

Syme's Prosthesis—A Brief Review and a New Fabrication Technique

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The traditional Syme's amputation is a disarticulation of the ankle with a transection just above the articular cartilage of the tibia. The heel pad is preserved and secured over the end of the tibia so that the body weight can be borne over the distal end of the stump (Fig. 1). In a similar amputation, Boyd's (1), the calcaneus with the heel pad intact is fused to the distal tibia.

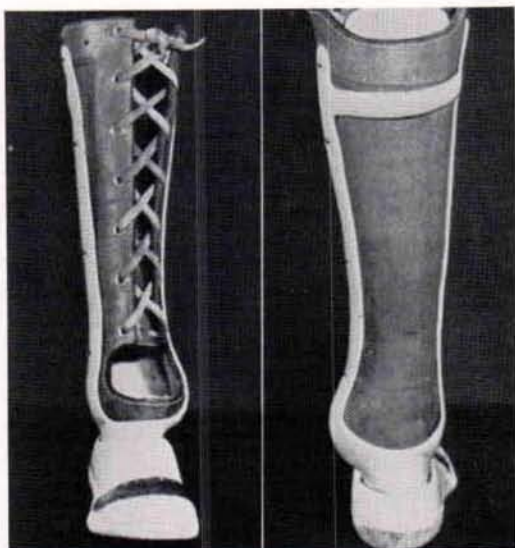
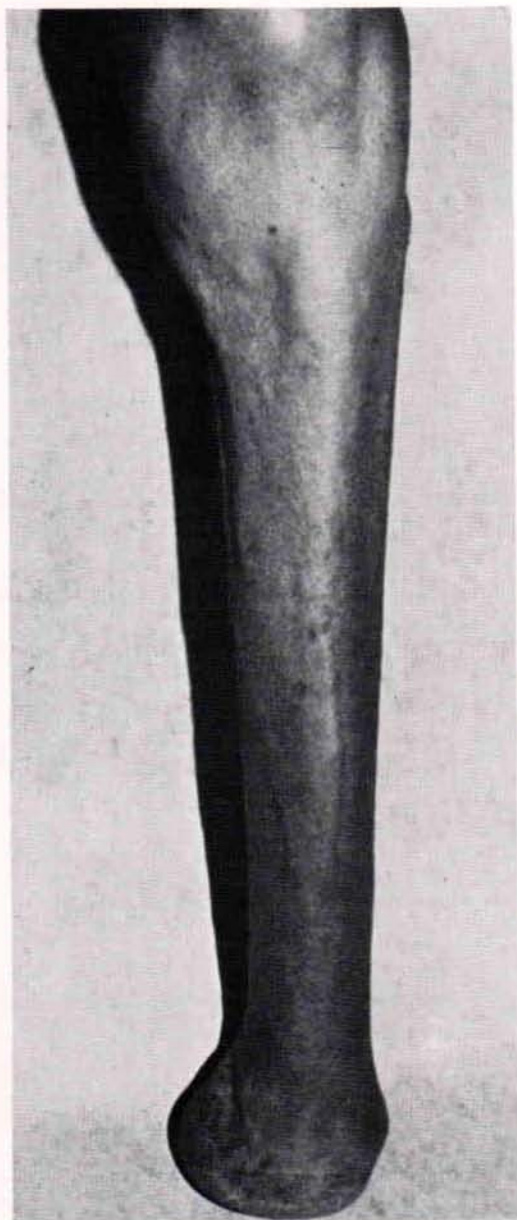
Syme's amputation was first described in 1843 by Sir James Syme of Edinburgh, Scotland (10,11). The procedure seems to have been accepted in many parts of the world but gradually fell into disrepute largely, some believe, because the original procedures were modified or forgotten as the years went by. The bulky prostheses (Fig. 2) required when metals, leather, and wood were the only suitable available materials did not provide much encouragement to surgeons to amputate in the region of the ankle. However, Syme's amputation did survive in Canada (5) where McLaurin, Hampton, and Foort (2,3,4,12) used polyester-and-nylon laminates in the design and fabrication of the Canadian-type Syme prosthesis (Fig. 3) in 1952 which resulted in lighter, stronger, and more cosmetic prostheses. Many modifications to the original design have been introduced through the years (7,8,9) but the basic principle remains.

