

Techniques of lower limb prosthetic manufacture using Lightcast II

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Introduction

Lightcast II is an orthopaedic casting system consisting of an open weave fibreglass tape impregnated with a photo-sensitive resin which will harden in three minutes when exposed to light in the 3,200-4,000 angström range.

A total of 393 lower limb amputees have been fitted to date with the Lightcast II system which has now become the standard temporary fitting procedure of the West Park Amputee Centre.

TABLE ONE

Numbers of prostheses fitted to date

	Temporary Stage	Definitive Stage
Hip disarticulation	20	0
Above-knee	3	0
Knee disarticulation, Callander or Gritti		
Stokes	50	10
Below-knee	250	35
Syme	25	0
TOTAL	348	45

Lightcast II tape has been found to be especially useful for the fitting of the below-knee amputee. It has also found occasional use in the construction of definitive prostheses for geriatric amputees.

In almost all cases the Otto Bock modular endoskeletal prosthetic system has been used. This is the authors' choice of system, however the technique can be easily modified to suit all modular systems provided that the same principles of attachment of the modular hardware to the Lightcast II socket are followed. A Lightcast II socket can also be incorporated in an exoskeletal prosthesis. However, the advantages of the porous socket are lost in this case.

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Lightcast II has a rough surface texture which necessitates the use of some padding material to separate weight bearing surface tissues from the socket wall. Various materials have been tried. A porous P. E. Lite* material has been found to be most satisfactory, since it can be moulded easily and directly to the amputee's stump and complements the porosity of the Lightcast II tape.

Although the finished socket is strong, the bonding between layers of Lightcast II can be comparatively poor unless each layer is rubbed well into the previous layer.

The techniques for constructing prostheses using Lightcast II are outlined below. An instruction manual has also been written and may be referred to for a more detailed description (Ruder *et al* 1976).

Prosthesis for the below-knee amputee

To fabricate a Lightcast II socket for a below-knee amputee it is best to have the patient lying in a supine position on a stretcher. A foam rubber distal pad is placed so that it will also cover the anterior distal aspect of the tibia. If necessary, extra relief pads can now be adhered directly over any other prominent bony areas. A cast sock, suspended firmly, will hold the pads in place and also sufficiently compress the soft tissue.

A conical sleeve is constructed from P. E. Lite to the stump measurements, heated until soft, and quickly pulled over the residual limb well proximal of the femoral condyles. A P. E. Lite cap is glued to the distal end.

Several strips of approximately 300 mm in length are cut from a roll of Lightcast II tape (100 mm wide). The first strip is applied distally from a posterior to anterior direction. The second strip is started medially and carried around the distal end in a lateral direction. The remaining strips should cross the first strips diagonally. Three or four strips are now placed

*P. E. Lite 60245P obtainable from Fillauer Orthopedics, Chattanooga, Tennessee, U.S. 37401.

starting just above the patella medio-laterally, overlapping each other by half, moving distally and leaving the popliteal area open. Circumferential wrapping is now started distally and under firm but controlled tension carried proximally well over the femoral condyles. The completed socket wrap is well moulded and rubbed to ensure good adhesion between layers. A close fit in weight bearing areas is ensured by applying pressure during the curing process in the Lightcast II lamp. The amputee's knee should be held in a slightly flexed position (5 to 10 degrees) during the whole of this procedure.

The best way to attach modular hardware to the Lightcast II socket is to fabricate a special laminated cup. This cup is formed from 3 or 4 layers of nylon stockinette and 2 layers of glass fibre. An aluminium base plate 80 × 80 mm is incorporated between the laminations. The cup forms a cylinder of about 120 mm in height and 110 mm in diameter. It is split in several places to allow spreading and easy moulding over the distal end of the Lightcast II socket. The hardware is bolted to the reinforced base of the cup. It is necessary to sand the outside of the cup to aid the adhesion of Lightcast II tape.

A mixture of resin and sawdust can be used between the socket and the cup to provide an even more secure attachment. Once the distal cup has been moulded in the proper alignment a roll of Lightcast II tape (100 mm wide) is wrapped circumferentially to secure it to the socket. Buckles for the cuff suspension are fastened to the socket.

After final curing of the socket it is removed from the amputee's stump. The proximal rim is outlined and trimmed with a cast cutter. To finish the proximal edge of the Lightcast II socket a strip of P. E. Lite is moulded over the outside rim and adhered to the internal lining as it extends above the Lightcast. The prosthesis can now be assembled and fitted with a regular wool sock (Figure 1).

