

A Below-Knee Prosthesis With A Porous Socket

VIRGIL FAULKNER, C.P.O.¹

CHARLES PRITHAM, C.P.²

Porosity in the socket wall of a limb prosthesis has long become recognized as a feature, especially in humid climates. Porosity permits constant interchange of air that cools the stump and helps eliminate the accumulation of water in the socket which in turn helps to retard the growth of unwanted bacteria.

The idea of a porous socket is not new. The Army Prosthetic Research Laboratory was experimenting with the idea of a porous socket before 1957. However, the technical expertise and time consuming procedures developed to date have caused most practitioners to exclude this technique from their amputee management program.

In recent years much attention has been given to the so called "instant prosthesis", "adjustable prosthesis", and the temporary, or preparatory, prosthesis. To make these new type prostheses economically feasible, several modular, endoskeletal type systems have been developed. Many new types of plastics are being introduced to complement the new modular systems, and much attention has been focused on the polyethethlene and polycarbonate families of plastics.

Recently, the Prosthetics Laboratory at the University of Virginia was asked to participate in a program to study and find uses for the application of a system consisting of fiberglass impregnated with unsaturated polyester resin that has been treated so as to begin the first stages of polymerization. The polymerization of the product is interrupted before it is completed and it is packaged in an air tight container to prevent further poly-

merization until the material is ready to be used. The fiberglass, BETA type, was developed by NASA and is being marketed under the trade name of Lightcast®.³

Our attention was drawn to the material by the Navy Prosthetic Research Laboratory, Oakland, California in a preliminary report entitled *Lightcast Amputation Stump Socket* (1) which advocated application of the material over the stump. We made several sockets according to the instructions given in the preliminary report, but found that it was all but impossible to apply pressure properly to pressure tolerant areas and to relieve in areas that are pressure sensitive. These studies led us to the development of the procedure described in this paper which involves the use of a rectified model of the stump.

MATERIALS AND EQUIPMENT REQUIRED

1. Lightcast lamp®.
2. Four rolls of four-inch Lightcast®.
3. One, five-ply stump sock.
4. One, endoskeletal type modular system.
5. One SACH foot.
6. One cosmetic cover.
7. One complete channel assembly for a Fillauer-type removable brim. (2)
8. Two rolls of two-inch Lightcast®.
9. Two rolls of three-inch Lightcast®.

CASTING AND MODIFICATION

A negative cast is taken in the usual way using elastic plaster-of-Paris bandages. The cast is filled with plaster of Paris, and the positive model is modified in the usual manner (Fig. 1).

FABRICATION OF THE SOCKET

The step-by-step fabrication procedure for the Lightcast® socket is as follows:

¹Lecturer in Orthopedics, University of Virginia.

²Prosthetist, University of Virginia, Department of Orthopedics, Division of Prosthetics and Orthotics.

³Solar Laboratories, Inc., Torrance, California.

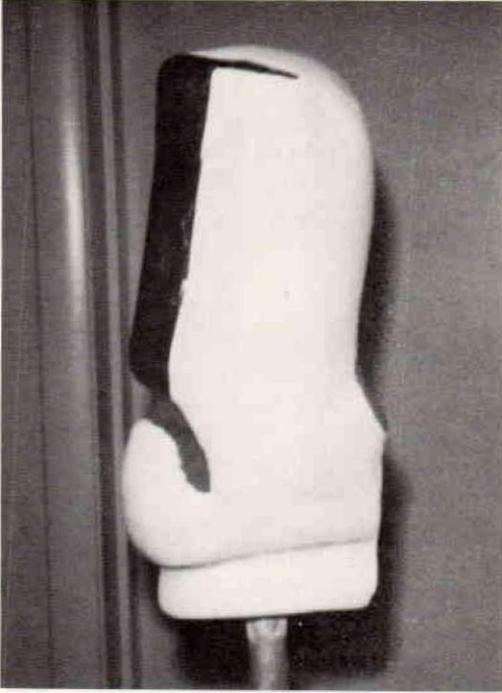


FIGURE 1

1. Coat the positive model with a parting lacquer.

2. Apply a five-ply wool stump sock to the positive model. Do not stretch the material. Staple to the proximal end of the mold (Fig. 2).

3. Apply two layers of four inch Light-cast® material over the five-ply wool stump sock (Fig. 3).

4. Place the mold in the Lightcast® light for three minutes (Fig. 4).

5. Make one longitudinal cut down the medial aspect of the socket with an electric cast saw. Do not cut the five-ply wool stump sock (Fig. 5).

