Autumn 1986
Volume 40
Number 3

Orthotics and Prosthetics

Journal of the American Orthotic and Prosthetic Association

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Autumn, 1986 **Volume 40, Number 3**

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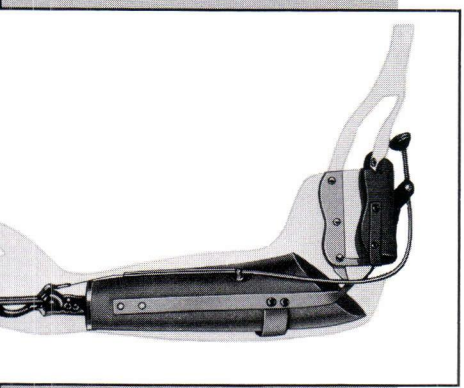

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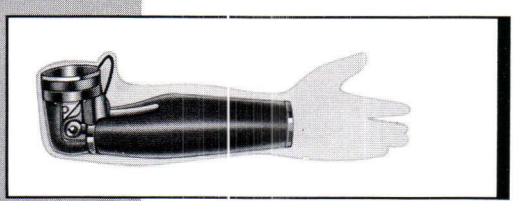

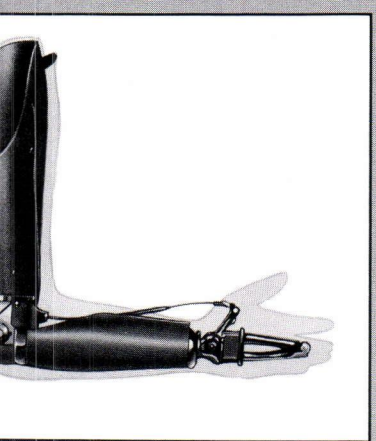

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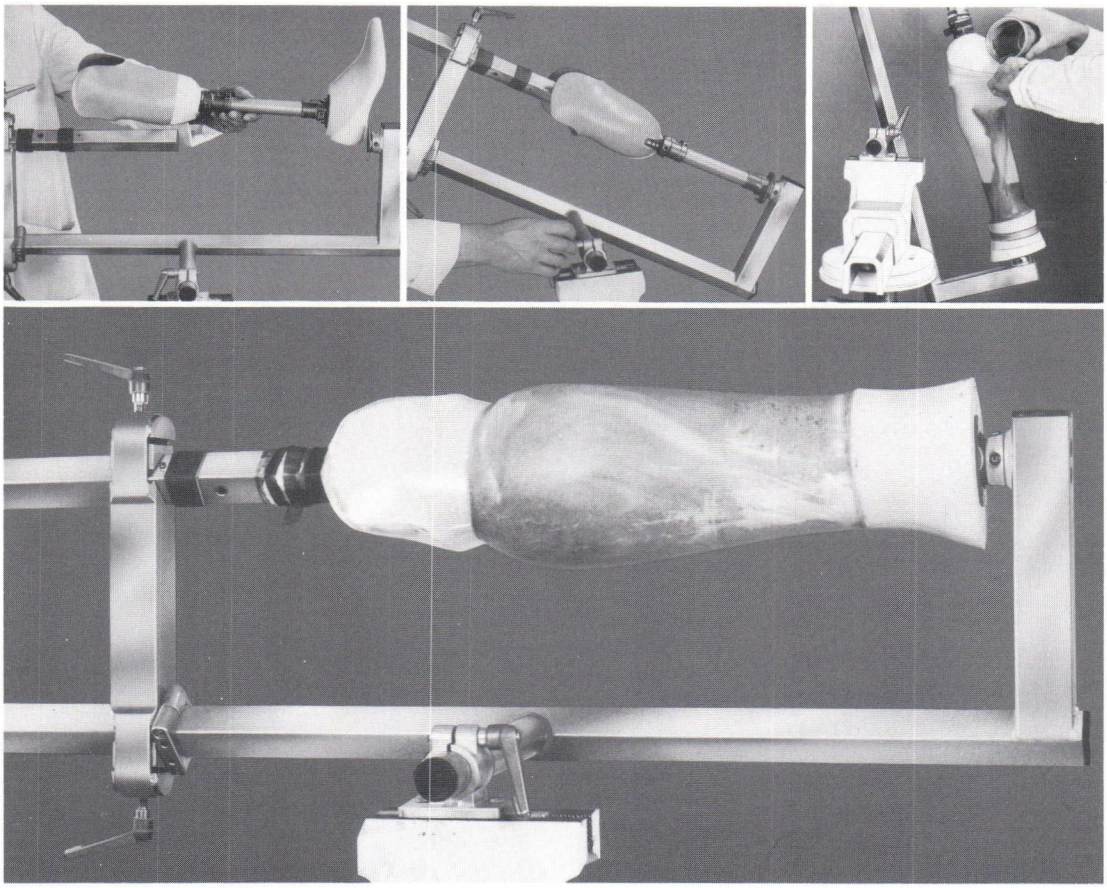

