 8.—M. I., Mahommedan male, aged 8 years. Fracture of right femur two months ago. Shortening one and a half inches, bad angulation. Open operation on the 19th August, using Henry's incision; ends trimmed; Kirschner wire through tubercle of tibia; 9 pounds weight and Thomas' splint. Good union; discharged with no shortening three months later. No walking caliper necessary.

Case 9.—B. K. R. C., aged 24 years. Admitted on the 11th September, 1933. *X*-ray showed comminuted fracture middle third of the right femur. One inch shortening and angulation. Kirschner wire through tubercle of tibia; 18 pounds weight and Thomas' splint; wire removed on the 19th October.

Discharged on 12th November in a walking caliper. Good union with no shortening.

Case 10.—B., Hindu male, aged 38 years. Admitted on the 8th August, 1933. Old fracture of the left femur of two to three months standing. *X*-ray showed overlapping and angulation with a lot of callus. Shortening two inches open; open operation on the 18th August, ends trimmed; callus removed; Kirschner wire through tubercle of tibia; 18 pounds weight and Thomas' splint. Wire removed on the fortieth day. *X*-ray on the 7th October showed a good alignment and abundant callus (figure 9).

Discharged on the 6th November walking with a stick; no shortening and no caliper necessary.

Case 11.—M., Hindu male, aged 10 years. Admitted on the 31st July, 1933. Compound fracture of right tibia and fibula. Wound excised and put up in plaster by Winnet Orr's method. Wound healed but *x*-ray showed position not good and one inch shortening. Refractured on the 21st September; Kirschner wire through os calcis; 12 pounds weight. Wire removed on the 23rd October and plaster-of-Paris splint.

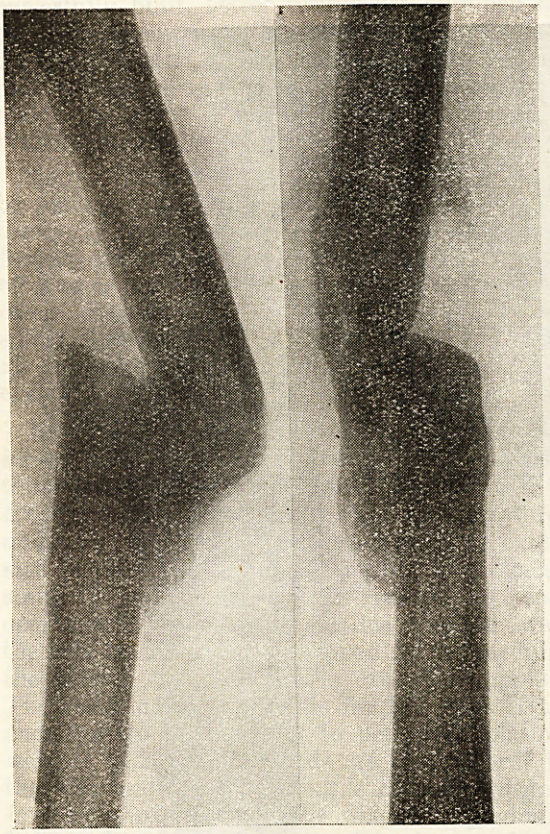
Discharged 12th November with half an inch of shortening remaining, but good functional result.

Case 12.—K. N. S., Hindu male, aged 19 years. Admitted on the 16th October, 1933. Comminuted fracture upper third of the left femur. Alignment good

but one and a half inches of shortening. Kirschner wire through tubercle of tibia; 15 pounds weight and Thomas' splint. Wire removed on the 18th November.

Discharged on the 6th December in walking caliper splint with good union and no shortening.

Case 13.—B., Hindu male, aged 40 years. Admitted on the 22nd January, 1934. Severe compound comminuted fracture. Wound excised and put up in plaster-of-Paris splint according to the Winnet Orr's method. Severe sepsis supervened and plaster was removed on the 8th February, when the leg was found to be in such a septic condition that the question of amputation was considered. It was decided to put a Kirschner wire through the os calcis with a weight of 10 pounds and to treat by mercurochrome irrigations on a Braun's



(*a*) (*b*)

Fig. 9.—Case 10. (*a*) Before operation, and (*b*) 2½ months later.

splint. The sepsis slowly yielded to this treatment and the condition of the bones on 10th October is shown in figure 10. At the end of May healing of the wound was so far advanced and the bones uniting in such excellent position that the wire was removed after a stay of three and a half months, and a plaster-of-Paris splint was applied. It is unlikely that this limb could have been saved by any other treatment.

