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A PROSTHESIS FOR FOOT AMPUTATION NEAR THE TARSAL-METATARSAL JUNCTION

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The human foot is one of the most elegant examples of physiologic engineering. The skeletal framework and the muscular forces acting upon it are so arranged that they are held in delicate balance throughout standing, walking, and running. When an amputation is carried out through the foot, this balance is lost. As we realize the complexity of the human foot and the tasks required of it in standing and walking, we begin to appreciate the crippling effect caused by the loss of any weight-bearing segment.

A common result from an amputation near the tarsal-metatarsal junction is either an equinovalgus or equinovarus deformity that presents an almost impossible condition for satisfactory prosthetic fitting and normal gait.

PURPOSE AND GOALS

A prosthesis can serve as a functional replacement for the lost portion of the foot. It can also prevent deformities and provide cosmetic restoration.

The primary goal is distribution of weight-bearing loads to areas of the remaining portion of the foot in such a manner that the blood flow is unimpaired. Another goal is to prevent spreading of the remaining portion of the foot; that is, to hold the foot in proper anatomical alignment while free motion is allowed at the ankle along with subtalar motion of inversion and eversion. In addition, adequate retention of the foot in the socket is very important.

Currently most prostheses consist of an ankle joint and corset, a molded socket with a flexible felt or rubber toe section. While this design does satisfy some of our goals, the fabrication time is considerable and the result is a bulky and ill-appearing prosthesis.

A NEW DESIGN

Over the past several years, we have been using a prosthesis that meets the functional requirements given above and one that is cosmetically acceptable.

This prosthesis is designed similar to a UC-BL shoe insert except for the trim lines which are more proximal. The socket is an acrylic lamination using banlon and fiberglass cloth reinforcements on sole, sides and heel areas. The toe piece is SACH-foot heel-cushion material[2] (soft for children, medium for youths and firm for adults). The posterior portion of the socket extends proximally to the retrocalcaneal bursa, and anteriorly to the most proximal portion of the instep around the mid-malleolar level. The posterior midline is parted to a point on the plantar surface. This is done for easy donning of the prosthesis. The socket and toe section are bonded together with epoxy resin.

FABRICATION PROCEDURE

Because this prosthesis fits snugly in the shoe, the plantar interface must match the interface of the shoe sole. To duplicate this, a plaster wrap is taken while the patient is standing on a casting form[3].

- Before wrapping the plaster, two layers of tubegauze are placed over the foot and 1/4-in. rubber tubing is inserted along the anterior portion of the foot to facilitate removal of the cast.
- An elastic plaster-of-Paris wrap is applied.
- The foot is placed on the casting form (Fig. 1). Particular attention is given to leg-foot alignment. The ankle should be in a neutral position; not in plantar or dorsiflexion. With the thumb and long finger, the retrocalcaneal dimples are palpated

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[2]Kingsley Manufacturing Co., Placentia Ave., Costa Mesa, California.

[3]Foot Casting Boards (Available from Fillauer Orthopedic).

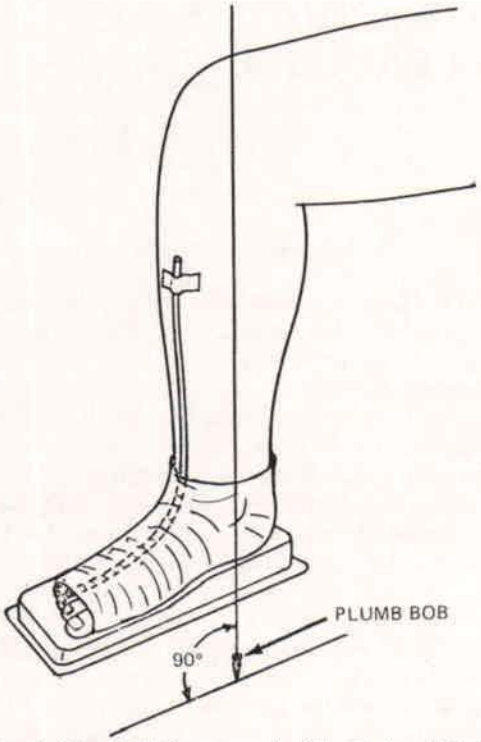

Fig. 1. The foot is wrapped with plaster-of-Paris bandage and placed on the proper casting form.

with moderate compression. With the other hand the forefoot is held firmly on the casting form.

- After the plaster has set and alignment marks have been drawn across the parasagittal cut line, the wrap is removed by cutting along a line over the tubing.
- The negative mold is poured. The cast modifications consist of plaster build-ups over bony areas and mild removal of plaster over the retrocalcaneal dimples which serve as the suspension mechanism (Fig. 2).
- A PeLite[4] distal pad is formed over the cast to provide for growth and relief when necessary. In several cases we have used a PeLite pad on the plantar surface to provide relief from excessive pressure.
- The cast is now ready for lamination with 4 layers of tricot, 2 layers of fiberglass cloth, sandwiched between the tricot layers covering the plantar surface and up the posterior aspect. A 70% rigid, 30% flexible acrylic resin laminate with vacuum is recommended.