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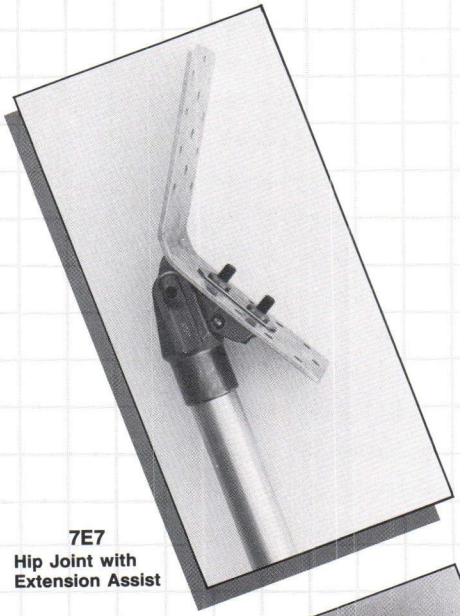
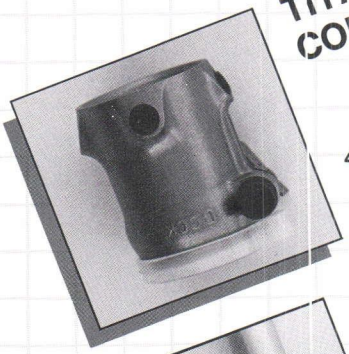


7E7
Hip Joint with Extension Assist



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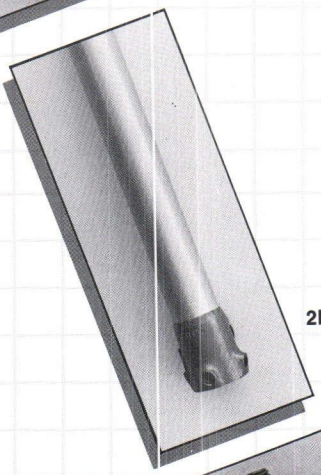
Tube Clamp Adaptor



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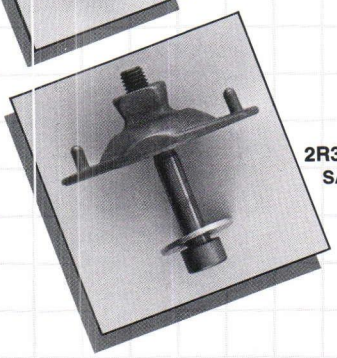

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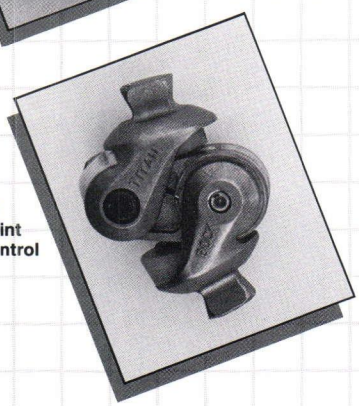
SACH Foot Ada



3R35
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1986

October 24–25, American Academy of Orthotists and Prosthetists Continuing Education Conference 5-86, "Spina Bifida," Cincinnati, Ohio. Contact: Academy National Headquarters, (703) 836-7118.

October 27–31, UCLA International Prosthetics Techniques Seminar, Los Angeles, California. Contact: Timothy B. Staats, MA, CP, UCLA POEP, Room 22-46, 1000 Veteran Avenue, Los Angeles, California 90024.

October 28–29, USA Medical Advances, USA Catalog/Video Show, Vienna, Austria. Contact: Kenneth D. Blum, Commercial Counselor, US & FCS Foreign Commercial Service, American Embassy, Vienna, Austria, APO NEW YORK 09108.

