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Technique for Forming Sockets Directly on Above-Elbow Stumps

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The ability to make a socket by applying a thermoplastic material such as Polysar X-414 (Polymer Corp. Ltd. TM) directly to an amputee's stump offers many advantages to the prosthetist, as pointed out by Wilson *(4).* Direct forming obviously eliminates the casting procedures necessary to produce a good modified replica of the stump and eliminates the laminating procedures necessary to produce the socket. The thermoplastic properties of Polysar X-414 allows quick postforming of the socket in areas which may require relief, and the material lends itself well to the attachment of components during assembly. These time-saving advantages enable the prosthetist to fit amputees with a temporary prosthesis much earlier than the time normally required for a definitive fitting. This hastens the amputee's rehabilitation and helps to condition him *and* his stump for the definitive prosthesis. The prosthetist also has the advantage of noting any corrections which are applicable to the definitive prosthesis. These advantages are also helpful to the research prosthetist, for he can save valuable time in evaluating new control techniques and testing new components.

A direct-forming technique related to those developed by Staros and Gardner *(3)* for below-knee PTB sockets and by Labate and Pirrello *(1)* for below-elbow sockets using Polysar X-414 has been developed for above-elbow sockets. If done properly, this technique will provide a well-fitting socket which has the above-mentioned advantages. A complete above-elbow prosthesis can be fabricated in approximately three hours.

The technique was used at this center to construct Polysar sockets for four above-elbow amputees who participated in an evaluation study of externally powered upper-extremity prosthetic components. Each amputee (described briefly below) wore his prosthesis successfully for two hours a day, three days a week, during a two-month period without problems.

D. H., a 38-year-old male, with a right above-elbow amputation 11 in. distal to acromion, acquired in June 1964. He was fitted with a standard above-elbow prosthesis, which he has used actively as a laborer since.

R. W., a 35-year-old male congenital amputee, with a right 11-in. above-elbow stump from the acromion. He was fitted with his first standard above-elbow prosthesis in June 1954, and has been an active prosthesis wearer since that time. He is presently employed as a hotel clerk.

J. H., a 44-year-old male with a left above-elbow amputation 8% in. distal to the acromion, acquired in March 1964. He was fitted with a standard above-elbow prosthesis and has been an active prosthesis wearer since that time. He is presently employed as a quality-control inspector for a leather factory.

R. R., a 22-year-old male with a left above-elbow amputation 9 1/2 in. distal to the acromion, acquired in November 1968. He was fitted with a standard above-elbow prosthesis and has used it actively since.

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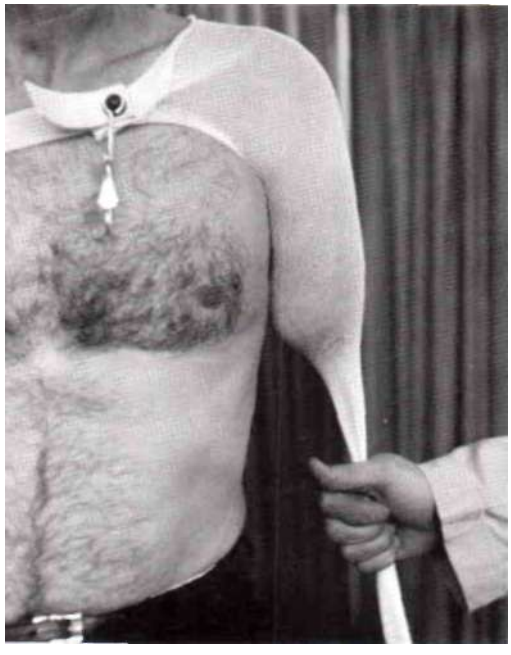

Fig. 1. Tubular gauze suspended with elastic webbing.

