Technical Note:

Water Safe Prosthetics

Edmond E. Koester, C.P.

INTRODUCTION

The following article is a presentation on the fabrication of a waterproof prosthesis for the below knee amputee. It is an economical process because it is basically a modification of an existing prosthesis.

The prosthesis is made using a 4mm subortholene socket, Otto Bock pedilen foam, and a Kingsley Beachcomber foot set up (Figure 1). The adhesive for attaching the foot is a Dow Corning general purpose adhesive. A silicone sealant is used around the edge of the section where the ankle and foot are bonded together (Figure 2).

FABRICATION

The following is a description of the molding of the subortholen socket and the set-up of the prosthesis.

First, the lay up of the PTB or PTS positive model is shown with the use of one cast sock, one nylon, and clear sealant (Figure 3). The next step is to insert the PTB or PTS positive model in a vacuum forming system, pulling the cast sock and nylon over the positive model. Now the subortholen is ready to be vacuum molded over the cast.

Figure 1: The components of the waterproof below knee prosthesis include a subortholene socket, "Beachcomber" foot and ankle, and Pedilen foam.

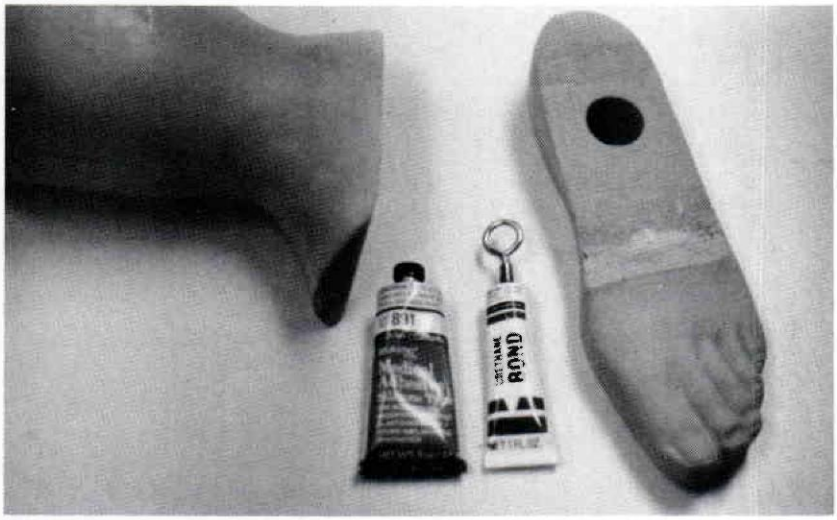

Figure 2: Attachment of the foot is accomplished by the use of Dow Corning general purpose adhesive and a silicone sealant.

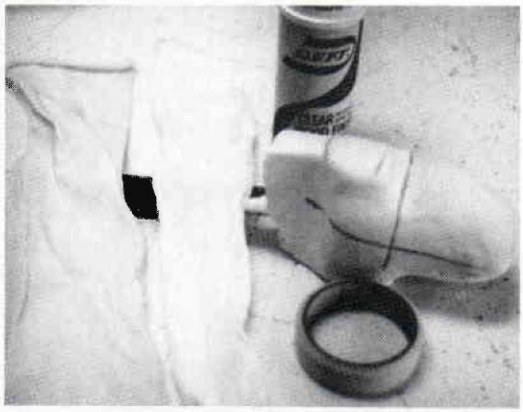

Figure 3: The layup for the subortholene socket includes clear sealant, one nylon, and a cast sock.

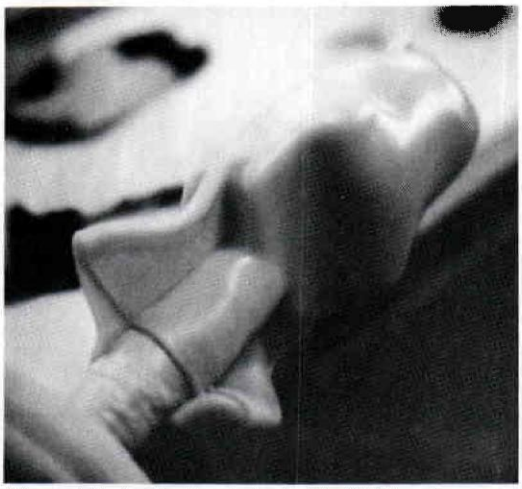

Figure 4: Subortholene is heated to 400°F and vacuum molded over the cast.

After the subortholen has been heated to 400°F, it is then molded, sealed off, and a vacuum is allowed to form, causing a weld. The excess subortholen is trimmed off while it is hot, with vacuum still on (Figure 4). The subortholen socket is then cooled with an air gun, and allowed to become completely cool. This is very important in order to allow the subortholen to bond well. Trim lines are then determined on the socket, and the cast is broken out. At this point, the socket is completely finished as a standard PTB or PTS socket.

The basic components of the waterproof prosthesis may now be assembled. These consist of the subortholen socket, Kingsley Beachcomber foot, pedilen Otto Bock foam system, and standard three layer nylon laminate. In our work, the urethane bonding agent for the Kingsley foot is virtually unbreakable as compared to any other agent which has been used in the fabrication of waterproof prostheses.

The first step is to assemble these components temporarily on an alignment jig, preferably a Staros Gardner coupling. The patient is then allowed to walk barefoot with the prosthesis through the normal alignment procedure. Emphasis is placed on the fact that the action will not be that of

a SACH foot or any kind of multi-axis ankle joint. It is therefore primarily necessary to align the prosthesis more for standing comfort than functional walking comfort. Since the prosthesis is constructed only for light duty use, the prosthesis weight is kept to a two to three pound maximum.

