

## **Technical Note**

# **An Acrylic Lamination Technique for An Ultralight Below-Knee Prosthesis**

**T**he first patient that this type of prosthesis was fabricated for was a 70-year-old male, five feet, ten inches tall, and weighing 158 pounds. Amputation on the left side below the knee was carried out secondary to diabetic gangrene. He also has a longitudinal partial foot amputation on the right, leaving the great toe intact, but weakened for push off.

The first prosthesis was a conventional patellar-tendon-bearing leg. It weighed 5 pounds, one ounce and was delivered to the patient in December, 1976. He was quite active in this prosthesis with a cane and was without problems except for an occasional replacement of the liner because of shrinkage of the residual limb.

The patient's main complaints about the prosthesis were the weight and the resultant high rate of energy consumption while walking. He asked that a lighter prosthesis be provided. The prescription called for a PTB with soft socket, SACH foot, cuff suspension strap, and waistbelt.

Originally, we planned to fabricate the prosthesis of polypropylene, but we were not satisfied that this material is the answer to the ultralight question. Not only do we question the integrity of the material itself, but the additional expense of the oven, plastic welder, and a vacuum system and the lack of success in our hands and others in fabricating a polypropylene PTB led us to seek another solution.

Using materials and equipment available in most prosthetic laboratories, we have devised the procedure described below which makes use of acrylic resin in the lamination process.

### **Fabrication Procedures**

Impression taking, model modification and soft interface fabrication remain the same. A check socket is desirable, since the thin laminations leave little room for error.

#### **Steps in the First Lamination**

1. Dry the model in oven for 8 hours at 140 degrees F.
2. Paint model with parting agent.
3. Apply PVA bag.
4. Apply one layer of half-ounce Dacron felt.
5. Apply two layers of Perlon stockinet.
6. Apply four layers of glass stockinet.
7. Apply two layers of Perlon stockinet.
8. Apply PVA bag.
9. Laminate with 80% rigid-20% flexible acrylic resin.

#### **Static Alignment**

Use the Bock 1S19 SACH foot with external foam keel. Be sure that the midline of the socket (A-P placement) is over the center of the foot, so as to reduce to a minimum the pressures exerted on the keel.



We also used the Bock 743Z4 adaptor to the BK adjustable leg and a 2R8 SACH foot adaptor instead of the conventional foot plug because this gives further adjustability at the ankle without the need to change the position of the socket.

### Transfer Process

1. Put the aligned prosthesis in vertical fabrication jig. Tighten the knee yoke screws in the keel to hold foot in alignment. Fill the socket with plaster to maintain its shape.
2. Remove the BK adjustable leg and smooth the distal end of the socket.
3. Apply a polyvinylchloride (PVC) bag to the socket to prevent foam from adhering to it. Do *NOT* use PVA, because the moisture needed to soften a PVA bag will affect the foam. Use heat to soften the PVC, and seal the distal end of the bag. Cover the bolt hole in the keel with tape.
4. Apply a sleeve to contain the foam.
5. Foam from keel to the proximal trim line.
6. Remove leg from the vertical fabrication jig.
7. Shape shin according to measurements and blend the foam to the proximal trim lines. Leave foam in the patella-tendon indentation and any other undercut areas to facilitate removal of socket from outer shell in later stages.

### Final Lamination

1. Separate the sole and the cushion heel from the keel of the SACH foot.
2. Make "knotholes" in foam at distal socket (anterior, posterior, medial, and lateral sides) to allow contact between outer shell and socket.
3. Run a string from the keel to the vacuum source.

4. Apply a PVA bag.
5. Fill "knotholes" with "gunk" and let set in depressions. This will bond to the laminate.
6. Apply six to eight layers of perlon/glass stockinet.
7. Apply a PVA bag.
8. Laminate with acrylic resin.
9. Seal distal lamination on underside of keel so that the lamination is left smooth.