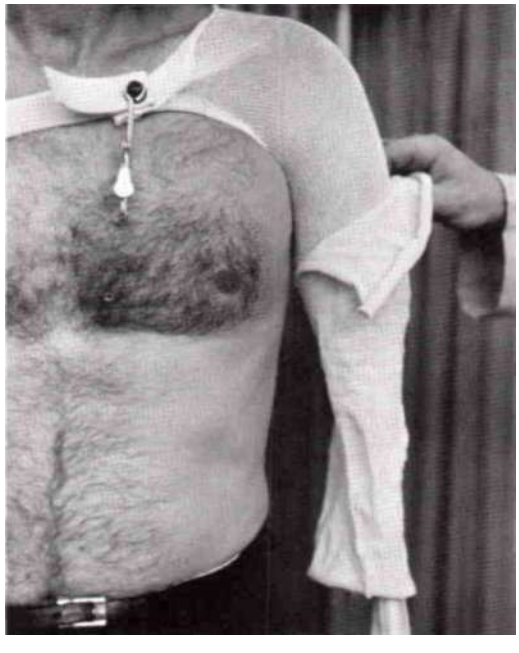

Fig. 2. Heavy east sock applied to distal one-third of stump.

He is a student in college at the present time.

MATERIALS AND EQUIPMENT

A tube of the synthetic rubber 3 in. ID x 1/4 in. x 12 in. is adequate for the average above-elbow stump. The diameter can be reduced for smaller stumps by elongating the tube after it has been heated. Larger sizes of tubing should be used for larger stumps.

The only special equipment needed is a deep, water-filled container, approximately 20 in. in height and 8 in. in diameter. The water should be preheated to a temperature of 160° F to 180° F.

The following materials and equipment should be available within the prosthetic facility:

Two 1 in. x 40 in. elastic webbings
Four Yates clamps
Tubegauz (TM), size #56 (tubular gauze)
Heavy cast sock
Braided Dacron (TM) line, approximately 130-lb-test

Standard Hosmer elbow turntable
Hose clamp, expandable to 11-in. circumference
Hot plate
Parallel bar
Pressure-sensitive tape

PREPARATIONS FOR CASTING

Cut a length of tubular gauze approximately 18 in. longer than the stump and slit it 6 in. from the proximal end. Apply the tubular gauze with the slit in the axilla, allowing the tubular gauze to encompass the shoulder proximal to the acromion process. Pass a piece of 1-in. elastic webbing under the axilla on the sound side and attach it to the anterior and posterior wings of the tubular gauze (fig. 1). Cut the toe from a heavy cast sock and slit the proximal end in the same manner as the tubular gauze. Pull the cast sock on the distal third of the stump, with the slit under the axilla (fig. 2).

Mark the proximal section of the synthetic rubber tube to be cut out for the axilla. The width of the section will depend on the stump size, and the depth

Fig. 3. Cutting out axilla section after tube is heated.

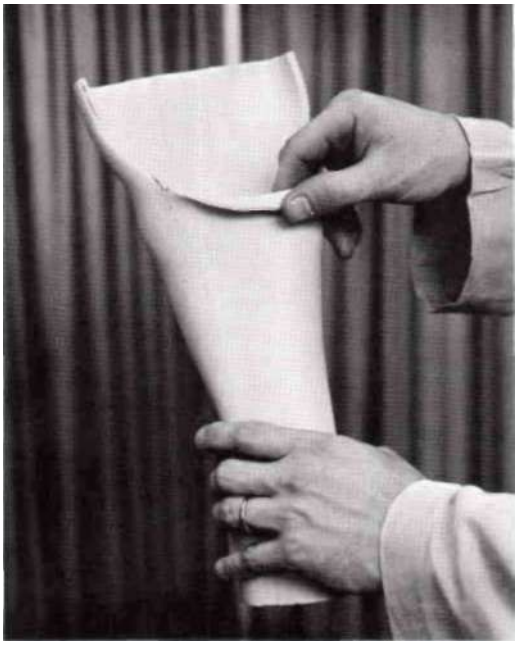

Fig. 5. Medial edge rolled to provide a good flare for axilla.