The purpose of this paper is to discuss briefly these designs, and to explain a technique I have worked out for a good Syme's prosthesis.

Whether Syme's or Boyd's procedure is used, proper technique by the surgeon is critical to provide a stable heel pad and thus comfortable accommodation of the forces encountered over the distal end of the stump during standing and walking. The residual limbs resulting from each procedure are similar in appearance, both having a bulbous end that provides good weightbearing where a comfortable self-suspending prosthesis can be applied.

These types of amputation when carried out properly provide more function and comfort than a below-knee amputation. They allow the amputee to get from one point to another without a prosthesis. Fewer adjustments are needed to maintain a comfortable, well fitting prosthesis. I feel that the Syme's level of amputation is preferable over any other level. The only real shortcoming is the large ankle area which, for some women, presents a cosmetic problem.

Early Syme prostheses were made of a steel frame with a leather socket, (Fig. 2). This, of course, was quite heavy and bulky when they were strong enough to withstand the high forces generated during walking and running.



The original Canadian design (Fig. 3) used a posterior opening to permit insertion of the bulbous stump and the SACH-type foot was built around the socket. The Veterans Administration adopted immediately the Canadian con-

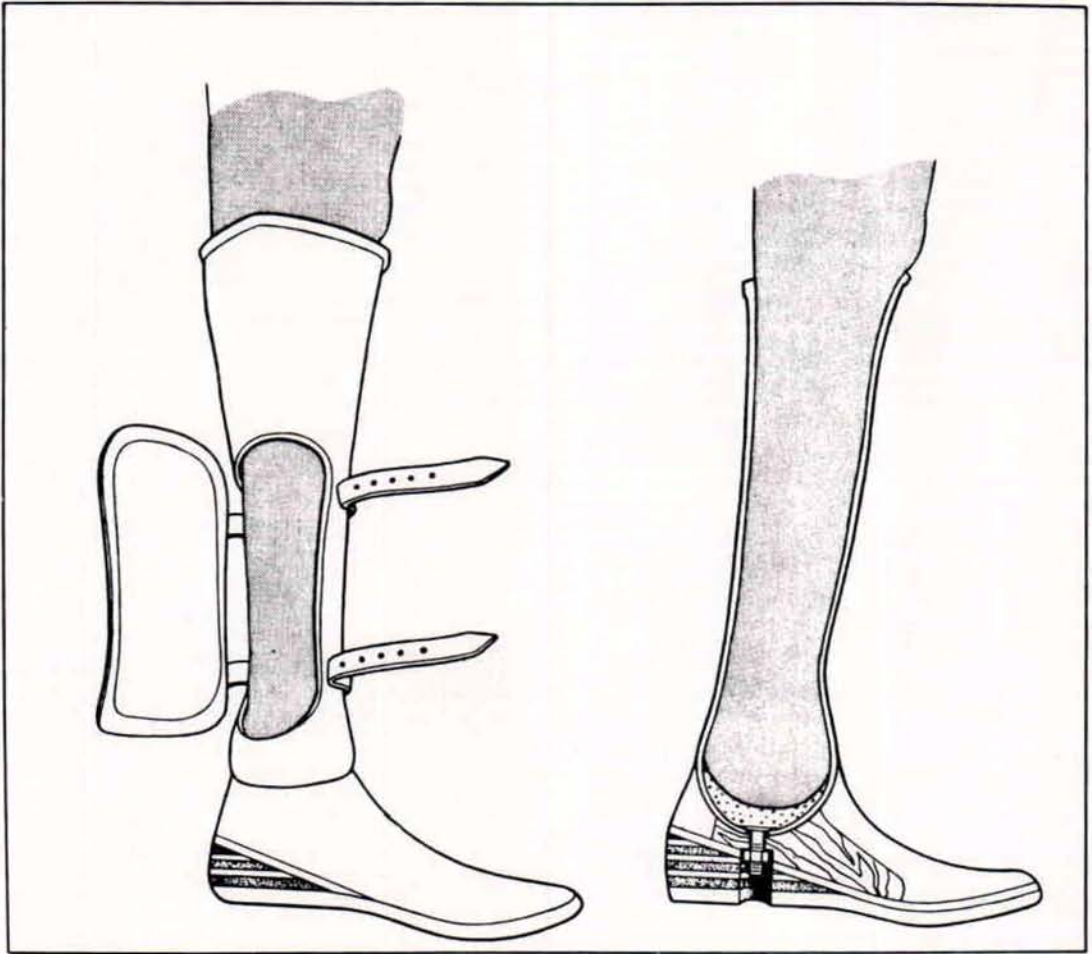


Fig. 4. The Canadian-type Syme prosthesis modified by VAPC to provide a medial opening.

