A Below-Knee Weight-Bearing Pressure-Formed Socket Technique

by Robert F. Hayes, C.P.

I'm pleased that the Academy has requested that I update and rewrite the Below-Knee Weight-Bearing, Pressure-Formed Socket Technique article I originally wrote in 1975. It's hard to believe that ten years have passed since the original publication of this paper.

I haven't made any significant changes regarding the principles or application of this procedure, but let's go back to some of the reasons this concept was developed.

As I explained in the original article, my son was being fitted for ski boots and it occurred to me that we might make use of some of the techniques used by ski boot designers. The ski boot had an inflatable inner bladder. With the foot under weight-bearing, a conforming material similar to certain silicone compounds was injected into the bladder to give a perfect form-fitting in the attitude of weight-bearing. The incentive to apply this technique to limb prosthetics was reinforced while I was casting a below-knee patient who was a dentist. We exchanged thoughts on molds and changes when pressures are applied. Dentists take one mold for a cast which is filled with dental impression cream (similar to alginate). This is applied to the patient under pressure to give a more accurate impression, and then this is filled to form the definitive positive mold.

The standard method of fitting a below-knee amputee involves taking a negative cast in a non-weight-bearing condition, forming a positive model, modifying it in size to present dimensions by removing material to create pressure, and applying material to relieve pressure on the stump as appropriate. A socket is then molded over this model with the hope that, with small adjustments, it will fit the patient.

Wouldn't it be wiser to develop a socket under pressure that will adjust to and fit the patient, rather than fit the patient to the socket? In trying to answer this question, the procedure described here was developed.

THE PROCEDURE

Measure the patient in the usual manner. Place a sheet of plastic wrap material, such as Saran, over the patient's stump to keep it clean of indelible pencil, and to make removal of the cast easy. If a wool sock is to be used, apply it, and then apply the plastic wrap. Apply a cast sock or tube gauze over the stump. Bond 1/4" felt over all pressure-sensitive areas: the crest of the tibia and the head of the fibula.

Figure 1. Place a sheet of plastic wrap, such as Saran, over the patient's stump to keep it clean and to ease removal of the cast.

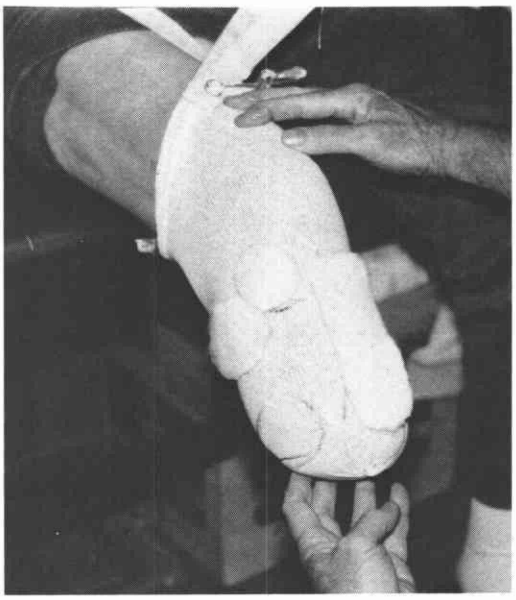


Figure 2. Apply cast sock and felt relief pads.

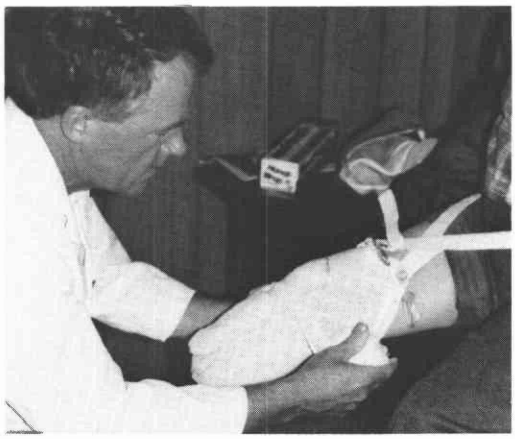


Figure 3. Using Plaster-of-Paris, wrap the residual limb in the usual manner.