6. Remove the socket from the mold.

APPLICATION OF THE SOCKET TO THE MODULAR SYSTEM

The VAPC adjustable pylon (3) is used routinely in our laboratory for below-knee prostheses, and the procedure for attaching this system to the socket is described here. However, the skilled practitioner will find that any one of the commercial available systems can be adapted to this socket.

1. Attach the correct size SACH foot to the VAPC shank and ankle plug assembly using the instructions provided by the manufacturer.

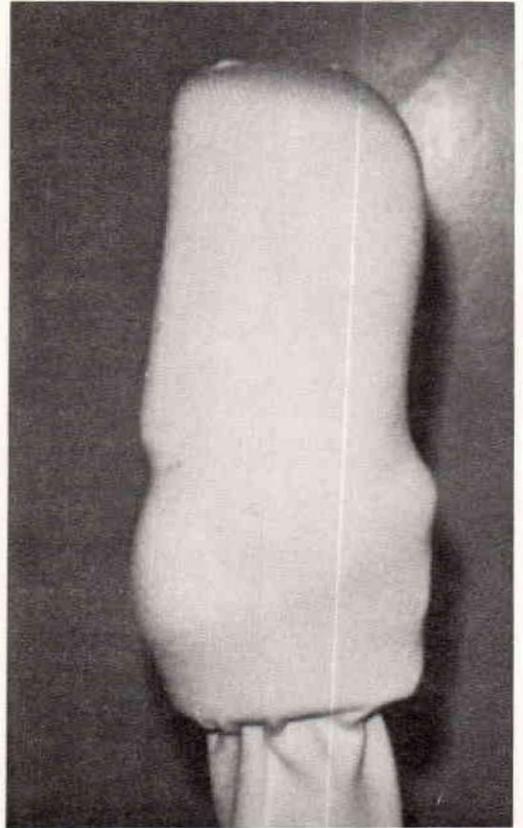


FIGURE 2

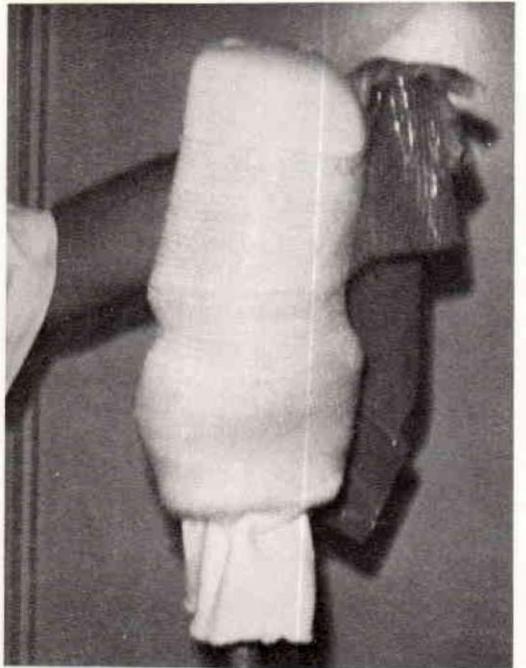


FIGURE 3

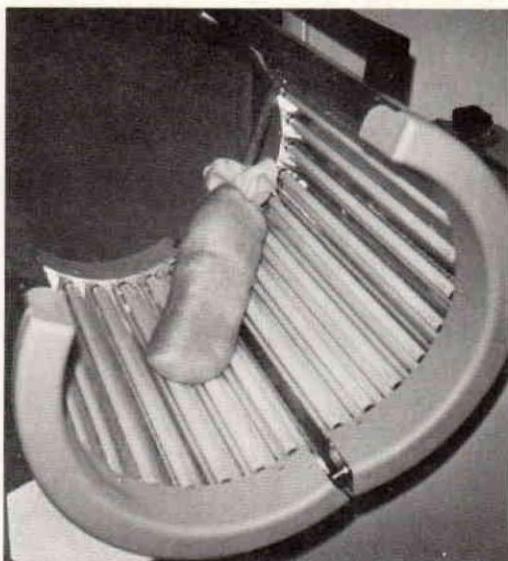
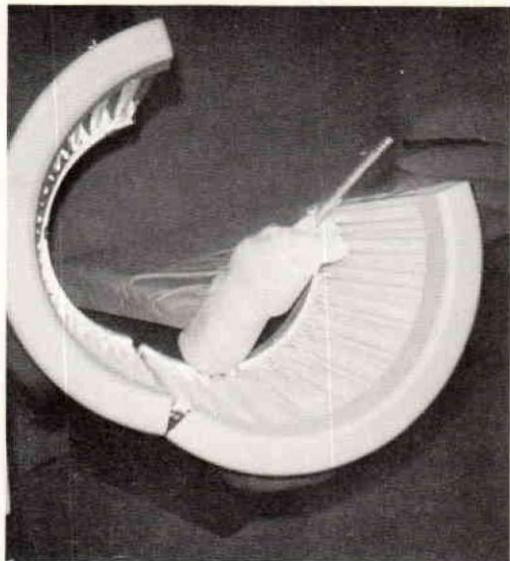


