

TOTAL-CONTACT BELOW-KNEE SOCKET LINERS OF "CORDO SOLUTION": FABRICATION PROCEDURE

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INTRODUCTION

This paper describes the fabrication of a total-contact below-knee socket liner made of "Cordo Solution."

Appliances which were functionally and cosmetically adequate previously are no longer acceptable. Patients now demand a higher degree of cosmetic restoration as well as better function, leading to the use of materials which feel like body tissue and which can be readily shaped. For this purpose we have found "Cordo Solution" superior to other surface materials for internal socket liners in total contact with the stump.

"Cordo Solution" may be dipped, brushed, or sprayed over successive layers of stocking material to form a reinforced cross section of any desired elasticity. It is durable, flexible, has no odor, and is nontoxic.

MATERIALS

Cordobond^a P-315-B2 is a polyvinyl chloride resin formulated in a gelatinous mass for bulk shipment. Before it can be used, it must be heated to form a solution which permits mixing with additional thinner to control its viscosity and with plasticizers to obtain the desired flexibility and strength.

The following procedure is used to compound "*Cordo Solution Plain*":

^a Registered trademark of the Ferro Corporation.

1. Mix together:

A. Cordobond P-315-B2 two-thirds parts by volume.

B. Cordobond Thinner P-371 one-third part by volume.

Place in a large container and warm carefully in an 88 deg. C. air oven or a water bath; the mixture must be stirred occasionally until a solution is obtained. Since both materials are very flammable, *open flame must not be allowed in the room*. If a cover is used over the container it must be *loosely placed*. Ample ventilation is a necessary safeguard.

2. The ingredients listed may now be mixed with the "Cordo Solution Plain" in the following amounts to obtain the desired flexibility and strength for a socket liner, forming "*Cordo Solution*" with *Paraplex G-50 added*:

A. Cordo Solution 'Plain	2760 gm.
B. Paraplex G-50 Plasticizer	300 gm.
C. Cordobond Thinner P-371	1000 gm.
D. Stabilizer #21	40 gm.
E. Coloring	as needed

The "Cordo Solution" without Paraplex G-50 is nonelastic. The proportion of Paraplex G-50 added to the base "Cordo Solution" controls the elasticity of the coating or flexibility of the material. The mixture shown above can be varied to suit the user's needs. We have found the above formula to be best suited for below-knee socket liners, below-knee leg covers, arm covers, cosmetic gloves, and facial restorations.

The methods of application may vary from a dip process to brush applications or spray coating. Approximately 15 minutes drying time must elapse between applications. Dry in a well-ventilated area with air moving over the surface of the work.

Paraplex G-50 Plasticizer is a product of Rohm & Haas Co., Resinous Products Div., Philadelphia, Pa. 19105.

Stabilizer #21 is available from Stauffer Chemical Corp., Specialty Chemical Div., 299 Park Ave., New York, N.Y. 10017.

Coloring is Marshall photographic oil colors available at any artist's supply store.

Cordobond P-315-B2 and Thinner P-371 are products of the Ferro Corp., Composites Division, 34 Smith Street, Norwalk, Conn. 06852.

For more information on the compounding of "Cordo Solutions" see "The Compounding of 'Cordo Solution' for Prosthetic Applications" by Gearhart, appearing elsewhere in this issue of the Bulletin.

To soften the liner, $\frac{1}{8}$ and $\frac{1}{4}$ in. sheets of Plastazote are used as fillers between layers of tube gauze impregnated with "Cordo Solution."

FABRICATING THE BELOW-KNEE TOTAL-CONTACT SOCKET LINER

The following presents a step-by-step procedure for fabricating a below-knee total-contact socket liner:

Stump Casting

Apply a plaster-of-paris wrap cast over the stump in the manner described for casting PTB Prostheses, and modify (Fig. 1) as recommended in the "Patellar-Tendon-Bearing Below-Knee Prosthesis" manual by Radcliffe and Foort of the Biomechanics Laboratory at the University of California at Berkeley, 1961.

Preparing the Mold Formed from the Cast for Liner Fabrication

A. Bore three holes through the mold into the pipe for later application of vacuum during the liner molding process. Place one hole in the patellar-tendon area and two holes in the popliteal area.