Figure 4 (left). Remove the tube gauze and felt buildup from the negative cast.

Keep in mind that all areas being built up will be filled with alginate to give contact, yet minimizing pressure. There are some prosthetists who have adopted this technique and claim they apply direct pressure over the crest of the tibia. My experiences do not agree with that. In particular, since many of our patients are diabetic with very thin skin, extra caution should be taken to reduce pressure and especially friction over all bony prominences.

Using elastic Plaster-of-Paris bandage 4″ wide, wrap the stump in the usual manner, and reinforce with 3″ or 4″ wide regular plaster bandage. Remove the cast and remove the tube gauze and felt buildup from the negative cast.

Pour the positive model, remove the negative cast, and modify in the usual manner, but do not touch areas that were covered with felt. Build up the distal end of the positive model at least 1″.

Figure 5. Pour and modify the positive model.

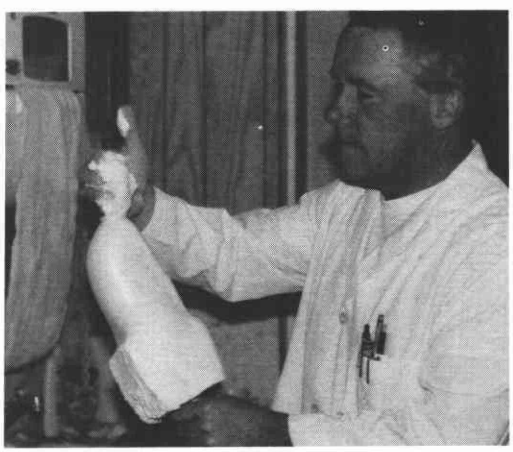


Figure 6. Build up the distal end of the positive model at least 1″.

Make a check socket. This is a perfect application for vacuum-forming. Plaster bandages or laminates can, of course, be used. Drill two holes ¼" in diameter in the distal end and rough up the inside surface of the socket. For the first fitting, apply the stump sock of choice, and place plastic "wrap" over the stump sock to act as a separator. An invaginated balloon will not work because it adheres to the alginate that is to be used later.

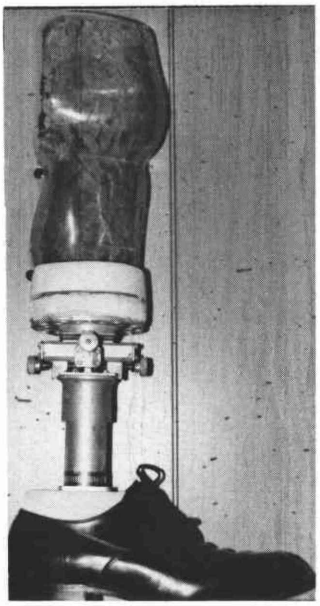


Figure 7. Set up the transparent check socket for dynamic alignment.

Some prosthetists apply the check socket to the patient's bare stump (no socks) for visual inspection. It bothers me to think what happens to the fit of this socket when the prosthesis is finished from this exact mold and the patient applies the usual stump sock of 3-ply or 5-ply. When the check socket is applied on new patients, I recommend using a thin-fitting sock in anticipation of stump atrophy. On seasoned, well-shaped stumps, I use the same sock that the patient usually wears. When using inserts that tend to compress, i.e. Pelite®, you may use a 3-ply and, after several weeks of prosthetic use, the socket should accommodate a 5-ply sock. Of course, there are many factors to be considered, and this is the area where the prosthetist's knowledge and experience will play the major role as to how well his or her patient does.

Mix about ½ pint of dental impression cream or alginate (which is more economical). Pour about ⅓ of the total amount in the distal part of the socket and, with a spatula, spread the rest around the remaining surface of the socket. It is necessary to work quickly at this point.

