THE STANMORE COSMETIC CALIPER

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The disadvantages of orthodox long leg calipers are well known. Firstly, their weight is a handicap. Secondly, they are so unsightly that a patient may refuse to wear one. Thirdly, they are made of materials some of which cannot be easily cleaned. Fourthly, the considerable time required for manufacture and for long-term maintenance, both of appliance and footwear, is an adverse factor which has become worse with the increasing scarcity of skilled craftsmen.

During the past three years a much lighter type of caliper—intended for permanent use either for splintage or weight-bearing or both—has been developed in the Unit for Research and Development of Orthopaedic Appliances associated with the Department of Biomedical Engineering. Seventy-three of these appliances have been made and effectively fitted during the past two and a half years. Most of the patients had residual paralysis from anterior poliomyelitis but some were hemiplegics. They were selected for the trial because their conventional calipers were constantly breaking or wearing out.

The purpose of this paper is to describe the new appliance, its method of manufacture and its advantages. Two patients will first be described to illustrate its value.

Case 1—This woman, aged twenty-five, contracted anterior poliomyelitis at the age of two. The right lower limb was virtually flail, with gross wasting of the calf muscle. The true shortening was 6·5 centimetres. She wore a traditional long leg caliper (Figs. 1 and 3) and a surgical shoe with a 5 centimetre raise under the heel tapering to 2·5 centimetres under the tread. She considered that she walked well in this appliance, but after being supplied with a Stanmore cosmetic caliper (Figs. 2, 4 and 5) she volunteered that the old one had in fact limited her activities and had been a social embarrassment.

Case 2—This girl, aged sixteen, contracted anterior poliomyelitis at the age of six, which left her with some weakness of the left arm. The major disabilities were a total paralysis of all the muscles acting upon the left hip and lower limb, and genu recurvatum of 20 degrees. She refused to wear a caliper because she found the limb uncontrollable unless she used sticks or crutches. She had accepted a below-knee caliper with a drop-foot spring, but found this led to pain in her unstable knee. When fitted with a cosmetic caliper (Fig. 6) the knee soon became comfortable and she found her independence increased. She can now play table tennis with considerable agility and walk up to two miles.

MANUFACTURE OF THE CALIPER

A plaster shell of the lower limb is made with the patient lying supine on a plaster table and the limb held in the position of greatest correction. Particular care is taken in aligning the knee and foot. Careful moulding of the cast improves the function of the appliance because close contact between the two main plastic components of the splint and the skin of the patient's limb greatly reduces strain on the other parts of the appliance.

The plastic components, namely the thigh cuff and the calf and foot piece, are made of high density polyethylene (Ortholen), the thigh portion 3 millimetres thick and the calf portion 6 millimetres. This is moulded by hand at a temperature of 190 degrees Celsius to the outside surface of the positive plaster cast. The thigh portion can be fitted with a separate washable plastic inner lining of Plastazote 0·5 centimetre thick. The particular qualities of Ortholen in
sheet form are that this material is strong enough to allow direct attachment of the metal side members by stainless steel rivets; it has a relatively low fatigue rate and in consequence is rarely subject to stress fracture; and its resistance to wear meets the differing requirements of individual patients. Ortholen also combines the qualities of flexibility and strength in such measure that a closely moulded cast of the calf and sole controls a drop-foot or flail foot as well as any orthodox method.

A variable thickness of cellular Plastazote can readily be bonded to an Ortholen calf portion using adhesive. Usually with a shapely opposite calf as the model, the Plastazote can then be trimmed so as to make an excellent cosmetic substitute for a wasted calf. The bonding of more Plastazote on to the upper surface of the foot piece allows a precision moulding of the sole which finds the greatest practical application in patients with neuropathic diseases. An important point is that both plastics can be supplied in flesh tints to match the patient’s skin.

The side members which join the proximal and the distal Ortholen components to the knee hinge are made of aluminium alloy (H.E.15) or of stainless steel (En 56 and En 57, B.S. 970). They are shaped to slot into the cast sections of the knee hinge units, to which they are attached by screws.

