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Technical note

A new directly moulded patellar-tendon-bearing socket

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Abstract

Silicone rubbers and casting tapes individually have previously been used in the manufacture of sockets (Swanson, 1972; Sweitzer, 1973; Ruder, 1977; Graves, 1980; Aqualite, 1982). The authors believe that the present combination of these materials to manufacture a directly moulded socket with a complete silicone rubber lining of variable thickness has not previously been described.

The new socket, after addition of the modular components, allows fitting of an aligned below-knee prosthesis within three hours. The socket (Fig. 1.) is made directly on the below-knee stump, can be completed with experience in an hour and does not require the use of specialized equipment. The socket consists of an outer supportive Scotchflex* layer inside which is a lining of soft smooth biocompatible silicone rubber** of deliberately variable thickness to allow pressure tolerant areas to accept more load and pressure sensitive areas to accept less load (Fig. 2).

The thicker areas of silicone are produced by applying carefully cut Plastazote pads to the pressure sensitive areas. The thickness and extent of the pads is individually assessed according to the estimated sensitivity of the particular area (Fig. 3). The Scotchflex socket is then manufactured directly on the below-knee stump with these pads applied. The pads are then removed prior to insertion of a semi-liquid silicone rubber. Thus, when the socket with the liquid silicone rubber is re-applied to the stump, the space produced by the pads is filled by the rubber which then sets at room temperature. In this way a layer of variable thickness is produced.

During application the thumb, thenar eminence and finger pads are used to mould the setting Scotchflex tape into pressure tolerant areas. The amount of pressure applied depends

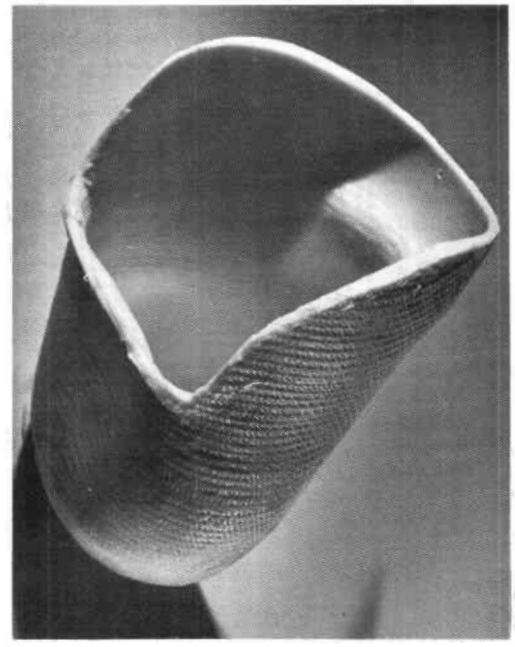

Fig. 1. Completed socket showing smooth inside lining of variable thickness. The silicone edge of the socket brim has been trimmed. Excess silicone has been removed from the outside of the socket.

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** Dow Corning Limited, Reading Bridge House, Reading, Berkshire, RG1 8PW, England.

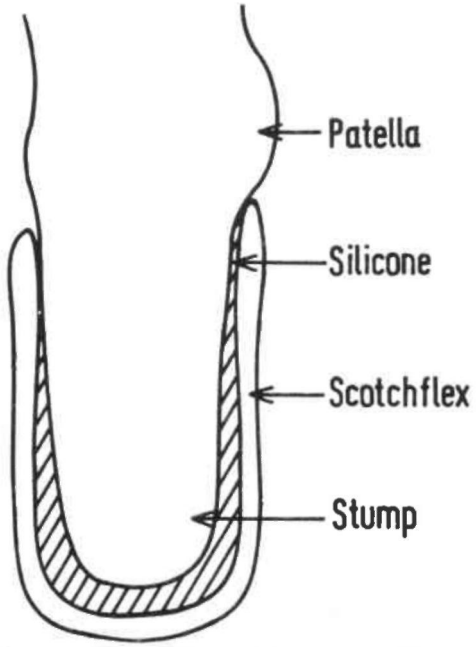

Fig. 2. Sagittal section of the new socket on a below-knee stump. In pressure tolerant areas, eg infrapatellar, the silicone is thick but smooth to allow pressure to be transmitted directly to the Scotchflex supportive layer. In pressure sensitive areas, eg distal stump, the silicone is thicker to provide greater cushioning. A sock (not shown) is usually worn between the stump and the socket.

on clinical assessment and is aided by direct feedback from the patient during the setting process. Subsequently when the liquid silicone is inserted only a thin layer is present in these areas. Thus, when fitted, pressure in these weight bearing areas is applied more directly to the outer rigid Scotchflex layer.

Socket fabrication technique

Prior to casting the stump is examined and its condition and musculature noted. Plastazote pads are applied to pressure sensitive areas using either one inch Micropore or medical adhesive (Fig. 3). The pads are normally cut from 10 mm Plastazote and have thinned edges to avoid ridges when moulding. The pads are re-usable and a range of shapes and thicknesses can rapidly be built up. Once the pads are situated two woollen socks are pulled over the stump. These are held in tension by an elastic belt passed around the patient's waist and clipped to the socks. The stump is held in five to ten degrees of flexion depending on the amount required to produce suitable stump definition.