November 1–15, Baghdad International Fair, Baghdad, Iraq. Featuring U.S. Pavilion, now selling exhibit space to display, among other goods, equipment for rehabilitation and the disabled. Contact: Edward K. Kimmel, U.S. Department of Commerce, ITA Rm. 4038, Washington, D.C. 20230; tel. (202) 377-3640.

November 3–7, UCLA Course, Prosthetics and Orthotics for Physicians and Allied Health Professionals, Los Angeles, California. Contact: Timothy B. Staats, MA, CP, UCLA POEP, Room 22-46, 1000 Veteran Avenue, Los Angeles, California 90024.

November 4–8, USA Medical Advances Exhibitions in Europe, in conjunction with IFAS '86, Zurich, Switzerland. Contact: U.S. & Foreign Commercial Service, Mr. D. Schaubacher, Commercial Specialist, American Embassy, P.O. Box 1065, CH-3001 Bern, Switzerland; tel. 41/31/43 73 43, Telex 912 603.

November 4–9, AOPA Annual National Assembly, Marriott's Orlando World Center, Orlando, Florida. Contact: AOPA National Headquarters, (703) 836-7116.

November 8, Fracture Management: Current Concepts in Isolated and Multiple Injury Patterns, Teaching Center, Long Island Jewish Medical Center, New Hyde Park, New York. Sponsored by the Dept. of Orthopaedic Surgery, Long Island Jewish Medical Center. Contact: Ann J. Boehme, Associate Director for Continuing Education, Long Island Jewish Medical Center, New Hyde Park, New York 11042; tel. (718) 470-8650.

November 10–12, Hosmer Electric Systems Workshop and Seminar, Orlando, Florida. Contact: Catherine Wooten, Hosmer Dorrance Corporation, 561 Division Street, Campbell, California 95008; tel. 800-538-7748, (408) 379-5151.

November 30–December 5, A symposium on Starting a Handicap Ski Program, Winter Park Resort, Winter Park, Colorado. Contact: Winter Park Handicap Program, tel. (303) 726-5514, ext. 719.

1987

January 22–27, American Academy of Orthopaedic Surgeons Annual Meeting, San Francisco, California.

February 15–22, Academy Annual Meeting and Scientific Symposium, Hyatt Regency Tampa, Tampa, Florida. Contact: Academy National Headquarters, (703) 836-7118.

March 9–12, UCLA Total Surface Bearing Suction Below Knee Prosthetics Course, Los Angeles, California. Contact: Timothy B. Staats, MA, CP, UCLA POEP, Room 22-46, 1000 Veteran Avenue, Los Angeles, California 90024.

March 16–25, UCLA CAT-CAM/Narrow ML Above Knee Prosthetics Course, Los Angeles, California. Contact: Timothy B. Staats, MA, CP, UCLA POEP, Room 22-46, 1000 Veteran Avenue, Los Angeles, California 90024.

March 20–21, Oklahoma Association of Orthotics and Prosthetics, the Texas Association of Orthotists and Prosthetists, and Texas Chapter, American Academy of Orthotists and Prosthetists combined meeting, Dallas, Texas. Contact: Mike Allen, CPO, 2504 W. Ohio, Midland, Texas 79701; tel. (901) 683-5280.

March 30–April 2, UCLA Total Surface Bearing Suction Below Knee Prosthetics Course, Los Angeles, California. Contact: Timothy B. Staats, MA, CP, UCLA POEP, Room 22-46, 1000 Veteran Avenue, Los Angeles, California 90024.

April 2–4, AOPA Region IV Annual Meeting, Stouffer's River View Plaza, Mobile, Alabama.

April 13–22, UCLA CAT-CAM/Narrow ML Above Knee Prosthetics Course, Los Angeles, California. Contact: Timothy B. Staats, MA, CP, UCLA POEP, Room 22-46, 1000 Veteran Avenue, Los Angeles, California 90024.

May 4–13, UCLA CAT-CAM/Narrow ML Above Knee Prosthetics Course, Los Angeles, California. Contact: Timothy B. Staats, MA, CP, UCLA POEP, Room 22-46, 1000 Veteran Avenue, Los Angeles, California 90024.