Prosthesis for the Syme's amputee

The method of construction is similar to that used for the below-knee prosthesis. In order to permit removal of the prosthesis after completion a 25 mm foam rubber pad is adhered to the P. E. Lite liner just proximal to the most prominent malleolus (usually medial). In some cases it is necessary to cut an obturator

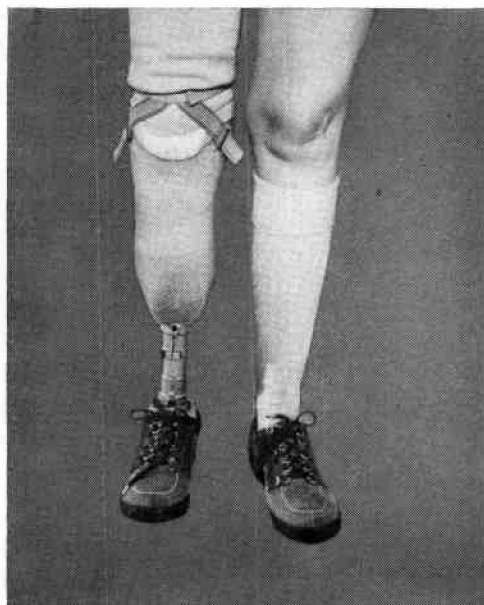


Fig. 1. Temporary below-knee prosthesis with Lightcast II socket.

in the socket without cutting the P. E. Lite liner which serves as a protecting tongue.

A prefabricated cup is bolted to a Syme SACH foot, heated and held in place with proper alignment and then secured with 1 or 2 rolls of Lightcast II tape (100 mm wide). Minor alignment corrections can be made by adding a wedge between the base of the SACH foot and the plastic cup.

Prosthesis for the knee disarticulation amputee

In the past it has always been difficult to construct a temporary prosthesis at reasonable cost with a satisfactory fit for a knee disarticulation, Callander or Gritti-Stokes amputation. The Lightcast II system again makes this a relatively easy task.

In most cases it is possible to fabricate the socket directly on the amputee's residual limb thus eliminating lengthy casting and modification procedures. The socket construction follows the same technique as outlined above. A distal pad or relief pads are rarely needed.

Several methods can be used to allow for removal of the socket depending on the bulbous nature of the amputee's stump. Often a vertical cut in the socket is all that is needed to provide sufficient flexibility. This cut should

begin distally to the widest part of the bulbous end of the stump and should extend proximally to a level where the stump has the same diameter. If necessary this cut can be continued to the proximal brim of the socket or, if so desired, an obturator can be cut. Again the P. E. Lite liner should not be cut since it will serve as a tongue.

After completion of the Lightcast II socket the prosthetic unit can be attached. This may be external hinges, the four bar linkage unit, or if sufficient clearance allows, the Otto Bock knee unit 3R16 bolted to a stainless steel cup which is then adhered to the socket with epoxy paste and reinforced with Lightcast II. A cosmetic foam cover may be added.

Prosthesis for the hip disarticulation amputee

The fabrication of a temporary hip disarticulation prosthesis is best done with the patient lying on his sound side on a stretcher. A dacron felt wrap is tailored to fit the amputated side of the pelvis snugly. The wrap extends around the sound side and overlaps anteriorly. It is held in place with tape.

Several strips are cut from a roll of Lightcast II tape (150 mm wide). The middle of the first strip is applied distally and both ends are pulled firmly around the pelvis, one posteriorly and the other anteriorly. More strips are now applied, each overlapping the previous one by a half, moving proximally well over the iliac crest and enclosing the lumbar region posteriorly and the abdomen anteriorly. A second layer of strips is now applied beginning distally and medially, crossing the first layer of strips at right angles and finishing at the proximal edge of the basket. The Lightcast II lamp is placed over the completed wrap which is cured while hand moulding over the lumbar and abdominal areas, as well as over the iliac crest, continues in order to achieve both maximum suspension of the basket and distal flattening to aid weight bearing (Figure 2).

With the patient now in a supine position the base plate of an Otto Bock modular system is fitted as close as possible to the Lightcast II basket in the proper place of alignment. It is adhered with a mixture of resin and sawdust. More strips of Lightcast II tape are now



Fig. 2. Temporary hip disarticulation prosthesis. Application of pressure during curing to ensure a good fit.

applied to cover the base plate and reinforce the basket.