### Assembly

1. Remove plaster from socket.
  2. Clean proximal trim lines.
  3. Separate the socket from the outer shell.
  4. Remove foam from shell using prosthetic router. Pulling tools can be used to remove foam from keel.
  5. Bond the socket to the outer shell with Siegelharz gunk. Be sure to bond "knotholes" projections to outer shell to forestall breakage.
  6. Bond the sole of the foot to bottom of keel.
  7. Apply suspension straps.
- The key points in this procedure are:
1. Prevention of breakage through alignment.
  2. Prevention of breakage through the use of "knothole" projections to contact the outer shell.
  3. Use of lightweight acrylic resin.

The finished prosthesis weighed two pounds, five ounces, compared with five pounds, one ounce for the old prosthesis. The components are shown in Figure 1.

This article was originally submitted for publication in April, 1978. I came across my copy in my BK notebook again, whereupon I rewrote parts of the fabrication section since I had discovered in the meantime easier ways to carry out some steps.

Since January 1, 1978, our laboratory has fabricated about 20 ultralight be-

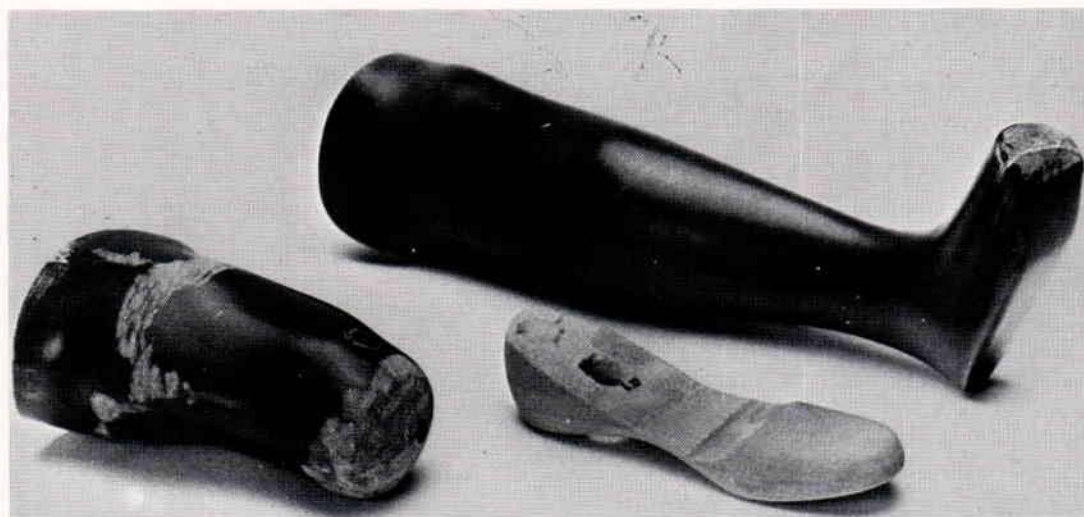


Fig. 1. Major components of the ultralight below-knee leg using acrylic resins for lamination.

low-knee prostheses for both male and female patients, from 23 years of age to a 98-year-old gentleman. Patient weights have ranged from 87 lbs. to 226 lbs. Activity levels have varied from a cosmetic leg for a wheelchair user to our super active 23-year-old rock singer (on weekends) who won't sit down.

Thus far there has been no breakage. On old users, I have not seen the patients as often for problems as I did before making the ultralight prosthesis.

The 23-year-old presented the greatest problem with acceptance of the new leg because she did not believe a prosthesis that light would support her. It took two to three weeks for her to become accustomed to the absence of weight. Now, she doesn't want to take off the prosthesis for fear I will pour lead into the hollow section.

Finished weights of the prosthesis range from one pound, nine ounces to two pounds, fourteen ounces (without corset and joint uppers) and suspension from cuff to supracondylar to supracondylar/suprapatellar to joints and corset. Only two patients have wanted to use waist belts because they felt "naked" without them.

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