cept and improved the strength and durability by developing a technique to provide a medial window (Fig. 4) (6). Manufacturers of the SACH foot later provided feet designed especially for Syme's prostheses.

A design that is tubular with no opening is, of course, stronger for a given weight, and designs were developed that eliminated this opening, but some cosmesis was lost. For smaller, bulbous ends, one design incorporates an expandable inner liner that is built up to fill in the small volume about the ankle to make it the same circumference as

that of the bulbous distal end, and thus provide suspension (Fig. 5) (9).

This system has the inner socket laminated with 385 Elastomer, a Dow Corning product, over the distal area to allow expansion for the large end to pass through. The proximal part of the socket and outer shell is laminated with polyester resin.

A partial medial insert (Fig. 6) (8) can also be used to provide suspension for a solid tubular socket.

These designs are useful and are well described in the literature. However,

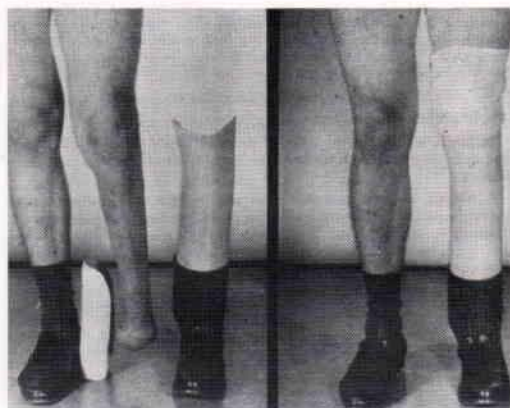


Fig. 5. Syme prosthesis using an expandable inner liner to provide suspension and avoid the need for a window in the socket. This type of socket is used mostly when the tibial condyles have been trimmed during surgery to provide a less bulbous stump.

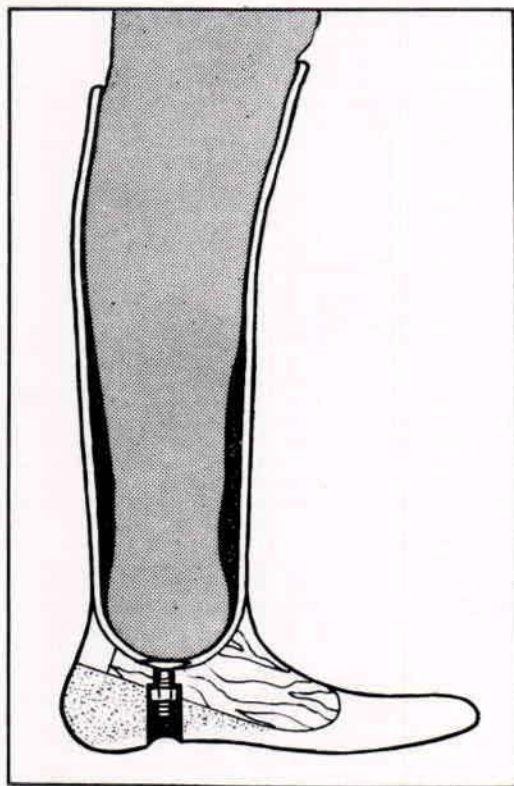


Fig. 6. Syme prosthesis that uses a medial partial insert to provide suspension yet avoid the need for a window to permit insertion. This type of socket is used mostly when the tibial condyles have been trimmed during surgery to provide a less bulbous stump.

they are more bulky than is desirable and a large bulbous end cannot be easily accommodated with these designs.