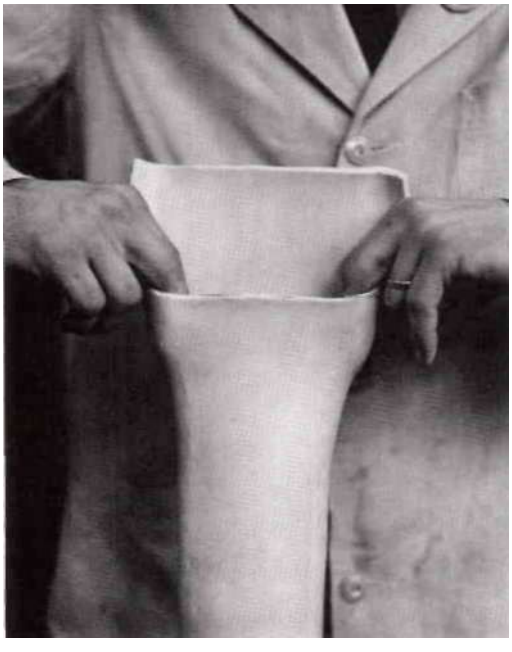

Fig. 4. Synthetic rubber tube stretched at axilla level.

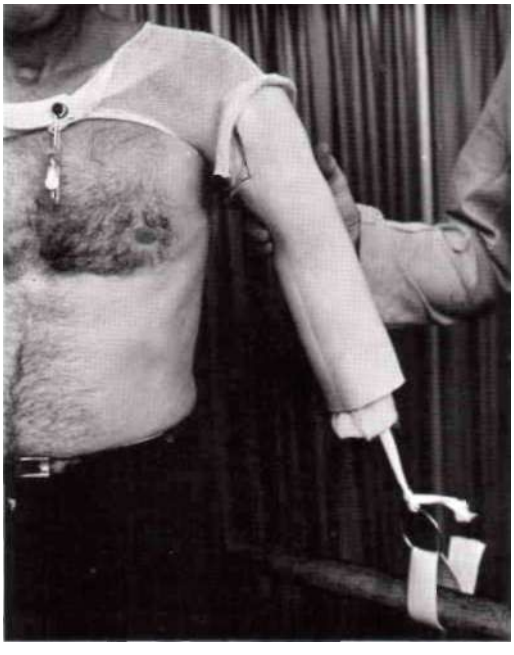

Fig. 6. Synthetic rubber tube applied to the distal end of the stump and t

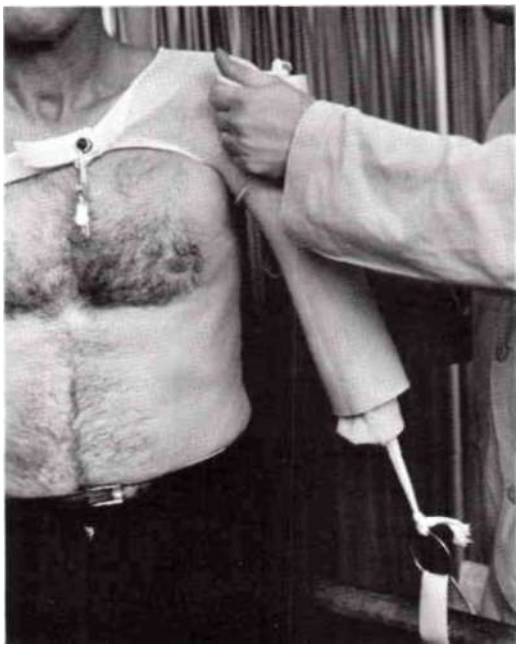

Fig. 7. Synthetic rubber tube is pulled up the stump.