FIGURE 4

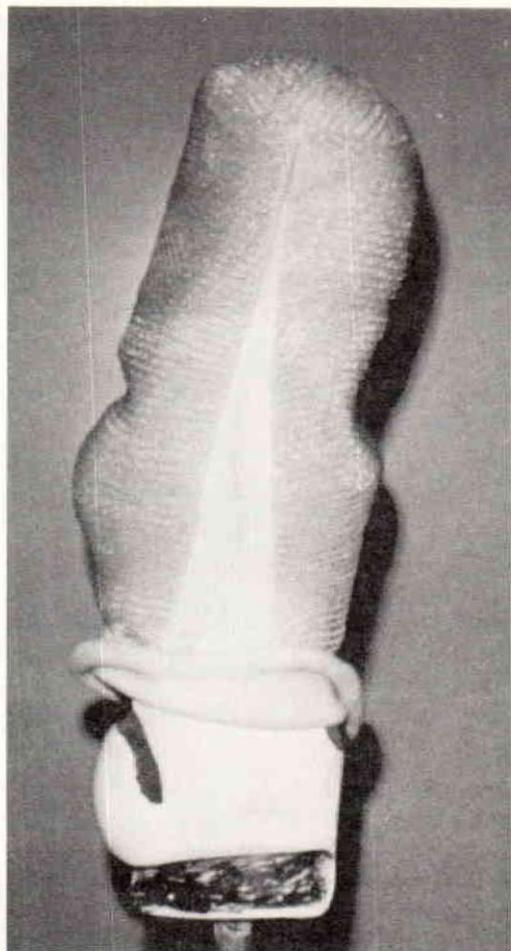


FIGURE 5

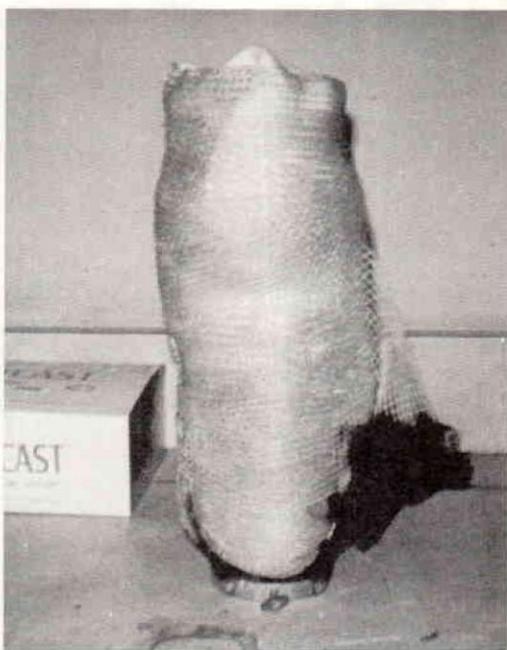


FIGURE 6

2. Set the Lightcast® socket into the socket attachment assembly and bend the four attachment straps to the contours of the Lightcast® socket.