Case 14.—A. A. S., Mahommedan male, aged 26 years. Admitted on the 12th February, 1934. Very severe gunshot wound with compound fracture of the right tibia and fibula, the ends of the bones protruding from the wound. Usual excision of wound; Kirschner wire through os calcis; 10 pounds weight; Braun's splint and irrigations of mercurochrome 1 in 1,000. The *x*-ray (figure 11) shows the condition one month later, the bone is severely comminuted and there are innumerable pieces of metal in the soft parts. In spite of this union was so far advanced four months later that the wire was removed and plaster-of-Paris splint applied. In neither of these cases did the presence of the wire for four months produce any ill effects. The excellent position of the bones will be noted in the skiagram. I think it may fairly be claimed that such results are impossible

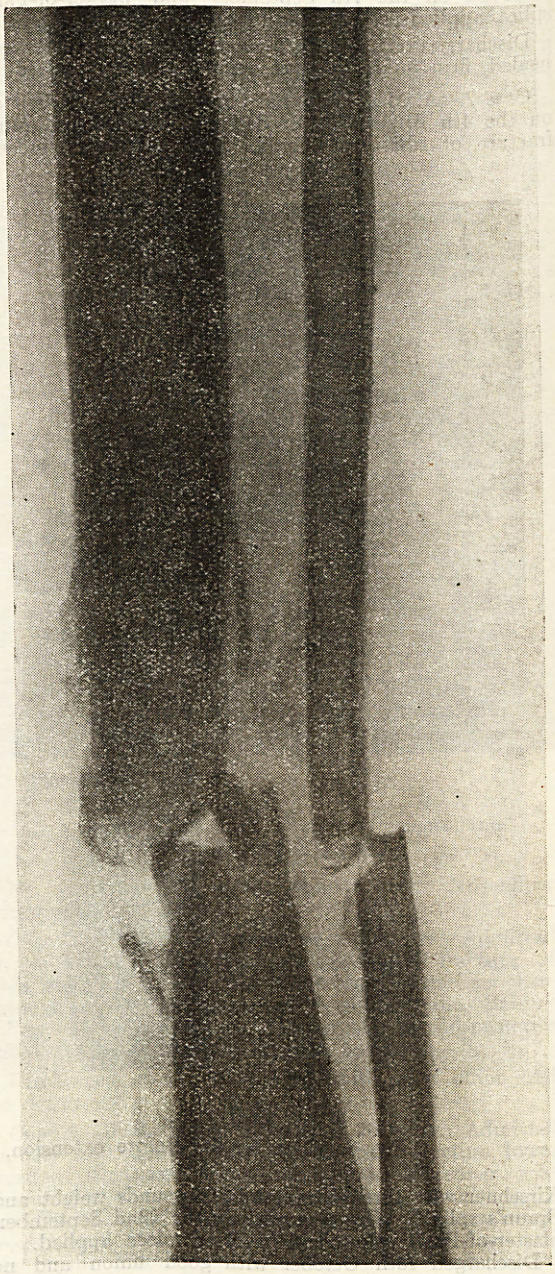


Fig 10.—Case 13. Antero-posterior view.

of attainment in such bad cases by any other method of extension. The apparatus is not expensive and the technique is soon acquired. The patients are very comfortable and the work of the nursing staff is much facilitated.

For specifications of the splints the reader is referred to two excellent articles by