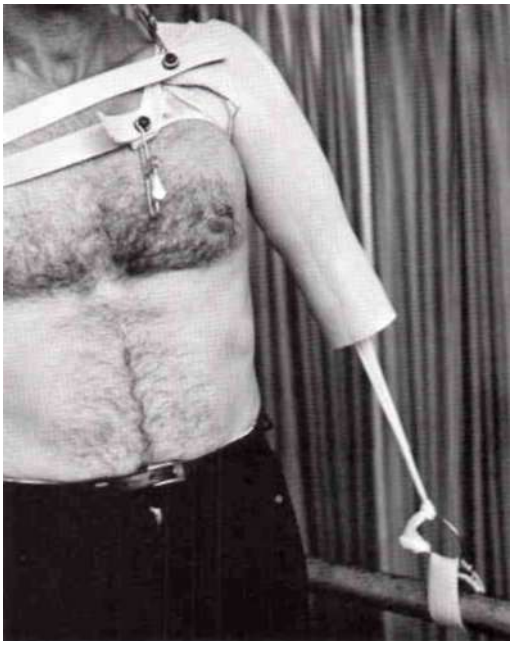

Fig. 8, The tube suspended with elastic webbing.

must be sufficient to allow the synthetic rubber to pass over the acromion. The synthetic rubber stretches well; therefore, caution should be taken not to cut out too large a section. For average stumps, a section 3 in. x 3 in. is adequate.

Completely immerse the synthetic rubber tube in the preheated water. The tube will rise to the surface when it has reached the appropriate temperature. Remove it from the water and cut out the axilla section (fig. 3). Allow the tube to cool until the hand may be placed inside the tube without discomfort.

APPLICATION OF SYNTHETIC RUBBER

Stretch the proximal end of the tube at the axilla level to aid in starting the tube on the stump (fig. 4). Roll the axilla edge to provide a good flare for the axilla (fig. 5). Insert the tubular gauze and cast sock through the tube and apply the tube to the distal third of the stump.

The tubular gauze is anchored to a parallel bar so that the amputee can

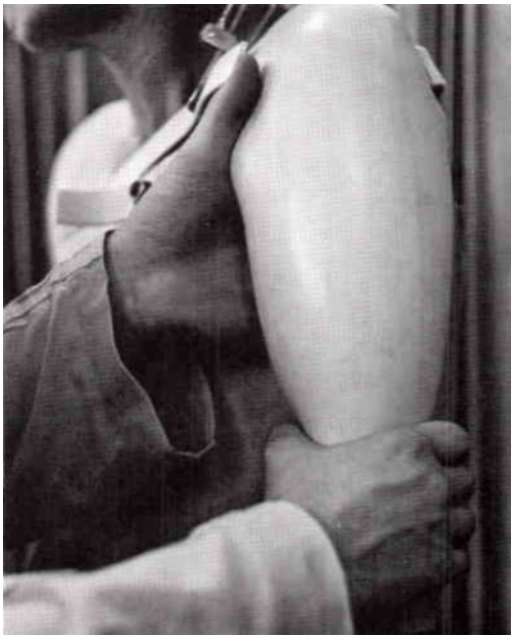

Fig. 9. Left hand in the axilla and right hand contouring distal end of socket to accept elbow turntable

Fig. 10. Right hand contouring the proximal socket.

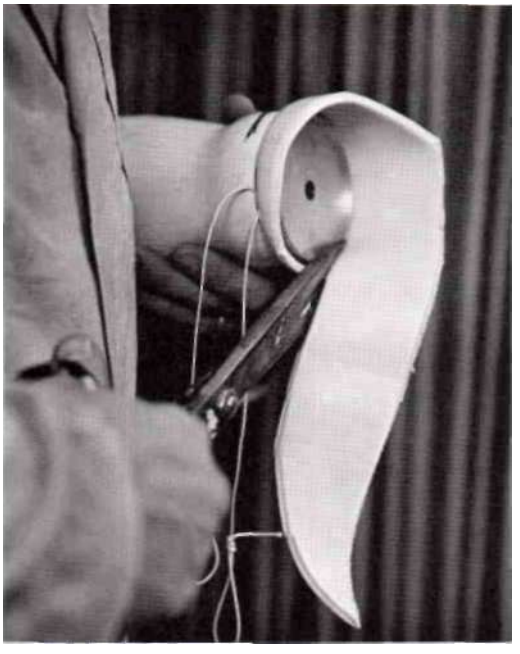

Fig. 11. Turntable tied in place and excess synthetic rubber trimmed.

apply tension on the tubular gauze. The tension will compress the stump tissues and prevent tissue-bunching while the synthetic rubber tube is being applied. An adjustable webbing belt with an O ring is used as the anchoring point on the parallel bar (fig. 6).

