THE CHARNLEY WALKING CALIPER

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This weight-relieving caliper was designed by Charnley during the war, and was accepted by the War Office as the standard Army caliper for short-term use in adults, for the treatment of fractures of the femur that had reached that stage of union which was not yet considered solid enough for unprotected weight bearing.

It is essentially a temporary caliper, and as such has valuable advantages. It can be mass-produced. It is cheap to make. It can be fitted in half an hour from stock, so that a patient can have his plaster removed and be fitted directly into a caliper. The ring can be correctly fitted to the root of the limb and is then comfortable. The components of the caliper can be used again and again on different patients. It eliminates the inevitable delay when ordering a caliper from a proprietary source.

The use of calipers in the Army in fracture work permits of early ambulation, and frees hospital beds to allow the patient to proceed to Convalescent Depot where periodic joint movement out of the caliper can be carried out; thus rehabilitation, both local and general, can be carried out while in a caliper at these centres.

Patients evacuated from Commands abroad are frequently seen fitted with a caliper of a proprietary type made to measure from local resources, to fit individual patients, who shortly after arrival in this country are able to discard this caliper, which can now not be used again. If, instead, the patient has been fitted from stock with a Charnley Walking Caliper, these parts could be taken into use in this country. Further, there is a tendency in some Commands abroad to produce their own variety of the Charnley caliper, and these models show defects.

The purpose of this paper is to describe the caliper in detail so that the standard model, of proven value during the war, can again be used throughout the Army, either in the United Kingdom, in Commands abroad or during the long chain of medical evacuation from Commands abroad to the United Kingdom; and to point out that there are two types of heel sockets, one for the use of fractured femora and the other for use in fractured tibiae.

INTRODUCTION

The Charnley Walking Caliper is not a complete weight-bearing caliper. If this is required (e.g., for aseptic necrosis of the femoral head following a dislocated hip) a caliper with a patten, made to measure by an instrument maker, and with the shoe of the normal side raised, is required. On the other
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hand, where a long knee brace only is required, and where weight relief is not the primary function of the caliper, such as in paralysed quadriceps after poliomyelitis, a half ring with a soft front of leather strap and buckle is more comfortable and quite adequate.

Some indications for the temporary use of this caliper are:

1. Fracture of the Femur

There is no doubt that a well-fitting Charnley caliper can relieve a fractured femur from the major part of the body weight, but if it does not fit, the splint becomes dangerous and useless.

(a) Fractured neck of femur after insertion of a Smith-Petersen nail. Some surgeons use it until there is X-ray evidence that the fracture is united.

(b) Trans-trochanteric fractures in young adults. This type of fracture, whether treated conservatively or by open reduction and metallic fixation, is prone to late varus deformity if the fracture is not perfectly reduced or if there is cortical destruction of the medial buttress of the upper end of the lower femoral fragment, and complete weight bearing should be delayed for six months from the fracture date.

(c) Shaft. A caliper is not required as a routine. Certainly the oblique, the spiral and the comminuted fractures unite readily without danger of late angulation or deformity. Transverse fractures with little callus, particularly if the callus is present on one side only, are prone to refracture or to angulate on weight bearing. War wounds of the femoral shaft where bone loss has occurred, and where union has taken place through a frail bony bridge, are an indication for the use of a caliper.

(d) Femoral condyle fractures, where active knee-joint movements is desirable while the fracture is consolidating. The patient is ambulatory with partial weight bearing, permitting intermittent non-weight-bearing exercises to the knee.

(e) Orthopaedic surgeons may consider a caliper is a useful adjunct to the operative treatment of fractures of the femoral shaft after Kuntscher nailing.

2. Fractures of the Tibia

(a) Fractures of the tibial plateau. In the young soldier it is important to prevent the development of late genu valgum. This may be obtained by plaster fixation and the prohibition of weight bearing until the crushed cancellous bone is strong enough to prevent collapse into knock-knee deformity. This period of non-weight-bearing and plaster fixation can be cut short by fitting a Charnley caliper to allow for early ambulation and periodic non-weight-bearing knee movements, if the caliper is removed for certain periods during the day.