A wrap of four inch Scotchflex tape is applied to the stump beginning distally and finishing at a level just below the superior aspect of the patellar. A second roll of tape may be required to produce the necessary four to six layers of proximal thickness and the two layers distally. Although not toxic it is preferable to wear rubber gloves whilst applying the tape. The number of proximal layers will vary according to the patient's weight. To assist in smoothing and shaping the cast when wrapping is completed, the surfaces of the Scotchflex may be lubricated with 3M* hand cream. This removes the tacky feel of the material prior to curing. The tape is smoothed and moulded to the contours of the stump until adhesion of the layers has been achieved. Pressure is then applied to the patellar tendon and popliteal areas using thumb and fingers in opposition. As the Scotchflex begins to harden the thenar eminences are used to apply pressure to the medial and lateral aspects of the tibial shaft while maintaining a popliteal pressure. These four main weight bearing areas should be moulded until curing is complete (about five minutes depending on water temperature).

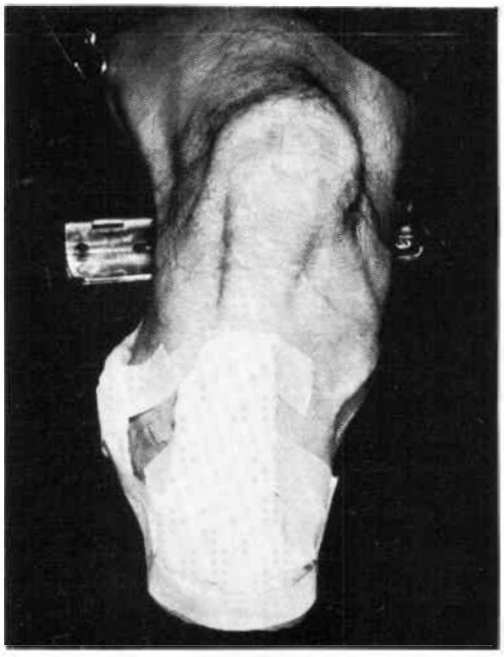

Fig. 3. Below-knee stump with Plastazote pads attached with Mircopore. A smooth finish is not required at this stage.

The cast can then be removed from the stump and the woollen sock separated from the tape. The cast is then trimmed to the required PTB brim shape using an electric cast cutter or plaster shears. The posterior aspects of the brim may be flared if required by cutting a series of vertical one centimetre slits, one centimetre apart along the brim and then gently moulding the cut sections to the required angle. The cut edges of the cast must be smoothed with sandpaper before the next stages of fabrication. The prepared cast is then fitted to the patient's stump to ensure accuracy of fit and assess the number of socks required for the next stage. Generally it is found that to allow for stump swelling and to give greater comfort one thick woollen sock is required to be fitted to the stump before taking the impression.

It has also been found that to avoid distal anterior tibial pressure, a small triangular Plastazote pad should be placed over the end of the tibia before taking the impression. A specially made rubber sock to fit over the stump was made for the authors by Specialised Latex Services***. These special rubber socks were then fitted over the woollen sock and pad and held in tension as before. The cast should be tried on once more to ensure an accurate fit.

Silastic 382* a room vulcanizing bio-compatible silicone rubber is then mixed with its catalyst. After thorough mixing using half of the normal quantity of catalyst, the silicone is poured into the socket taking particular care to cover the upper inner aspect of the Scotchflex socket. As the socket is then applied to the stump with gentle pressure the excess silicone is squeezed out of the top and also out of the holes at the inferior aspect of the socket. This explains the need for having this inferior area of the socket only two layers thick to allow excess to escape. Pressure is continued until a good infrapatellar fit is obtained. The setting time is approximately five minutes. After removal the rubber casting sock is then peeled from the inner wall leaving a smooth total contact surface which varies in thickness according to the degree of pressure tolerance at each point. The socket is then ready to be fitted with a cuff suspension and attached to the jig assembly (Fig 1).

The modular components used were supplied by Kelly Intermed****. A specially made four steeled metal below-knee wrap-in attachment is shaped around the socket in the required alignment and held in place with one roll of Scotchcast tape. This is moulded in a similar fashion as before, using gloves and 3M hand cream for protection, to ensure a tight bond to anchor the attachment to the socket. Two alignment jigs connected by 30 mm tubing and attached to a S.A.C.H. foot complete the assembly. After alignment the patient can begin rehabilitation within three hours of commencing fitting.

A preliminary clinical trial on 17 patients has displayed that the performance, comfort and appearance of the new socket compares favourably with the more conventional socket made of polyester resin lined with tepe foam and cordovan leather. A larger trial is being mounted to test these early findings.

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**** Kellie Intermed, Rutherford Road, Dryburgh Industrial Estate, Dundee DD2 3XF.

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