May 7–10, AOPA Regions II and III Combined Annual Meeting, Hershey, Pennsylvania.

May 7–10, SinoMed '87, an international exhibition and conference program, Shanghai Exhibition Centre, Shanghai, People's Republic of China. Contact: Kallman Associates, Five Maple Court, Ridgewood, New Jersey 07450; tel. (201) 652-7070.

May 27–30, UCLA Total Surface Bearing Suction Below Knee Prosthetics Course, Los Angeles, California. Contact: Timothy B. Staats, MA, CP, UCLA POEP, Room 22-46, 1000 Veteran Avenue, Los Angeles, California 90024.

May 28–31, AOPA Region V Annual Meeting, Grand Traverse Hotel, Traverse City, Michigan.

June 5–7, AOPA Region IX, COPA, and the California Chapters of the Academy Combined Annual Meeting, Doubletree Inn, Monterey, California.

June 8–17, UCLA CAT-CAM/Narrow ML Above Knee Prosthetics Course, Los Angeles, California. Contact: Timothy B. Staats, MA, CP, UCLA POEP, Room 22-46, 1000 Veteran Avenue, Los Angeles, California 90024.

June 10–13, AOPA Regions VII, VIII, X, and XI Combined Annual Meeting, Fairmont Hotel, Dallas, Texas.

June 18–21, AOPA Region VI and the Midwest Chapter of the Academy Combined Annual Meeting, Embassy Suite, Indianapolis, Indiana.

June 24–27, Tenth INTERBOR Congress, Barcelona, Spain. Contact: José Ma Camós, Secretary of the Congress, Grau Soler, Buenos Aires, 52, Argentina.

July 5–10, International Conference on Disability Education, Jerusalem, Israel. Contact: Isreel Rehabilitation Society, 18 David Elazar Street, Tel Aviv 61901, Israel.

July 12–16, International Conference of Rehabilitation Journalists, Jerusalem, Israel. Contact: Israel Rehabilitation Society, 18 David Elazar Street, Tel Aviv 61901, Israel.

September 11–12, Ohio Orthotics and Prosthetics Association/Ohio Chapter, American Academy of Orthotists and Prosthetists combined meeting, "Bridging the Profession," Dayton, Ohio. Contact: Norma Jean Finissi, Executive Director, O.O.P.A./Ohio A.A.O.P., 4355 North High Street, #208, Columbus, Ohio 43214; tel. (614) 267-1121.

September 21–27, AOPA Annual National Assembly, Hyatt Regency Hotel, San Francisco, California. Contact: AOPA National Headquarters, (703) 836-7116.

1988

January 25–31, Academy Annual Meeting and Scientific Symposium, Newport Beach Marriott Hotel and Tennis Club, Newport Beach, California. Contact: Academy National Office, (703) 836-7118.

May 19–21, AOPA Region V Annual Meeting, Charleston, West Virginia.

June 2–4, AOPA Region IX, COPA, and the California Chapters of the Academy Combined Annual Meeting.

June 9–11, AOPA Regions II and III Combined Annual Meeting.

June 14–18, AOPA Regions VII, VIII, X and XI Combined Annual Meeting, Seattle, Washington.

September 5–9, 16th World Congress of Rehabilitation International, Keio Plaza Inter-Continental Hotel, Shinjuku, Tokyo, Japan. Contact: Secretary General, 16th World Congress of Rehabilitation International, c/o the Japanese Society for Rehabilitation of the Disabled, 3-13-15, Higashi Ikebukuro, Toshima-Ku, Tokyo 170, Japan.

October 25–30, AOPA Annual National Assembly, Sheraton Washington Hotel, Washington, D.C. Contact: AOPA National Headquarters, (703) 836-7116.

1989

January 31–February 5, Academy Annual Meeting and Scientific Symposium, Wyndham Hotel, Orlando, Florida. Contact: Academy National Office, (703) 836-7118.

June 1–3, AOPA Region IX, COPA, and the California Chapters of the Academy Combined Annual Meeting.

October 2–8, AOPA Annual National Assembly, MGM Grand Hotel, Reno, Nevada. Contact: AOPA National Headquarters, (703) 836-7116.

1990

January 22–28, Academy Annual Meeting and Scientific Symposium, Hyatt Regency Hotel, Phoenix, Arizona. Contact: Academy National Office, (703) 836-7118.