(b) Delayed union of tibial shaft fractures. Some fractures of the leg bones show that, although union is proceeding clinically and radiologically, consolidation of that union is delayed beyond the time that these fractures ordinarily unite and consolidate. In these fractures with delayed union there may be a just perceptible range of movement at the fracture site. (If, however, the fracture
at this juncture shows a range of movement of five degrees in any one plane, then pseudo-arthritis is established and a bone grafting operation is required. It is in these cases of delayed union that caliper walking is valuable, allowing rehabilitation of the limb and the patient to proceed while consolidation of the fracture is occurring. The caliper, however, should only be used provided that:

(i) There is no backward angulation of the fragments.
(ii) The mobile type of heel socket is used.

(c) Orthopaedic surgeons may consider the caliper is useful while waiting for the skin to become healthy, particularly in war wounds, prior to bone grafting or bone plating, and again at some stage after these operations.

It must be appreciated that any caliper, and all below-knee irons, either single or double, are attached to the shoe or boot by a heel socket which can be either fixed or mobile.

The mobile type for fractures of the tibia must be sited concentric to the ankle joint. If not, anterior/posterior angulation of the lower tibial fragment on the upper will occur and precipitate non-union. In Charnley’s caliper the heel socket is mobile, but it is not concentric to the ankle joint. This is of no importance in the treatment of fractured femora, but it is dangerous if used in the treatment of fractured tibiae. To overcome this, Charnley has recently designed a fixed type of socket to be attached to the boot or shoe. This prevents any ankle-joint movements and is used for the treatment of fractured tibiae. This type of socket is not in use in the Army. If a more permanent caliper or double or single iron is required, then a fixed heel socket with an ankle-joint movement incorporated in the side bars and concentric to the axis of the anatomical ankle joint is required. This is an iron made to measure by instrument makers, and is expensive.

**DESCRIPTION OF THE CHARNLEY CALIPER**

The Ring is made of malleable \( \frac{1}{8} \) -inch mild steel rod padded and covered with leather, and is incomplete on the outer side so that the two free ends overlap. This allows a range of adjustments of the circumference of about 2 inches (1 inch increase and 1 inch decrease). When it is correctly adjusted to the circumference of the root of the limb, the overlapping ends are clipped by a ring clip similar to a hose-pipe clip, and the ring is thus rendered solid and rigid. The loose leather thong is soaked in water and lashed round the rough metal clip, and the end of the tail is tucked into the final turn but one with the points of the artery forceps. The wet thong can be moulded to the surface of the ring and the clip to give a smoother surface and thus protect the neighbouring skin.

The P.L.M.E. contains two sizes (the diameters are not given, but they are 21-inch and 18-inch respectively). Each size can be increased or decreased by 1 inch. These sizes will fit the root of the lower limbs of the vast majority of young adults.

The shape of the ring is that of a simple flat ovoid and is devoid of any surgical shape to fit the ischial tuberosity. The side bars are fitted into the centre of the ovoid. The rings are reversible and do away with the necessity
The Charnley Walking Caliper

Length Adjustment—Each ring is supplied with side bars of 
\(\frac{3}{8}\)-inch-thick mild steel rod welded into the ring and of a standard length measured from the upper surface of the padded ring to the lower end of the adjustable extension socket. The inner side bar is 24 inches long and the outer side bar 2 inches longer and is angulated at the trochanter level to accommodate the shape of the root of the limb. The extension socket consists of a male and female screw thread with a locking nut, which allows of a variation of 3 inches in the length of the side bars. To allow for varying length Extension Pieces of \(\frac{3}{8}\)-inch diameter of mild steel rod are issued in pairs in four different sizes. These screw \(\frac{1}{2}\) inch into for rights and lefts. The ovoid shape is achieved by being wider by 1 inch from side to side than from front to back. The ring is set at an angle of 30 degrees to the side bars by making the outer side bar 2 inches longer than the inner side bar, the length of which is 24 inches.

