QUADRILATERAL SHAPED BRIMS MADE FROM HIGH-DENSITY POLYETHYLENE FOR LONG LEG CALIPERS

G. E. Fulford and T. P. Cairns, Edinburgh, Scotland

From the Princess Margaret Rose Orthopaedic Hospital, Fairmilehead, Edinburgh

Quadrilateral shaped brims made of high-density polyethylene have been used with satisfactory results on more than 120 patients who needed ischial-bearing long leg calipers. At first the fitting technique was the same as that used for thigh amputees. Subsequently it has been possible to fit most patients from a range of pre-formed brims. The properties of high-density polyethylene allow the caliper side irons to be riveted directly to the brim which, with the use of ready-made brims, allows a patient to be fitted rapidly with a comfortable and effective caliper.

The quadrilateral shaped brim has been used for many years by prosthetists in parts of Europe for fitting thigh amputees. In 1946 a team of Americans visited Europe to study European prosthetic techniques and were particularly impressed by the fittings of Strieda in Kufstein, Austria (Radcliffe 1973). After this visit a reproducible and teachable technique of socket fitting for thigh amputees using a quadrilateral shaped brim was developed at the University of California, Berkeley (Radcliffe 1955). Since then the socket with a quadrilateral shaped brim has become universally recognised as a satisfactory method of fitting thigh amputees and is now used in many countries. In those countries where prostheses and orthoses are made in the same workshops the quadrilateral brim shape has been used for orthoses. In Britain, where prosthetic and orthotic manufacture are separate, the quadrilateral brim shape is being only slowly accepted by the brace maker. We have obtained very satisfactory results with this brim shape, and when it is made from high-density polyethylene it has resulted in quicker manufacture of the orthosis and has proved very acceptable to the patient.

PRINCIPLE OF THE QUADRILATERAL BRIM

The shape of the thigh at the level of the ischium is dictated by the tendon of adductor longus antero-medially, the ischial tuberosity postero-medially and the greater trochanter laterally. These three bony points form a triangle, but the brim is enlarged to a quadrilateral shape to contain the soft tissues antero-laterally and postero-laterally. The top of the posterior wall is rolled over to give a horizontal shelf which provides the bearing area against the ischium, the hamstring tendons and the glutei. The tendency for these structures to slip forwards off the horizontal shelf is prevented by the counter-pressure of the large anterior wall, which is shaped to give even pressure over the whole of the front of the upper thigh and inguinal region. The upper border of the anterior wall coincides with the natural flexion crease of the hip at the inguinal ligament and is slightly flared outwards to allow free hip flexion. The straight medial wall is horizontal so that it clears the inferior pubic ramus, while the straight posterior edge to the horizontal shelf prevents the brim from rotating but allows the ischium to come into contact with the seat on sitting (Fulford and Hall 1968).

METHOD OF MANUFACTURE

The quadrilateral shape is obtained by using University of California, Berkeley, metal brims (Fig. 1) which are made for left and right sides in a range of medio-lateral sizes and can be adjusted for antero-posterior size. The correct brim is found by measuring the distance from the adductor longus tendon to the greater trochanter and selecting a brim which has the same or slightly larger measurement marked on it (Fig. 2). The approximate antero-posterior size is found by sitting the patient on a hard flat seat and measuring the distance from the adductor longus tendon to the seat (Fig. 3).

The two parts of the brim are assembled around the patient's thigh and the medial side is adjusted to give the measured antero-posterior size. If the correct size of brim has been chosen, when it is firmly pushed up the thigh until the posterior seat is horizontal and bearing against the ischium the tendon of adductor longus is lying in the antero-medial corner, the ischial tuberosity is one to two and a half centimetres lateral to the postero-medial corner and the greater trochanter is in comfortable contact with the lateral border. The medial and lateral sides of the brim are then readjusted until the pressure of the ischial tuberosity and the gluteal muscles is comfortably transmitted to the horizontal posterior shelf. When the brim is fitting satisfactorily the antero-posterior measurements on the medial and lateral sides are noted, so that the brim can be reassembled to the same size after it has been removed from the limb.

The reassembled brim is closed at its bottom end and extended around the upper margin with a few turns of plaster-of-Paris bandage. Plaster-of-Paris is then poured...
Figure 1—One of the range of adjustable metal brims developed at University of California, Berkeley, for fitting thigh amputees.

Figure 2—Measuring the thigh to select the correct-sized brim (modified from Foort 1963).

Figure 3—Measuring the antero-posterior size of the medial thigh (modified from Foort 1963).

into the brim, filling it well above the top of the metal brim, and a piece of iron pipe is placed so that it sticks out from the centre of the mould. When the plaster has set the metal brim is removed and the male cast is held upside down in a vice by the iron pipe. A sheet of four-millimetre high-density polyethylene (Ortholen), which has been softened by heating in a hot air oven, is wrapped around the cast with the overlap anterior. A close fit is obtained by overwrapping the plastic with a heavy duty elastic bandage, paying particular attention to the posterior shelf and making sure that it is at a right angle to the posterior wall of the brim (Fig. 4). The upper and lower borders of the plastic brim are trimmed to the same shape as the metallic brim, a four-centimetre gap is made in the middle of the anterior wall and bridged over by a tongue of hard leather. The brim is completed by either leather straps and buckles or webbing straps with Velcro fastenings across the anterior opening (Fig. 5). Because of the qualities of this plastic, it is sufficient to attach the side irons directly to the brim by three rivets without a reinforcing metal strap between the side irons across the back of the brim.
CLINICAL EXPERIENCE

We have now fitted more than 120 patients with long leg calipers using quadrilateral brims. At first we used the technique described above to obtain the correct size and shape of brim. In this way we collected a range of plaster-of-Paris male casts of different sizes. We have since found that it is usually sufficient to measure the circumference of the thigh at the level of the adductor longus tendon and choose a plaster cast of the same or slightly larger size to obtain a satisfactory brim. We now keep a range of ready-made brims with circumferences increasing by 2.5 centimetres, from which we can select a brim that is satisfactory for nearly every patient.

The anterior opening in the brim, together with the springiness of the plastic, allows the brim to be opened sufficiently to insert the thigh into the brim. The anterior opening has straps across it to stop the gap from springing open whilst it is being worn; they also allow a little adjustment in the size of the brim. If the brim is slightly too large it can be adjusted temporarily by sticking hard felt to the inside of the anterior wall, as this pushes the ischium farther back on to the horizontal shelf.

Most of the patients we have fitted have been young people who required long leg calipers as a stage in the treatment of their femoral fractures. The brim has been fitted to double side irons without knee hinges and has usually been worn for about six weeks. Because we now have a range of ready-made brims, because the method of fixing the brim to the side irons is simple, and because of the satisfactory shape, we are able to fit these patients with an ischial-bearing caliper within an hour. For the same reasons we also use these brims for non-ischial bearing long leg calipers but adjust the length so that the ischial seat is a centimetre below the ischial tuberosity.

We have used these brims for patients who need to wear a caliper permanently. Many of these patients have previously used ischial-bearing brims made of leather but most of them have now changed over to the quadrilateral shaped brim made of Ortholen. These brims are also suitable for children, particularly with spina bifida because, unlike leather, they are easily cleaned when soiled. We now fit all children who require long leg calipers with these brims and so far we have found them satisfactory and we have had no problems with pressure sores.

We wish to thank Mr R. Pirie, Superintendent Prosthetist, for his advice and help and the Edinburgh orthopaedic surgeons who allowed us to fit their patients with this appliance.

REFERENCES