June 7–9, AOPA Region IX, COPA, and the California Chapters of the Academy Combined Annual Meeting.

September 11–16, AOPA Annual National Assembly, Sheraton Boston Hotel, Boston, Massachusetts. Contact: AOPA National Headquarters, (703) 836-7116.

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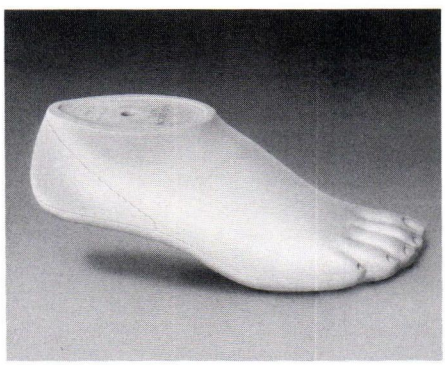

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Orthotics and Prosthetics, Vol. 40, No. 3, pp. 17–23.

The Seattle Foot™

Drew A. Hittenberger, C.P.

INTRODUCTION

Traditional prosthetic feet were designed only for walking. Most amputees were unable to run, and the physical benefits of vigorous sports were lost. Even highly motivated amputees were severely limited in their activities because of a lack of appropriate prostheses and training, resulting in a significant loss of self-esteem.

The Seattle Foot™ was developed to widen the range of prosthetic alternatives for lower extremity amputees, and to allow them to seek the physical and emotional rewards of increased activity. The purpose of this paper is to discuss the research and development leading to commercial release of the Seattle Foot,™ and to review the considerations for its successful prosthetic use.

BACKGROUND

Over the course of a five year study, the Department of Kinesiology at the University of Washington used a Kistler force plate to examine the biomechanics of walking and running for normal volunteers and amputees of different abilities and amputation levels. The equipment recorded anterior, posterior, medial, lateral, and rotational ground reaction forces while slow motion cameras measured joint placement. Analysis subsequently demonstrated vast differences in the motion force vectors for walking and running; similarly, large differences were seen between normal and amputee running.

The ground reaction forces during walking were different from those during running not only because of the segment of free flight, but also because of a marked difference in the magnitude of the downward force during heel contact. In walking, this barely exceeds body weight, but in running, the downward force during heel contact exceeds body weight by two to three times. This loading can lead to injury even in non-amputees, so that provision for prosthetic mechanisms to deal with these forces became a design requirement.

In addition, amputees had a marked inability to push off after foot flat; hence the drop-off phenomenon that is so evident when amputees try to walk fast or run with conventional prostheses. Prosthetic development therefore had to incorporate a mechanism to simulate the push-off phase of normal running.

DEVELOPMENT

The Seattle Foot™ is designed to control and store energy that is available at heel strike and foot flat, releasing it during push-off to increase the forward movement of the foot and eliminate "drop-off."

Early prototypes of the foot incorporated an unusually shaped keel. Devised by Devere Lindh,[1] these keels were made of preimpregnated fiberglass acting against a rubber bumper. The fiberglass keel extended into the metatarsal area to form a spring, and as the patient walked or ran, the keel deflected and sprang back,

thrusting the patient forward. These fiberglass keels functioned well for a number of patients, but excessive weight, an unacceptable failure rate, difficulties with tailoring the stiffness of the keel to the patient, and the labor requirements of the fabrication technique were drawbacks.

With the compilation of running data and experience with the fiberglass keel prototypes, Don Poggi and David Moeller[2] reevaluated the keel and suggested several design criteria. A successful foot would:

1. Be capable of deflecting 1¾ inches at the metatarsal area under a vertical load of 435 pounds. To do this reliably would require the longest possible spring.
2. Feel natural and stable in all phases of gait. This would require adequate dampening during the storage and release of energy at heel-strike and push-off.
3. Have a useful life of at least three years. This would require a durable material for the spring, to make it endure 50,000 cycles at 2.8 × body weight loading or 1,000,000 cycles at 1.4 × body weight, with a permanent set of less than .06 inches.
4. Have the lowest possible weight.
5. Have the lowest possible production cost. This implied a monolithic moldable keel rather than a composite one.
6. Have a natural cosmetic appearance.
7. Be compatible with existing prosthetic components and techniques.
8. Have a center of rotation as close to the natural ankle center as possible.