To create an acceptable Syme prosthesis, we must have the following:

- Properly fitting socket with easy access for adjustment
- Durable, strong socket-and-foot combination
- Light weight
- Ability to adjust alignment and length during fabrication
- Thin and cosmetic ankle area

The technique described below results in a medial-opening Syme prosthesis that fulfills the above requirements to a great extent.

Procedure

Begin by measuring the amount of limb-length discrepancy present with shoes off. Apply two cast socks on the stump to extend above the knee. While the patient is in a supine position on a table, outline the tibia, head of the fibula, and any other bony prominences. Apply 4-inch-wide plaster splints over the anterior half of the stump, and form a bead with the plaster along the edges.

Wrap one plaster splint around the stump; apply plaster at the ankle and again at the calf to hold the anterior section in place (Fig. 7).

Have the patient roll over onto his abdomen, and apply Vaseline or Murphy oil soap (in paste form) in a thin even coat to the entire posterior surface of the leg and $\frac{3}{4}$ inch over onto the anterior plaster.

Apply 4-inch-wide plaster splints to the posterior portion of the leg overlapping the anterior section by about $\frac{1}{2}$ inch. When the plaster has set, make keying marks over the edge of the plaster (Fig. 8) and remove the posterior section. Peel off the wrapped splints, and, with

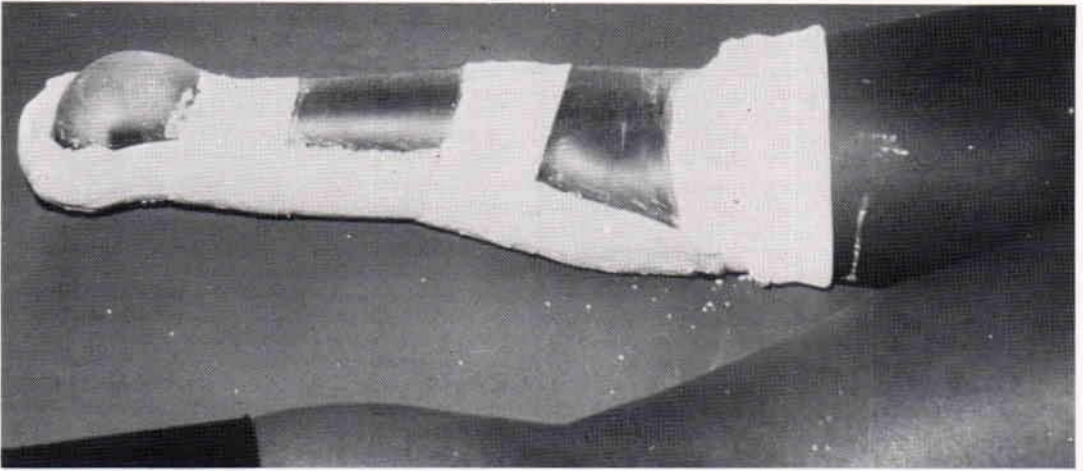


Fig. 7. Posterior view of the anterior portion of the cast in place.