It is Charnley’s contention that adequate weight relief is obtained by the simple flat ovoid ring, provided that the circumference of the ring fits closely and comfortably to the circumference of the root of the limb, and that the anatomically shaped ring which fits the root of the limb rather loosely does not, in fact, allow weight bearing on the tuber ischii. In all rings a large part of the weight is taken through the fibrofatty fold of the buttock and the lower border of the gluteus maximus in contraction, and really the ischial tuberosity is only an anatomical landmark for the important accurate fitting of the ring.

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the above adjustments, which will then allow a variation of total length of 3\(\frac{1}{2}\) inches when the adjustment is used.

The sizes of the extension pieces and the series of leg lengths are 16, 13, 10 and 17 inches. These lengths are those that Charnley now advises and differ from those in the P.L.M.E., which will be amended.

Four inches of each length can be absorbed into the overlap of the socket. For example, in the 16-inch the minimum extra length that can be obtained is 12 inches, but if only \(\frac{1}{2}\) inch is retained in the overlap socket, 15\(\frac{1}{2}\) inches extra length is available.

These extension pieces are threaded for 4 inches with \(\frac{3}{8}\)-inch B.S.F. and carry a \(\frac{1}{4}\)-inch B.S.F. locknut. The spur on each is 1 inch long, is at right angles to the shaft, round in shape and turned down to \(\frac{1}{2}\) inch, and at this point may be case-hardened.

The Heel Socket is unconventional but an important feature in the rapid fitting of the caliper. It is 3\(\frac{1}{2}\) inches wide, which is wide enough to project beyond the sides of the boot, but this, though ugly, allows the side bars of the caliper to clear the prominent medial condyle of the femur and the lateral bulge of the calf. If it is still not wide enough to achieve this the side bars can be bent. The tube socket is \(\frac{1}{3}\) inch inside diameter and is welded to a sole plate which is provided with four sharp steel spikes on its posterior edge. These spikes are driven into the leading edge of the heel on the undersurface of the instep, where it is fixed with wood screws. The socket lies forward of the conventional site and reverts to the original H. O. Thomas site.

Charnley's heel socket is of the mobile type and allows ankle-joint movement. This type only should be used for fractures of the femur.

A posterior support of leather, 4 inches wide, is provided to go behind the popliteal fossa. This is stitched to one side bar and left free at the other end so that it can be stitched or pinned to the other side bar at the appropriate tension when on the patient. The knee is held against the back support by means of a domette bandage wrapped round the knee and splint. This same bandage also holds the side bars together and prevents them jumping out of the heel sockets.

One special feature of the screwed length adjustment is that it enables the limb and therefore the foot to be placed in the required position of rotation; it can be locked permanently in this position by tightening the locknuts.

One of the mechanical defects encountered in using the caliper is the possibility of the screwed adjustment working loose. This should never happen if the locknut is finally tightened using two spanners—one to hold the female socket and one to hold the locknut.

**COMPONENTS**

To enable an immediate fitting to be made from stock, it is necessary to carry a stock of parts, and these can be grouped together into sets. A set comprises:
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2 Rings—large and small.
4 prs. Extension Pieces—very large, large, short and very short.
4 Heel Sockets.

In practice in peace, a Medical Equipment Depot abroad might be issued with six such sets, together with twice this number of heel sockets, as these elements wear out while the other components do not. In addition, the following kit of fitting tools is required:

2 Spanners, open jaw \( \frac{1}{2} \) inch \( \times \) \( \frac{1}{8} \) inch (R.A.O.C. issue).
1 Screwdriver (R.A.O.C. issue).
Several gross of \( \frac{3}{4} \)-inch wood screws (R.A.O.C. issue).

Charnley now states that the clamp, ring, bending, is no longer required and it will be deleted from the P.L.M.E.

Once the initial issue from the Depot to a Command Orthopaedic Centre is made, replacement of items is small provided that the calipers are returned after use. To keep them in service, all that is needed is renewal of the leather covering to the rings and new heel sockets as they wear out. Extra long and extra short extension pieces are infrequently required.