[4]A polyethylene foam distributed by Fillauer Orthopedic.

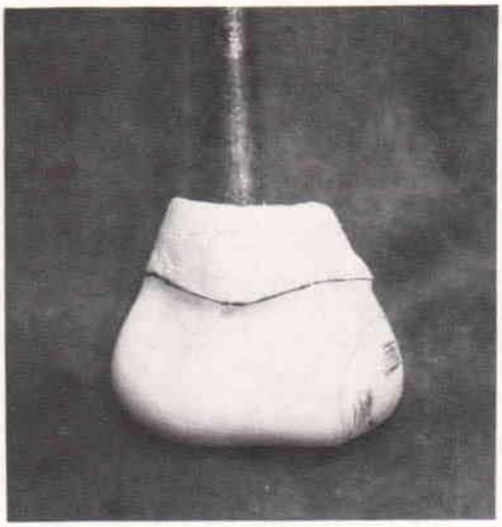

Fig. 2. The positive model.

- The socket is removed from the model. The proximal trim lines are left outsized. The posterior midline is parted to a point just on the plantar surface to make possible easy removal and donning of the prosthesis (Fig. 3).
- The profile of the toe section is outlined on a Kingsley SACH-Foot foam block, cut out, and shaped as needed (Fig. 3).
- The socket and shaped toe section are bonded together with epoxy resin (Fig. 4a). The two sections are placed in the shoe to insure proper alignment (Fig. 4b).
- Mannequin spray is used to finish the prosthesis, before fitting trials (Fig. 5).

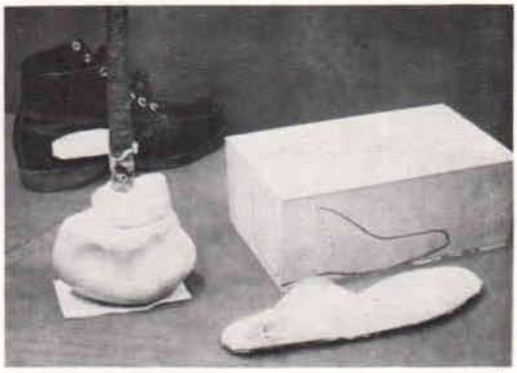

Fig. 3. The profile of the toe section is outlined on the SACH-Foot foam block.

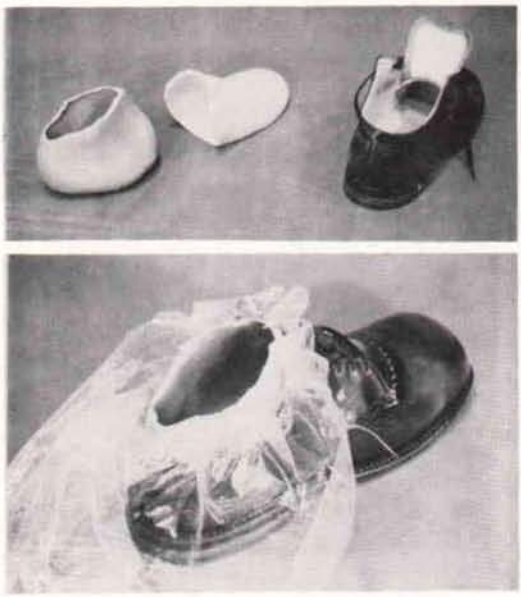

Fig. 4. Two photographs showing relationship of the components of the prosthesis.

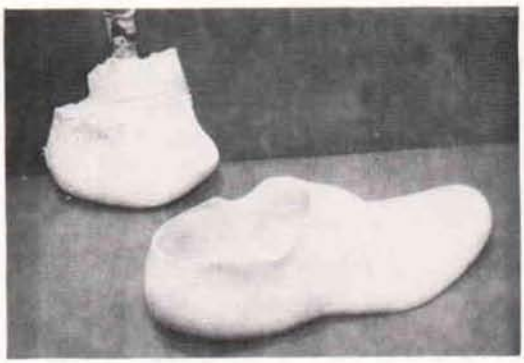

Fig. 5. The finished prosthesis.

FITTING DETAILS

The patient should wear the type of sock he generally uses. In the case of children, a heavy wool sock is desirable because thinner socks can be used to prolong the life of the prosthesis as the child grows. In adults a heavy cast sock or a three-ply cotton sock is preferred.

Entry of the foot into the socket is facilitated when the posterior opening can be spread apart. When donning is difficult, the anterior trim line can be lowered to accommodate the foot more easily.

Socket retention is accomplished by tightness over the heel section when the prosthesis is in the shoe. Therefore, well built shoes having rigid counters should be worn.

When acrylic resin is used, trim line pressure areas may be relieved by either grinding or by post forming under heat.

CONCLUSION

Each patient will undoubtedly present a new problem and require special precautions. Good weight-bearing areas as well as tender points that need protection should be noted. Under no circumstances are scar tissues or grafted skin areas to be subjected to pressure or friction.

This type of prosthesis should encourage active dorsiflexion, and thus avoid, or at least delay, heel cord lengthening procedures while providing an acceptable prosthesis, both cosmetically and functionally.