3. Adjust the straps until the socket is brought into good "bench" alignment.

4. Lay one strip of two-inch Lightcast® material under each of the four attachment straps.

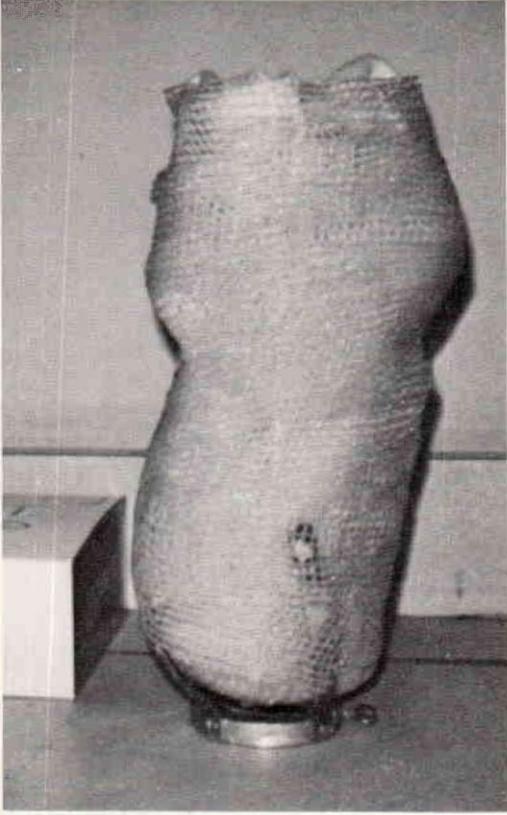


FIGURE 7

5. Starting one-half an inch above the proximal end of the attachment straps (Fig. 6), completely cover the straps by making circular wraps until two layers of Lightcast® material are laid down. This wrap should extend to the superior edge of the socket (Fig. 7).

6. Place the socket and socket attachment assembly into the Lightcast® light for three minutes.

7. Shape the Fillauer channel assembly for the socket.

8. Wrap a three-inch piece of Lightcast® material around the wings of the channel assembly.

9. Make one circular wrap around the proximal portion of the cast. Lay on the channel assembly and continue wrapping until four layers completely cover the channel assembly (Fig. 8).

10. Place the socket in the Lightcast® light for three minutes. Remove and make normal cuts with an electric cast saw to remove the medial brim.

11. Take 100 grams of 4110 polyester resin slightly thickened with sulfa flux and completely impregnate the material covering the four socket attachment straps and the Fillauer channel (Fig. 9).

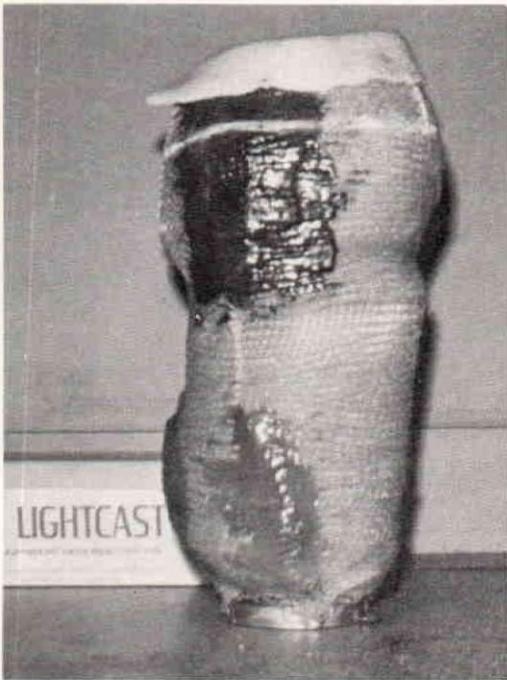


FIGURE 8

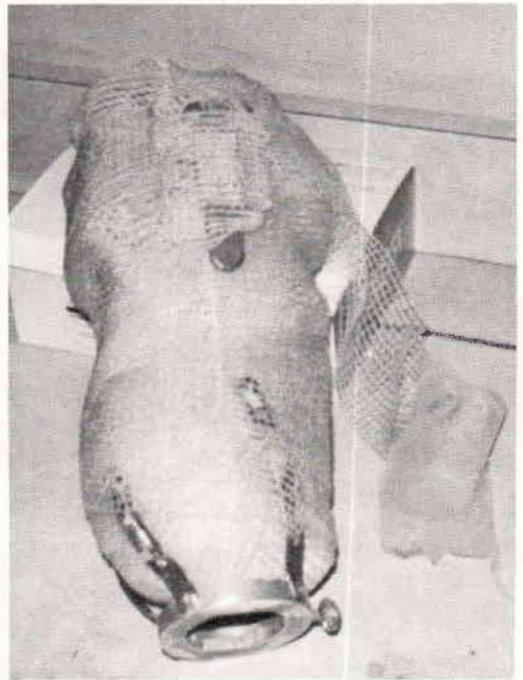


FIGURE 9

12. Remove the medial brim and trim the proximal edges.

13. Attach the socket and socket attachment assembly to the shank tube and the prosthesis is ready for dynamic alignment (Fig. 10).