After curing, the dacron felt liner can be pulled down over the edges of the basket and glued in place. Two velcro straps fasten anteriorly for suspension and the modular prosthetic system can now be reassembled and dynamic alignment performed (Figure 3).



Fig. 3. Temporary hip disarticulation prosthesis completed.

Prosthesis for the short above-knee stump

Every prosthetist is sometimes faced with an amputation at a very high level above the knee which may not be suitable for fitting with a conventional prefabricated adjustable temporary socket. Yet a definitive prosthesis may not be financially feasible at the time. Lightcast II provides a useful alternative by enabling the construction of a custom made socket at a reasonable cost.

The construction technique is similar to that used for the hip disarticulation prosthesis. A dacron felt prosthetic sock is tailored to the residual limb measurements with extra material

left laterally and posteriorly. It is pulled lightly onto the residual limb well over the greater trochanter laterally and the gluteal region posteriorly.

The patient is placed so that he is lying on his sound side on the stretcher. Strips of Lightcast II (150 mm wide) are applied beginning high up posteriorly and pulling around the distal aspect anteriorly, or vice versa, depending on the muscle coverage over the distal end of the femur. More strips are applied overlapping each other by half in such a way as to provide for good tissue cushioning distally when the socket is completed. The brim of the socket should be very high posteriorly and laterally but low enough anteriorly to allow for at least 90 degrees of hip flexion.

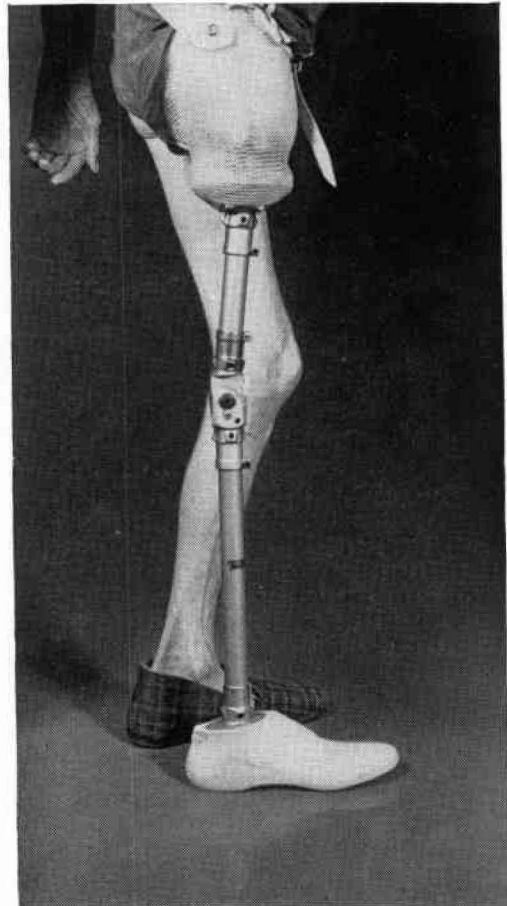


Fig. 4. Temporary prosthesis for very short above-knee stump, ready for dynamic alignment.

During the curing process in the lamp, rapid and correct modification and moulding are of the utmost importance to provide:

1. Firm support in the gluteal region.
2. A well formed ischial seat.
3. Compression of Scarpa's triangle.
4. A flattened medial wall.
5. A relief channel for the adductor longus tendon.

After curing a modular prosthesis is attached using a plastic laminated cup or the wooden base supplied with the Otto Bock modular unit. The latter may be adhered with a resin and sawdust mixture. The edges of the socket can now be covered by folding over the dacron sock and a silesian band is added for suspension. The prosthesis is now ready for dynamic alignment (Figure 4).

Advantages of the Lightcast II system

Lightcast II is a most welcome addition to the material available for the management of lower extremity prosthetic fittings. It is strong, light in weight, porous and fairly easy to use.

Time is saved in constructing a temporary or definitive prosthesis and the amputee can begin ambulation immediately enabling the prosthetist to complete the dynamic alignment in the same session. A definitive prosthesis can therefore in many cases be completed without delay at any amputee centre and only requires the addition of a cosmetic covering.

REFERENCE

- RUDER, K., KOSTUIK, J. P. and FERNIE, G. R. (1976). Lightcast II Casting System, Prosthetics Casting Manual. Merck Sharp and Dohme International, Rahway, New Jersey 07065, U.S.A.