H. R. Rishworth, which appeared this year in the January and March numbers of this journal.

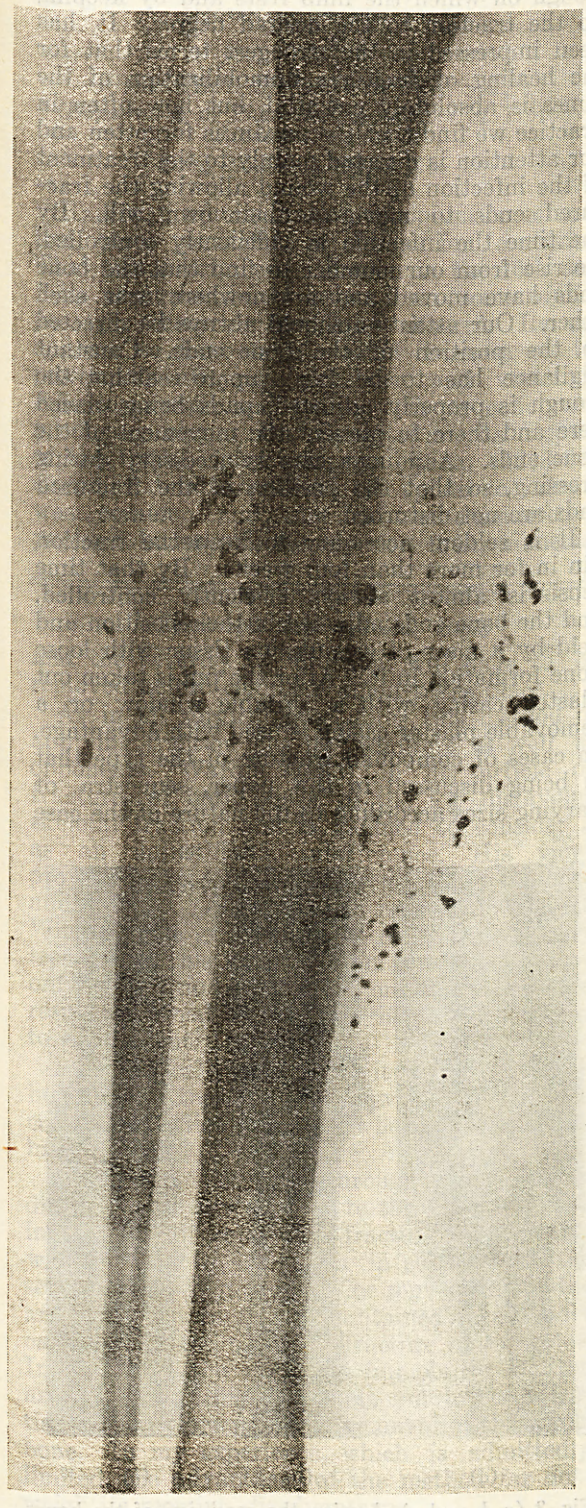


Fig. 11.—Case 14. Antero-posterior view.

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Harnett, W. L. (1928). The Treatment of Fracture of the Femur. *Indian Med. Gaz.*, Vol. LXIII, p. 233.

TREATMENT OF COMPOUND FRACTURES OF BONES OF THE LEG BY SKELETAL TRACTION

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THE majority of cases of fractures of both bones of the leg can be successfully treated with splints and plaster applied after proper reduction and without continuous traction. In oblique or spiral fractures, however, there is a tendency for the displacement to recur as soon as the manipulative extension is discontinued, and also in some cases of compound fractures coaptation of the fragments after reduction cannot be maintained unless adequate traction is continued during after-treatment. In compound fractures with a more-or-less trivial external wound and a moderate amount of damage to the underlying soft structures, open reduction after a thorough surgical toilet of the wound and immediate plastering gives very good results; but when the patients come under observation after the infection has settled in the tissues, or where there is extensive mutilation of the soft parts, the amount of toilet necessary for immediate plastering becomes impossible. In them it is imperative to keep the wounds open for purposes of free drainage of the infection and management of the wound. Winnett Orr's method can be used successfully in certain types of infected fractures, but there still remains a group of cases where any attempt to practice this method will cause the infection to continue and spread along the tissues, considerably jeopardizing the life and the safety of the limb of the patient. In these cases where immediate plastering is impossible one has to depend on continuous traction and proper splinting for their management.

I have found Thomas' bed knee splint bent at the knee to the desired angle admirable in maintaining fixation and giving support. As the presence of infected wounds on the surface

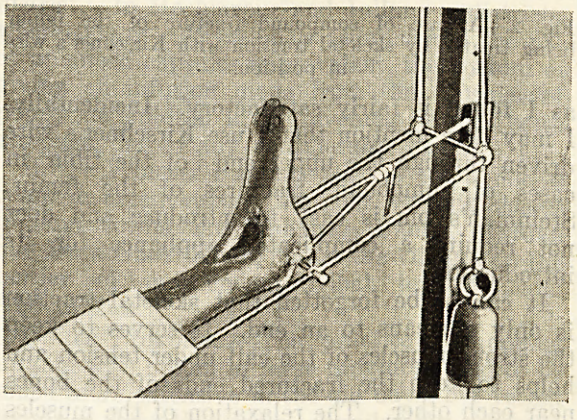

Fig. 1.—A case of compound fracture of the talus being treated by skeletal traction with Steinman's pin in position.