After dynamic alignment a semi-rigid foam product called Koroseal can be fabricated to form a cosmetic cover as described by the United States Manufacturing Company⁴.

DISCUSSION

The advantages of a porous socket made from Lightcast® are, the ability to permit the interchange of air and to some extent control the accumulation of fluids within the socket (Fig. 11). Lightcast® affords a light, porous, easy applied, and quickly cured material with a high resistance to impact for the construction of a prosthetic socket.

Many prosthetics facilities may find the application of this procedure to the patient prohibitive because of the high cost of the Lightcast® lamp.

The Lightcast® lamp uses a standard three-prong outlet, draws an average of nine amperes, and is designed to operate on a 120 volt system. A 15 ampere circuit is recommended. This device is necessary for curing Lightcast® because the polymerization process will not be completed unless the material has been subjected to ultraviolet light. However, it seems possible that most centers working with handicapped people will find this system of value because Lightcast® can be used in place of plaster of Paris in many instances including splints for immobilizing fractures. It also can be used to provide simpler splints in place of other plastics. Lightcast® is radio-transparent, and the patient is able to use it immediately after a three-minute curing period. A twenty-four hour waiting period before full weight-bearing is considered to be desirable but our experience has found it not to be essential.

REFERENCES

¹ Asbelle, Charles, and Michael Arrigo, *A "lightcast" amputation stump socket, a preliminary report*, Navy Prosthetic Research Laboratory, Oakland, Calif., May 15, 1970.

² Fillauer, Carlton, *A patellar-tendon-bearing socket with a detachable medial brim*, *Orth. and Pros.*, 25:4:26-34, December 1971.

³ Wilson, A. Bennett, Jr., *Recent advances in below-knee prosthetics*, *Artif. Limbs.*, 13:2:1-12, Autumn 1969.

⁴ 623 S. Central Avenue, Glendale, California 91209.

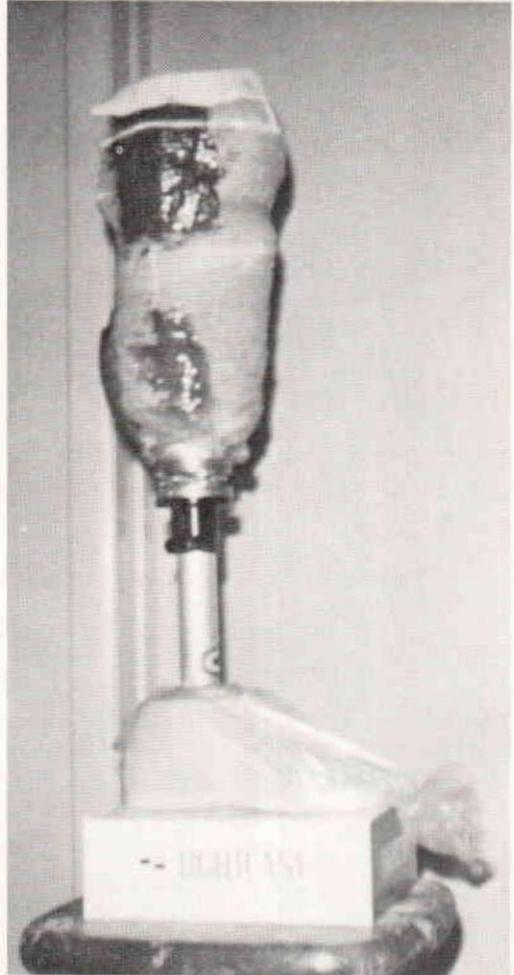


FIGURE 10

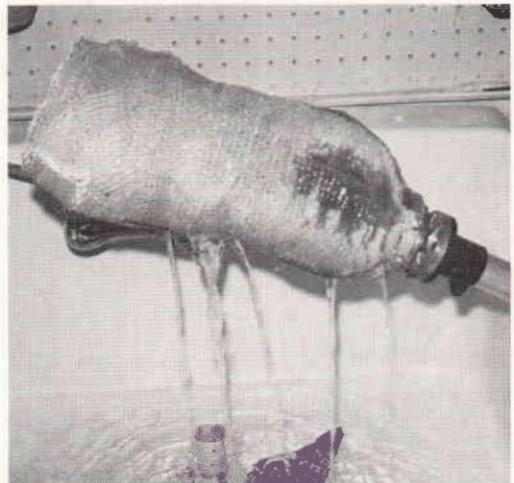


FIGURE 11