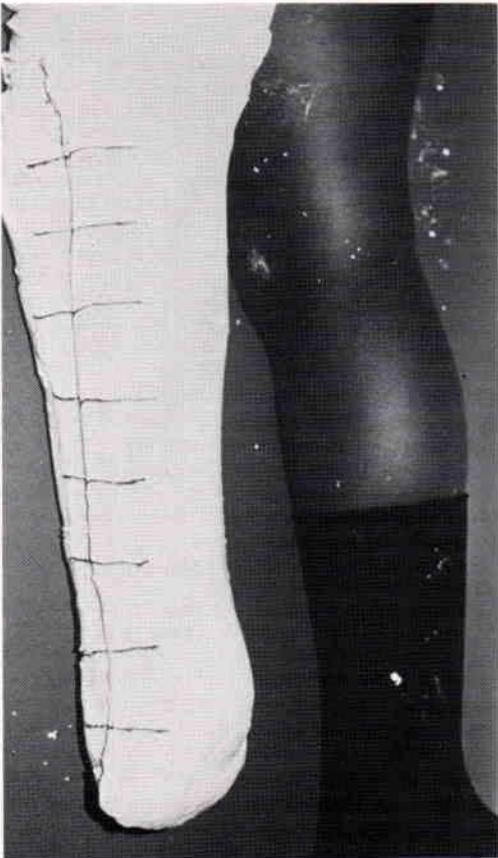


Fig. 8. Completed cast. Note the key marks.

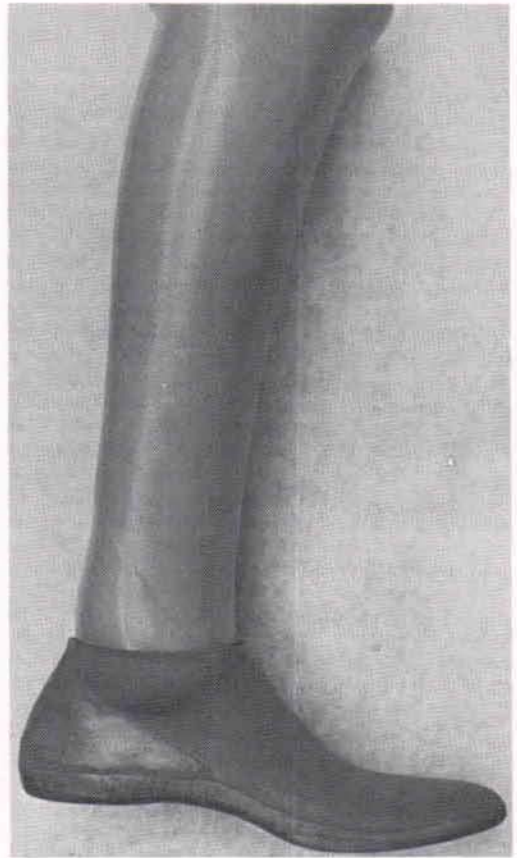


Fig. 9. Syme prosthesis using Kingsley-Syme-SACH foot.

bandage scissors, cut the outer cast sock to make removal of the anterior portion easier.

Secure the two halves with plaster splints and pour the positive model in the usual manner.

Cast Modifications

Do *not* provide for a patellar tendon bar in the cast. For a good endbearing Syme's amputation stump, weight does not need to be carried on the bar, which can present a possible source of irritation and discomfort.

Flare the popliteal area slightly. Position it $\frac{1}{2}$ inch lower than the tibial plateau to permit more knee flexion.

Build up bony areas for relief in the usual manner.

For medial opening, measure circumference of the bulbous distal end, move proximally and mark the cast at the point where the same circumference is found.

Measure M-L dimension at the distal end, move proximally and mark on cast the level where the same measurement is encountered.

Using these marks as a guide, outline roughly an opening on the medial distal area of the cast. Build up plaster to form a straight line along the outline from the calf to the bulbous distal end. This build-up will provide a gap along the sides of the medial opening to allow the bulbous end to enter the socket easier.

Checking The Fit

Make a check socket out of UVEX, polypropylene, or any other suitable material that can be thermoformed.

When fitting the check socket, keep the medial opening as small as possible and still allow easy entry into the socket. The smaller the opening, the stronger the socket will be. Check for good end-

bearing and proper fit for the rest of the socket. Be sure that more than 90 degrees of knee flexion can be obtained without forcing the stump up out of the socket. In general, the proximal trim lines are slightly lower than for a PTB prosthesis.

Correct the cast as needed and smooth it for lamination.

Socket Fabrication

Laminate the socket to be thin and strong. Listed below is the layup I use for an average size individual. For a large heavy person or for a socket that requires an unusually large medial opening, extra layers of fiberglass cloth and roving need to be added.