**KNEE HINGES**

Various types of hinge are used, all made of cast stainless steel. With one exception, they are supplied as pre-constructed units.
1) The ring-catch hinge-joint. The standard hinge-joint supplied by German manufacturers depends on gravity for locking to occur and on finger-tip release for unlocking (Fig. 7); both of these are unsatisfactory when the caliper is worn underneath clothing. In order to permit automatic locking the standard hinge has been modified by adding spring-controlled plungers behind the locking device and above the hinge (Fig. 8). Deep grooves on the block of the locking ring make it easier for the patient to release the hinge by hand through material. The male portion of the casting is also well rounded off so as to decrease local wear and tear of clothing. This is the most stable joint available. In order to operate it, however, the patient needs to have good control of the upper limbs and to require only one caliper.

2) The bar-lock hinge-joint. The bar-lock has one serious disadvantage: it is easily “tripped” by posterior contact with low furniture. It has been modified to prevent this, while the patient is still able to operate the lock through clothing. The bar is replaced by short collateral levers which the patient operates directly or remotely by the use of a cord attached to the thigh cuff (Figs. 9 and 10). This type of hinge is used for bilateral involvement. The criterion for operating the collateral levers is the same. When the upper limbs are weak the patient can operate the system by the thigh cuff cord.

3) The “set-back” hinge-joint. The design of these hinges allows them to be set at least 2·5 centimetres behind and below the axis of the knee joint (Fig. 11).
Case 1—The patient is shown wearing her new caliper inside commercially manufactured calf-length boots. She can also wear it inside conventional footwear.

Case 2—In this full-length appliance the patient had control of the knee and was able to wear backless clogs. (For detail of the set-back hinge-joint see Figure 11.)

Figure 7—A ring-catch hinge-joint as supplied by the manufacturer. Figure 8—Modifications of the standard ring-catch hinge-joint are the addition of an automatic device for locking by a spring-controlled plunger; deep grooving of the block of the locking ring to facilitate finger-tip release through clothing; and rounding off of the male portion of the joint to decrease wear on clothing.
This type is generally used for unilateral involvement with hyperextension of the knee. It allows the patient to walk with a stable knee and avoids the need for a locking device.

The only joints which are incorporated with the side units are custom built from sheet steel with movable parts of carbon steel. Their particular advantage is that they can be made close fitting and consequently more easily managed by a paraplegic patient requiring bilateral calipers.

Before the metallic parts of the caliper are assembled, they are heated in an oven and then held for a few seconds in a powder bath of fine white or coloured nylon particles. This provides a thin durable matt coating which not only avoids the need for final polishing of the metal but makes it smooth, rust-proof, washable and agreeable to look at. Some other details of manufacture have been described by Tuck (1966, 1971). The supracondylar control straps may be made from thin Ortholen lined with thin Plastazote. Patients with an unstable knee requiring control are fitted with a light removable knee cap in leather or in plastic.

Instead of the old-fashioned leather straps and buckles that were so devastating on clothing, full use is made of press-studs and Velcro for ease of application of the caliper and for quick release.

The only complication to occur with these appliances has been breakage of the moulded plastic foot piece at the heel on three occasions. This part is now made of Ortholen 6 millimetres thick and well thinned out towards the edges, and no further breakages have occurred.

Once the caliper has been fitted the only additional requirement is modification of the footwear, such as a raise or a float in order to compensate for shortening or to improve stability. Providing that shortening does not exceed 6·5 centimetres the appliance can be worn inside normal shoes. Steel sockets in the heel of the shoe, once a source of so much trouble, are of course dispensed with.

DISCUSSION

The Stanmore cosmetic caliper offers several practical advantages to the patient. It is approximately half the weight of an orthodox caliper and this is a great aid to mobility. Its
modular design is of individual manufacture and allows for quick adjustments and minimum maintenance. The cost is also economically practicable. Its strength is such that it has been most successfully used as a fully weight-relieving appliance in a man weighing 114 kilograms (252 pounds) who used to be in constant trouble from repeated breakage of the metal side members of his conventional caliper. Aesthetically it is much more acceptable, being easily applied and removed and washable; it soon becomes regarded as an article of clothing rather than as a cumbersome surgical appliance. However, it is the cosmetic appeal to patients of both sexes that has been outstanding. In addition to the simulation of skin colour and normal contour of the calf, patients have expressed a new-found freedom in their ability to conceal the lower part of the caliper under a sock or a stocking. Furthermore, many of the women have taken considerable pleasure in being able to enter a shoe shop and buy matching footwear for the first time in their lives (Fig. 5).

SUMMARY

1. The details of construction of the Stanmore cosmetic caliper using modern plastic materials have been described.
2. The considerable advantages of this light-weight caliper over the cumbersome traditional appliance are discussed.

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REFERENCES