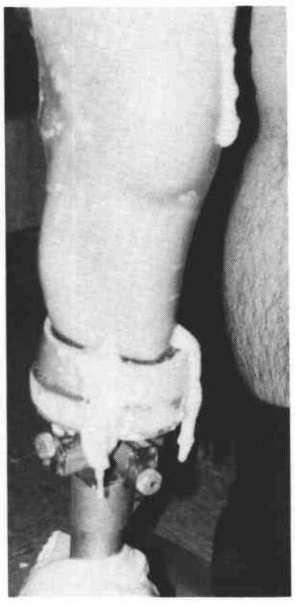


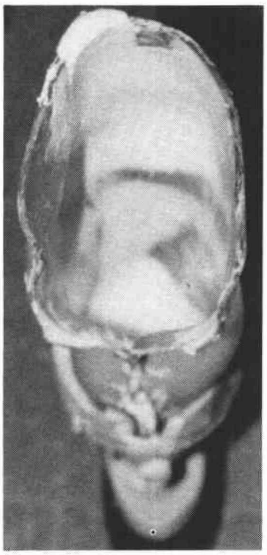
Figure 8. Pour the alginate and let it escape through the distal holes until the patient is lowered into the socket to the proper level at which time the holes are blocked. The alginate will then escape along the proximal brim of the socket.

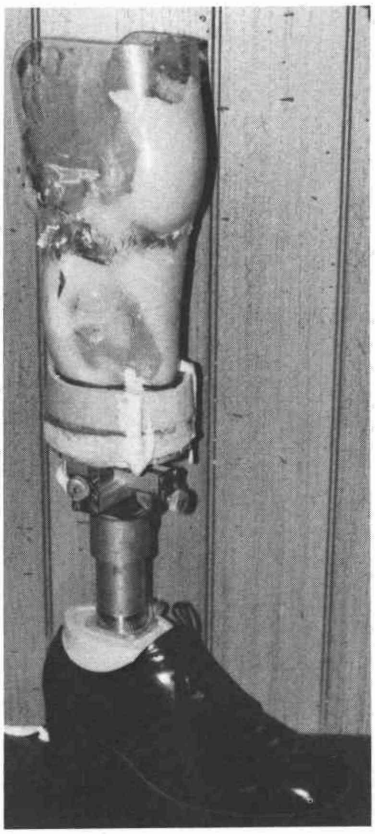
Place the socket on a fitting stool adjusted for height. Use some sort of pad to prevent slipping and cover the drilled holes in the socket with your thumb and forefinger. Have the patient place his stump in the socket. Let the alginate escape through the distal holes until the patient is lowered into the socket to the proper level, at which time the holes are blocked. Alginate will now escape along the proximal brim of the socket.

As soon as the alginate has set up, remove the stump from the socket and immediately fill the socket with plaster. The rigid socket and alginate are removed by using a cast cutter. The mold resulting is a perfectly smooth, pressure-formed, positive mold that can be used in any method of fabrication desired.

When this technique is used, patients can be fit with sockets without soft liners.

Only a minimal amount of additional time is required. I feel that the technique allows better fitting of "problem" stumps and that it may be used as a routine procedure to advantage, especially in central fabrication systems. Vacuum-forming procedures recently introduced make this approach to fitting even more attractive. We have since switched to clear plastic check sockets for the obvious advantage of visual inspection and also the ability to adjust check socket pressure areas with a heat gun on some plastics. We also now fit the check socket on the adjustable leg, rather than the fitting stool. This better simulates the pressures exerted on the stump by the definitive prosthesis, since we





Figures 9 (left) and 10 (right). The completed socket.

all agree that socket alignment greatly affects the application of pressure.

I know that this procedure has been used by many prosthetists in various parts of the country, and I have received many favorable comments about the benefits to the patient. This pleases me because this is the goal of the process. And I'm sure that in the future new devices and innovations will continue to add to and improve this concept to even greater benefit of the patient.

AUTHOR

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