Standard Lay-Up For SYME Prosthesis:

- One-ounce dacron sleeve
- One fiberglass reinforced stockinet
- One full fiberglass cloth wrapped from proximal end to and over the distal end.
- One fiberglass reinforced stockinet
- One thick cord of roving from proximal anterior, over distal end, to proximal posterior end of cast. Cord of roving around door cut out, $\frac{1}{4}$ inch behind trimline. One fiberglass mat at distal end when using Kingsley foot for Syme prosthesis.
- One fiberglass reinforced stockinet
- Two pieces of fiberglass cloth wrapped at ankle and over distal end. One fiberglass mat at distal end when using Kingsley Syme's foot.
- Two fiberglass reinforced stockinets

Method When Using A Kingsley Syme's Foot (Fig. 9)

Build up distal end of cast to provide room for half-rounded Syme's nut adapter. Place buildup in position so that

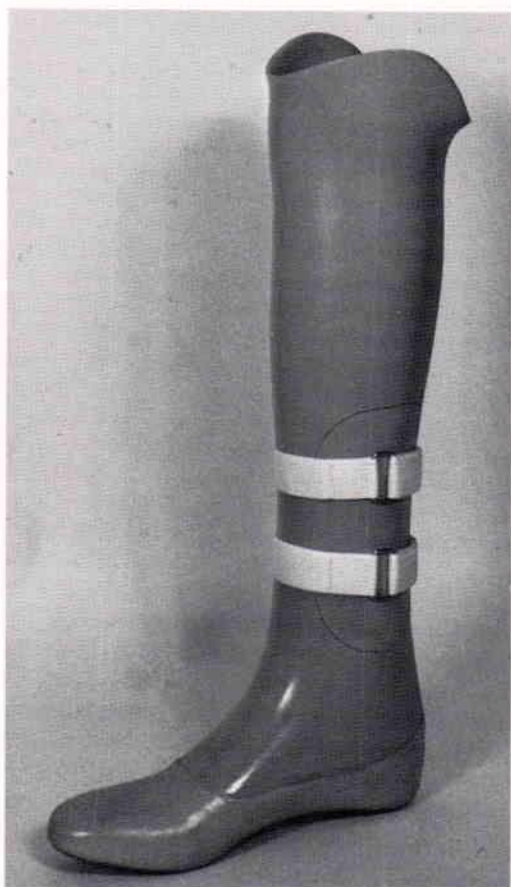


Fig. 10. Syme prosthesis using Otto Bock 1P5 Syme-SACH foot.

stump is aligned in slight flexion and adduction.

After the socket is completed, bolt the foot to the socket using a wood spacer inside the foot to maintain proper length and alignment. This spacer should be shaped like a small oval doughnut. When aligning the prosthesis, the wood spacer can be sanded or shimmed to provide proper alignment. Finish the socket as described later.

Using a strong filler (i.e. Cab-O-Sil or Solka Flock, etc.) thicken polyester resin and gunk the finished socket into the Kingsley Syme's foot maintaining alignment and length.