Stand the amputee away from the parallel bar with the stump in abduction and the shoulder in depression. This will assist in placing the tube well into the axilla. Pull the synthetic rubber tube onto the stump, using the cast sock to work it up the stump (fig. 7). Make sure it is well into the axilla and over the acromion. Support the tube with a piece of elastic webbing in the same manner as the tubular gauze (fig. 8). This will also aid in forming the proximal end of the socket. Eliminate any wrinkles in the cast sock by pulling on it at the distal end of the tube.

CONTOURING THE SOCKET

When contouring the socket for a left amputee, place the left hand firmly into the axilla, keeping the hand parallel to the sagittal plane. Have the amputee move back to the parallel bar, adduct his stump, and elevate his shoulder to the neutral position (fig. 9).

Firm tension should be maintained on the tubular gauze without causing the amputee to strain. Only the shoulder muscles should be used to maintain the tension. The finished socket will be loose if the stump muscles are contracted during contouring of the socket.

Reduce the diameter of the synthetic rubber distally to conform to the stump and to approximate the circumference of the turntable if necessary (fig. 9). Mold the proximal section by placing the right hand so that the thumb and forefinger outline the anterior and posterior borders of the deltoid muscle group. The thumb is used to mold the anterior wing, and the remaining fingers to mold the posterior wing (fig. 10). Hold the socket in this

Fig. 12. Socket compressed against turntable with pressure-sensitive tape.

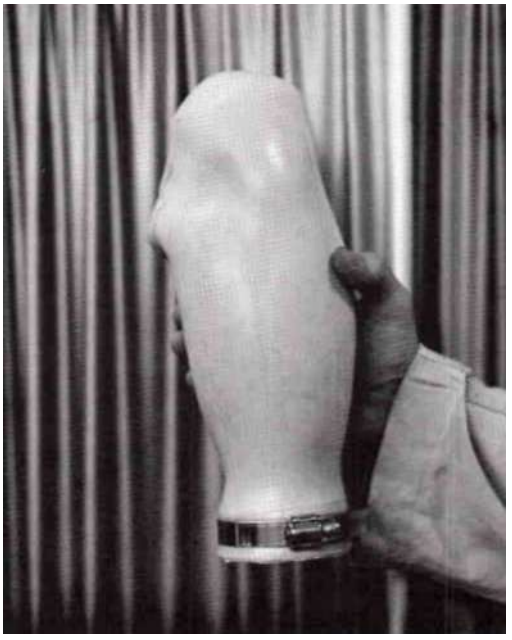

Fig. 13. Turntable attached with hose clamp.

Figs. 14 and 15. The completed prosthesis,

manner until the synthetic rubber cools enough to retain the contours.

Mark the proximal trim line before removing the socket. Either the conventional trim line can be used or the open-shoulder described by McLaurin et al. (2). After the trim line is cut out, the edges can be finished with a felt cone, fine-sand cone, or toluene.

ATTACHMENT AND ALIGNMENT OF TURNTABLE

Determine the proper distance for the elbow center from the acromion process and mark where the turntable will be located on the tube. Reheat the distal end of the tube approximately one-half inch above the mark by immersing it in water. Insert the turntable into the tube and work the synthetic rubber into the knurling and tie-off groove. Secure the synthetic rubber by wrapping 130-lb-test, braided Dacron (TM) line around the tube and pulling it into the tie-off groove (fig. 11). Two passes of line are sufficient. Cut away the excess tubing and apply pressure-sensitive tape around the tube, making sure the synthetic rubber conforms to the turntable (fig. 12). A hose clamp can be used for more strength if necessary (fig. 13).

Attach the elbow unit and forearm section and check the alignment of the turntable. If it is not properly aligned, reheat the distal end in water and realign.

The harness and cable system are attached in the conventional manner (figs. 14 and 15).

ACKNOWLEDGMENTS

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