FIGURE 1

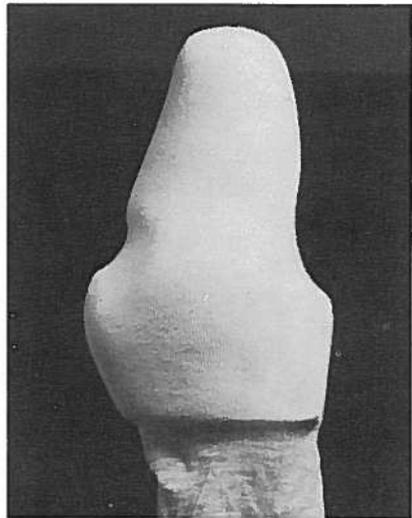


FIGURE 2

B. Pull stockinet over the mold (Fig. 2) to cushion the rubber-balloon cover which is to be applied next.

C. Inflate a large balloon and invert it over the mold (Fig. 3) to form a moisture seal and a separator. The inside of the balloon must be powdered before inflating to insure easy forming.

Pull a woman's nylon hose over the rubber-covered mold (Fig. 4) and impregnate by *brushing* on a coat of "Cordo Solution Plain" (Fig. 5). This should be done in a well-ventilated area.



FIGURE 3



FIGURE 4

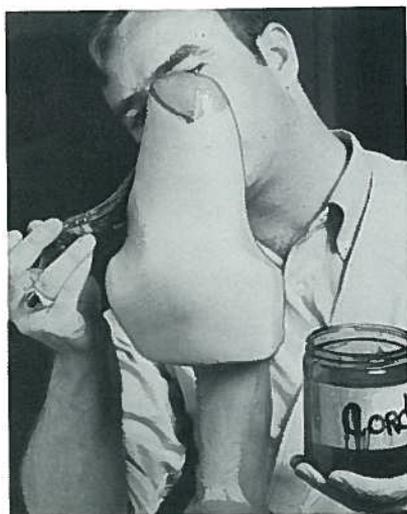


FIGURE 5



FIGURE 6

Fabricating the Liner

A. After the first brush coat of "Cordo Solution Plain" has set approximately 15 minutes, apply a second coat and let set for the same period of time.

B. Pull a layer of tube gauze over the mold (Fig. 6) and impregnate with two successive brush coats of "Cordo Solution" with Paraplex G-50 added (Fig. 7). The addition of Paraplex G-50 helps to soften the inner

layers of the liner. Approximately 15 minutes drying time is required after each brush coat. Do not pull the tube gauze too tight for this will cause it to span over the undercuts in the patellar-tendon and popliteal areas.



FIGURE 7

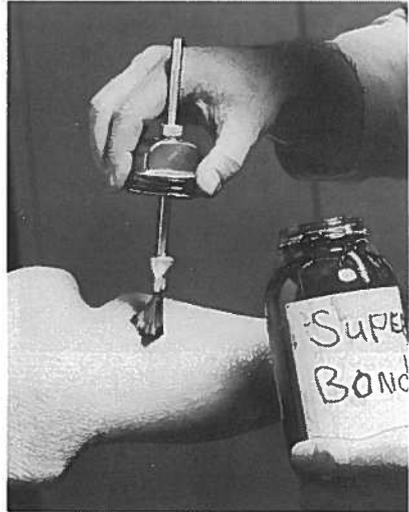


FIGURE 8

C. Pull a second layer of tube gauze over the liner and impregnate with two brush coats of "Cordo Solution" with Paraplex G-50 added. Allow each coat to set for 15 minutes.

D. Apply a vacuum to the cast pipe to pull the liner material tightly into the undercut areas of the mold. A coat of Super-Bond or Barge cement is applied over the entire liner surface for bonding a Plastazote filler to the "Cordo Solution" impregnated tube gauze (Fig. 8).

E. Cut a section of $\frac{1}{4}$ -in.-thick Plastazote large enough for a socket end-pad (Fig. 9). Coat one surface with Super-Bond or Barge cement.

F. Soften the Plastazote by applying heat with a heat-gun while molding and bonding into place (Fig. 10). The pad is carefully faired into the contour of the liner by sanding and the exposed surface is coated with Super-Bond or Barge cement.

G. Cut a section of $\frac{1}{8}$ -in.-thick Plastazote to encompass approximately two-thirds of the mold leaving only the posterior of the liner exposed (Fig. 11). One surface of the Plastazote is coated with Super-Bond or Barge cement and softened with a heat-gun to aid forming and bonding the material to the liner. The edges are trimmed and sanded into the contours of the liner.



FIGURE 9



FIGURE 10



FIGURE 11



FIGURE 12

H. Use a second section of $\frac{1}{8}$ -in.-thick Plastazote to cover the back of the liner (Fig. 12). This section is bonded in the same manner as described previously and its edges are sanded into the contours of the liner.

I. Bond, as described above, a final end-pad of $\frac{1}{4}$ -in.-thick Plastazote over the end of the liner (Fig. 13) and fair into the contours to finish the filler.