Whenever a patient has been fitted from stock it is necessary to indent on the Medical Equipment Depot for components to restore the stock of the Orthopaedic Centre to full strength, and Depots should keep their own pipelines of replacement filled.

TECHNIQUE FOR FITTING THE CALPER

It is an advantage to have a room where all the tools are readily to hand. The patient should be sufficiently mobile to stand up on crutches with the assistance of an orderly. It is useless to attempt to fit a bed-ridden patient.

With the patient supported on crutches, the fitter stands behind him and the caliper ring is tried on. The posterior half, to which side bars are attached and which supports the region of the tuber ischii, is adjusted first. This is performed by pressing the posterior-medial segment of the ring upwards and outwards until it is buried in the fat under the tuberosity in the position it will take when weight bearing. The air space between the outer aspect of the thigh and the inner surface of the lateral part of the ring is measured. This gives the amount by which the ring must be reduced in its side-to-side diameter. This reduction can be accomplished by compressing it from side to side, or with a hammer. If the ring needs enlarging it can be pulled open by the hands or with added assistance from the surgeon’s foot.

The ring is again tried on after dusting it with talcum powder, and if satisfactory the anterior half of the ring is closed down to meet the posterior half until it lies gently against the skin of the anterior surface of the thigh. The ring clip is now applied to the overlapping segments and the wet leather thong is lashed over it as previously described.
The heel socket is now applied and screwed home. A pair of extension pieces is chosen from the set likely to give the correct overall length to the caliper, and the splint is reapplied. The correct length is to allow a clearance of \( \frac{1}{4} \) inch between the skin of the under surface of the heel and the upper surface of the bottom of the boot. The foot should be neither inverted nor everted. The locknuts are then tightened with two spanners, one holding the female socket and the other the locknut. This final tightening is best done with the splint off the patient.

The back support is adjusted to the popliteal surface of the thigh and leg and is pinned to the outer bar. A domette or flannel bandage is applied and the result inspected. There should be no space between the greater trochanter and the outer side of the ring. It should be away from the anus. The fit of the ring should be such that a little effort is needed to pull it fully into the root of the limb. The caliper should be worn directly against the skin. The patient should not be walking with the toes turned in. This can be prevented by everting the foot to the desired degree before finally tightening the locknuts. The heel of the normal boot should be raised \( \frac{3}{4} \) inch and the patient instructed to sit well back on the ring, so as to keep the hip extended and so avoid pressure on the adductor regions of the groin by hip flexion. The patient is allowed to walk with crutches or with a stick until he chooses to discard them. He should acquire a good gait, and not a caliper roll, before a stick is dispensed with. This should be impressed on the physiotherapist. Caliper walking should be graduated until the patient can use it for the whole day. This may take a week or two. Periodically the caliper should be inspected as follows: The fibrofatty pad and the gluteus maximus should be well on the ring if the ring fits circumferentially when the patient stands on this limb. The patient should not be able to feel his heel touching the bottom of the boot.

Sometimes when the caliper is fitted there is difficulty in getting the patient's boot on. Heavy dusting with talcum powder on the outside of the sock helps. A larger size of boot may be necessary. Sometimes there is pressure on the back of the heel, which should be relieved by cutting out the back of the boot.

**SUMMARY**

The War Office pattern of the Charnley caliper is a useful instrument in the treatment of fractures of the lower limb. It should be clearly understood that in femoral fractures it is dangerous unless it is well fitted to the root of the limb and that this caliper, with Charnley's type of mobile heel-socket, should not be used in the treatment of fractures of the tibial shaft.

**ACKNOWLEDGMENTS**

The components of the War Office pattern Charnley caliper are made for the Army by the R.E.M.E.

This caliper is also made commercially by the London Splint Company, who have kindly lent me the block of the diagram of the splint.

I wish to thank the Director of Surgery, Brigadier J. Huston, F.R.C.S.(Edin.), and Mr. John Charnley for their suggestions when this paper was being prepared.