Once the prosthesis has been dynamically aligned, it is then finished as a standard prosthesis. The subortholen socket is completely roughed up with the large rough sanding cone. It is then shaped, and the bonding is done with the pedilen foam. The ankle block from Kingsley is cut to the lowest possible point. The prosthesis is then painted and sealed (Figure 5). Three layers of nylon are applied over the prosthesis and a normal lamination procedure is carried out. The only specialized lamination requirement is the extra time taken around the foot-ankle area and around the under cuts to eliminate as much weight from excess resin as possible. The base of the prosthesis is allowed to cure, and the distal end of the ankle section is ground to allow for a smooth flat bonding surface to the foot plate.

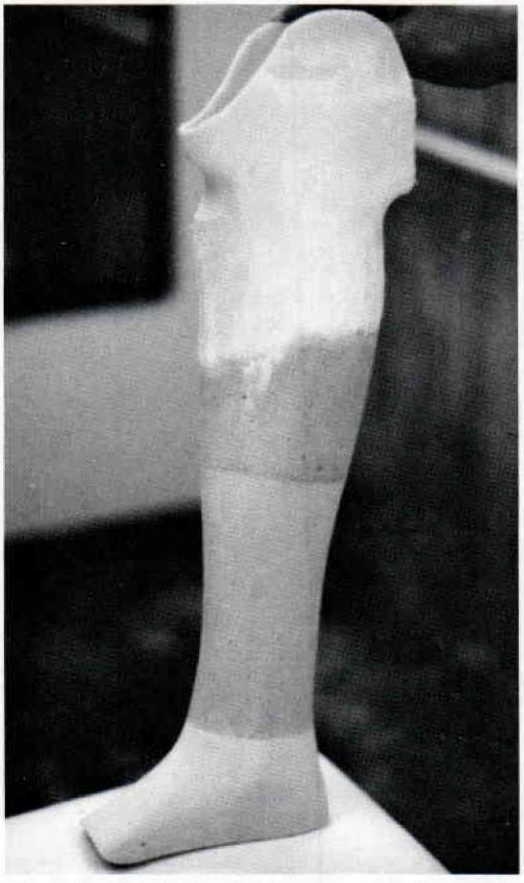

Figure 5: The limb, after bending and shaping, is ready to have the finish lamination applied.

The urethane bond is then applied to the foot, and the prosthesis (Figure 6), and requires twenty-four hours to cure. It is suggested that the adhesive be made smooth and even to make for a uniform bond. It should dry over night before removing tape (Figure 7).

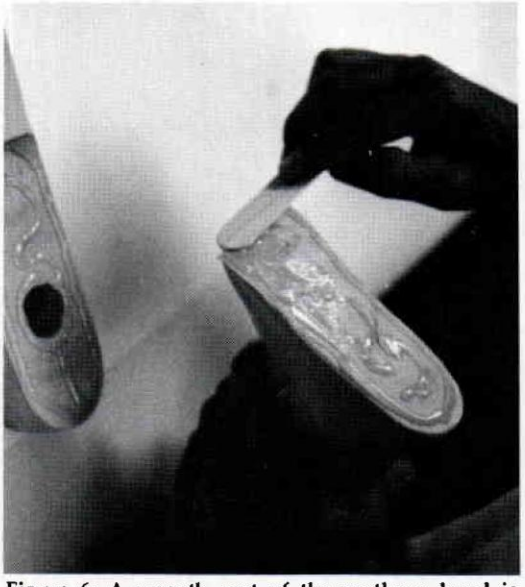

Figure 6: A smooth coat of the urethane bond is applied to the foot and ankle block.

Since urethane adhesive is a foaming agent, it does bubble and expand. Any excess should be trimmed off with a sharp knife. It should be smoothed with a felt cone or a very fine sanding cone. A medical adhesive should then be used to seal any areas which have been opened or exposed. A tongue blade may be used for this to give a uniform cosmetic appearance.

The upper section of the prosthesis is smoothed and completed as with a normal polyester laminate prosthesis. The advantage of subortholen in this system is its ease of workability, and ease of smoothing. The subortholen socket should only be made over a modified plaster positive

Fgure 7: After the foot is bonded, the foot and ankle block are taped and allowed to cure for 24 hours.

model that has proven to be a successful fit. Since the subortholen is only 4mm thick, it is impossible to relieve the socket much. The positive model used for the original prosthesis is saved. After the patient has worn his prosthesis for an extensive period of time, and proven it to fit well, then any small changes may be made to the positive mold, and the subortholen socket made from the corrected positive model.

CONCLUSION

I feel this system provides for an economical means to provide the patient with two prostheses: a standard prosthesis which may have a soft insert, and a multi-axis ankle joint or a SACH foot which cannot be allowed to get wet. The waterproof prosthesis enables the amputee to shower and enjoy water sports which he may have missed.

This prosthesis is very easy to construct, and offers reliability to the amputee, for its limited use. It can also be used at night as a temporary prosthesis, as it incorporates a flat heel SACH foot.

From the time this presentation was given, at the AOPA National Assembly in 1981, to now, more than two years have passed. My facility has supplied approximately twenty amputees with this prosthesis, and this system has proven itself to be successful. Work is presently being done on a similar system for above knee amputees, and within a few years a more complete study on waterproof prostheses should be available.

ACKNOWLEDGMENTS

The author wishes to thank his two assistants, John MacGregor and Holly Rames, for their help in performing this task. Also thanks to Kingsley Company for their Beachcomber foot, and Otto Bock for their waterproof components.

AUTHOR

The author runs Koester Prosthetic and Orthotics Labs, Inc., 4940 Gratiot, Saginaw, Michigan 48603.