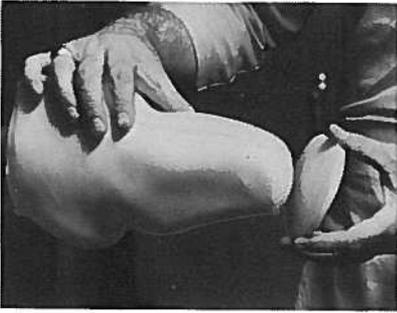


FIGURE 13

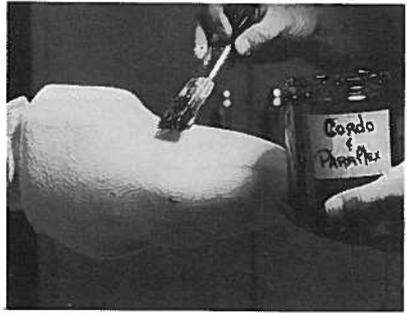


FIGURE 14

J. Pull a tube gauze over the Plastazote. A coating of "Cordo Solution" with Paraplex G-50 added is applied over the tube gauze to bond it to the Plastazote (Fig. 14). A layer of "Cordo Solution Plain" is then applied and permitted to dry (approximately 15 minutes).

K. Place a second layer of tube gauze (Fig. 15) over the Plastazote and impregnate with two coats of "Cordo Solution Plain." Allow each coat to dry approximately 15 minutes.

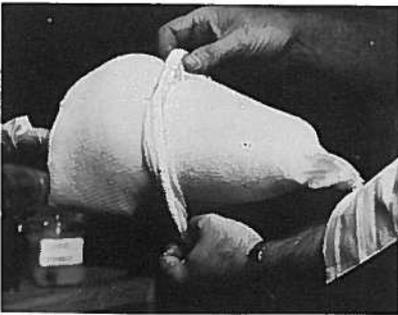


FIGURE 15

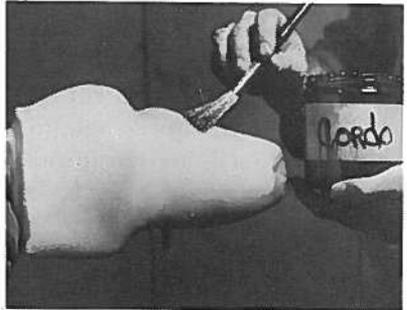


FIGURE 16

L. Use a layer of women's nylon hose to finish the exterior of the liner. The hose is given two coats of "Cordo Solution Plain" for final finish (Fig. 16) and allow each coat to dry 15 minutes.

Laminating the Socket Shell

After sufficient time to cure (when the material is cured tack-free), laminate a plastic socket shell directly over the liner (Fig. 17).

Trimming the Socket and Liner

Caution must be exercised when trimming the socket shell to avoid cutting the underlying liner. The liner should finally be trimmed to

within $\frac{1}{4}$ in. *above* the socket shell (Fig. 18). The edges of the liner are coated with "Cordo Solution Plain" to finish.



FIGURE 17

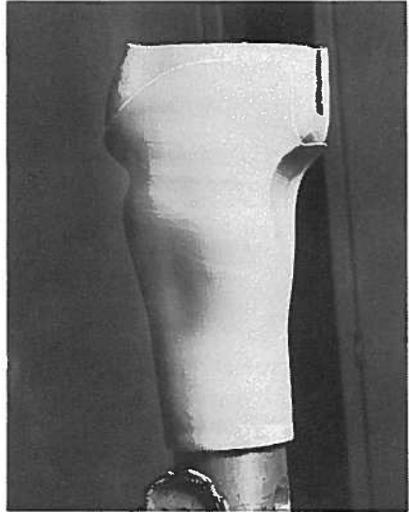


FIGURE 18

CONCLUSION

When used as a resilient bonding agent between layers of tube gauze and Plastazote, "Cordo Solution Plain" and "Cordo Solution" with Paraplex G-50 facilitate fabrication of difficult socket shapes. The elasticity or resiliency of the liner is controlled by the number of layers used of tube gauze impregnated with "Cordo Solution" and a layer of Plastazote sandwiched between them.

"Cordo Solution" is easily pigmented and nontoxic for convenient use next to the skin. It forms a liner which is light, extremely durable, and it can be washed frequently without affecting its physical properties. The technique described in this article is being used routinely for below-knee prostheses in the VAPC Patient Care Service and in several commercial limb facilities throughout the United States.

In addition, the use of "Cordo Solution" as a liner material has opened a new approach to the fabrication and fitting of the Syme's prosthesis by providing a removable liner which can be placed over the patient's stump before insertion of the stump and liner into the socket. Using this concept, an internally suspended total-contact socket can be fabricated without an opening in the ankle section, thus permitting a strong but thinner socket wall.