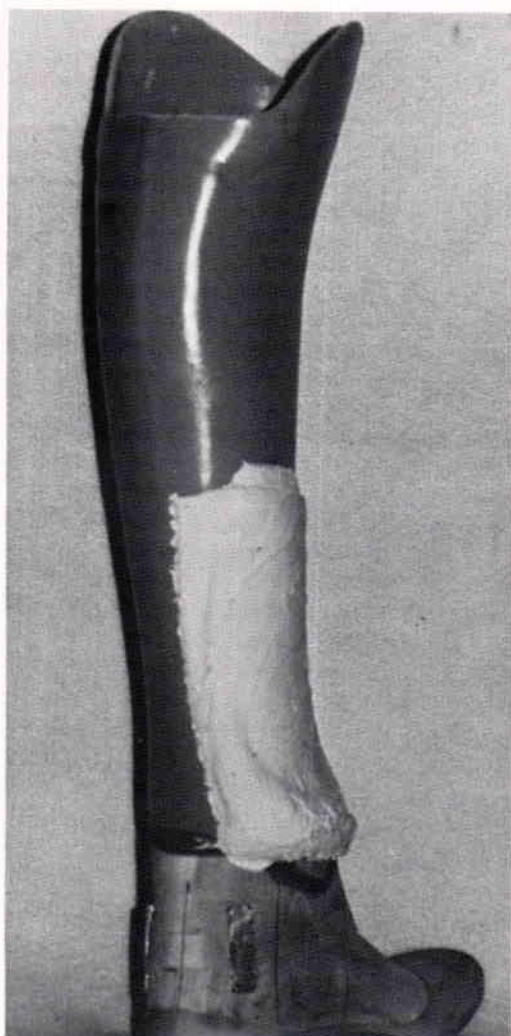


Fig. 11. Unfinished prosthesis with plaster splints formed in and over medial opening.

Method for Using Otto Bock 1P5 Syme's Foot (Fig. 10)

Set the socket in wood to the apex of distal end and level the socket in slight flexion and adduction angles.

Level the top of the foot.

Put foot on heel block of proper height and align socket of foot.

Keep foot as far laterally as possible in relation to the distal end of the socket

and still maintain a reasonable cosmetic appearance.

Position the socket in the A-P plane to provide an acceptable appearance from heel to socket and instep to socket.

Adjust height to exact length discrepancy measurement.

Using white glue (Elmer's) spot glue the socket to the foot temporarily.

Reinforce glue joint with #2 Scotch fasteners. The temporary glue joint can be broken by hitting the foot with a mallet. Wedging by sanding or addition of wood can be used to adjust alignment.

To finish, break apart the foot and socket and permanently fasten with glue while maintaining alignment. Reinforce glue seam with dovetails if desired.

When the lamination is completed, apply masking tape over the rubber part of the foot, and stretch standard PVA bag over the foot and socket. Be sure to extend lamination onto foot covering entire wood area.

Fitting the Prosthesis

Check the fit of the socket and height. Use an Ace bandage over medial opening to obtain suspension. Make all necessary changes for fit and alignment and try prosthesis on the patient again to be sure that optimum fit and alignment have been achieved.

Making Medial Opening Door and Finishing the Prosthesis

Put a smooth plastic bag over prosthetic socks on patient's stump.

Cover the shoe on the prosthesis for protection against plaster.

Have patient don prosthesis and stand up.

Apply 4-inch-wide plaster splints over medial opening overlapping onto socket. Contour and form tightly against the stump (Fig. 11).

Remove splint for later use. This medial door opening cover will suspend the prosthesis.



Fig. 12. Finished prosthesis when Velcro straps are used to hold medial door in place.

Roughen surface of socket except for $\frac{1}{2}$ inch on border around medial opening. This $\frac{1}{2}$ inch will be where the door overlaps onto the socket.

Reapply splint over medial opening and pour distal portion of socket with plaster and insert a pipe. Remove splint and smooth plaster at opening. Seal plaster and $\frac{1}{2}$ inch edge of socket with clear lacquer or some other suitable parting agent.

Layup for finish lamination as follows:

- Dacron felt or Dynalon over medial opening, extending $\frac{1}{2}$ inch onto socket.
- Four or more glass-tricot or some other reinforced stockinet over entire socket (and foot when using Bock foot 1P5).



Fig. 13. Finished prosthesis when an elastic anklet is used to hold medial door in place.

- Use only polyester resin for final lamination. Acrylic resin will adhere to the socket and the door over the medial opening and cannot be removed.

Using a sharp knife and a heat gun, cut out door $\frac{3}{8}$ inch from edge of medial opening.

To hold door in place use:

- Dacron webbing and Velcro straps (Fig. 12)
- Or a small elastic anklet (Fig. 13)
- Or a strong tape (i.e. filament tape)

Summary

The method discussed here is for a prosthesis for Syme's amputation with a large bulbous end. It utilizes a split casting procedure. Cast modifications do not have a PTB bar, but have a lower posterior flare and as small of a medial opening as possible. The medial door is made in the final lamination and provides an accurate fit and acceptable cosmetic appearance. It is important to be able to adjust length and alignment. Either the Otto Bock 1P5 foot or the Kingsley Syme's foot can be used.

Footnotes

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