To maximize the effective length of the keel and provide a natural center of rotation, a keel shape was chosen that ran posteriorly before curving down and forward to the metatarsal area. The keel also tapered in thickness as it ran through the foot, terminating in a thin upward flare in the toe area. A wide range of synthetic structural materials were evaluated in this configuration. Only Delrin 150® provided the necessary combination of strength, lightness, moldability, and intrinsic vibration, dampening. Amputees who felt "hurried" through stance phase when wearing a foot with a fiberglass keel found the Delrin® keel foot to be more comfortable.

The keels were covered with polyurethan foam formed in conventional SACH foot molds, but as psychological demands for cosmesis increased, a range of male and female molds were taken from human feet. Prosthetic feet from these molds are quite realistic (Figure 1).

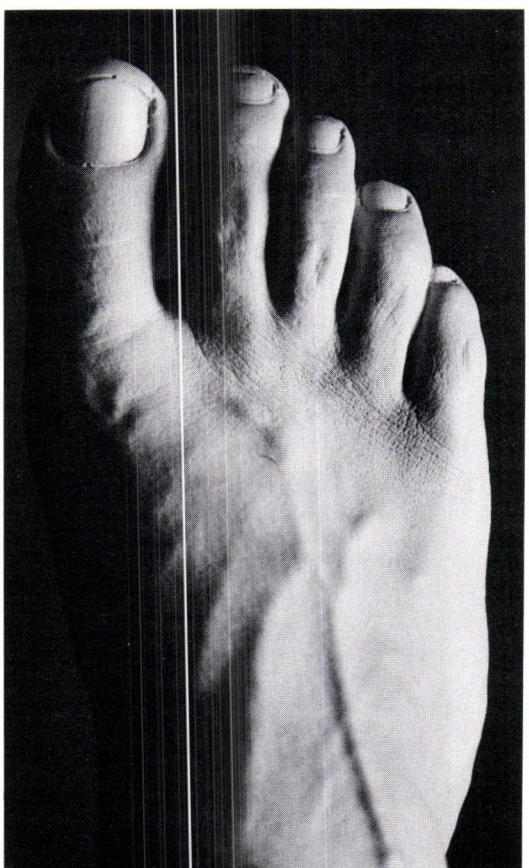

Figure 1. The exterior shape of the Seattle Foot™ is cosmetic. Note the anatomical details.

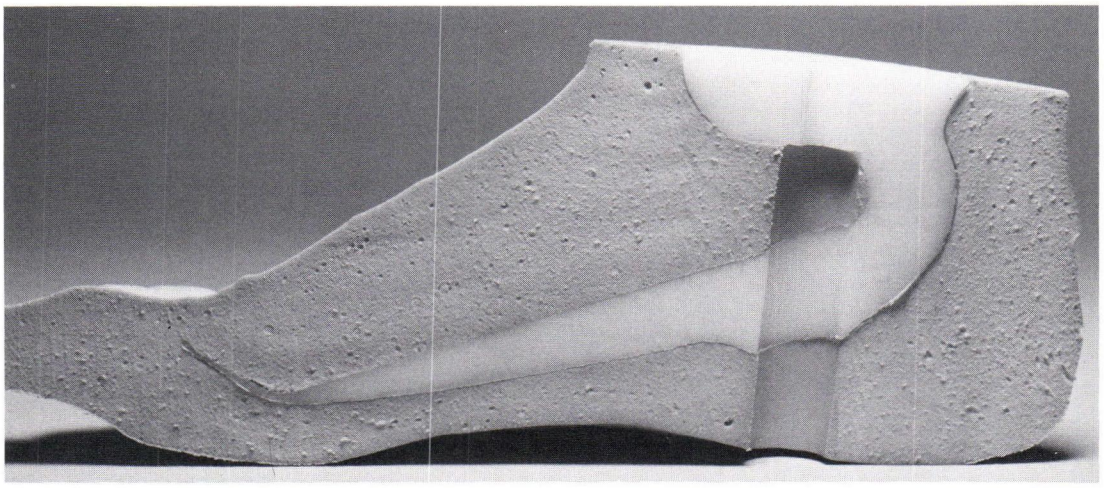

Figure 2. Initially, the Seattle Foot™ consisted of the keel and exterior foam. Note the toe section of the keel in the metatarsal area.

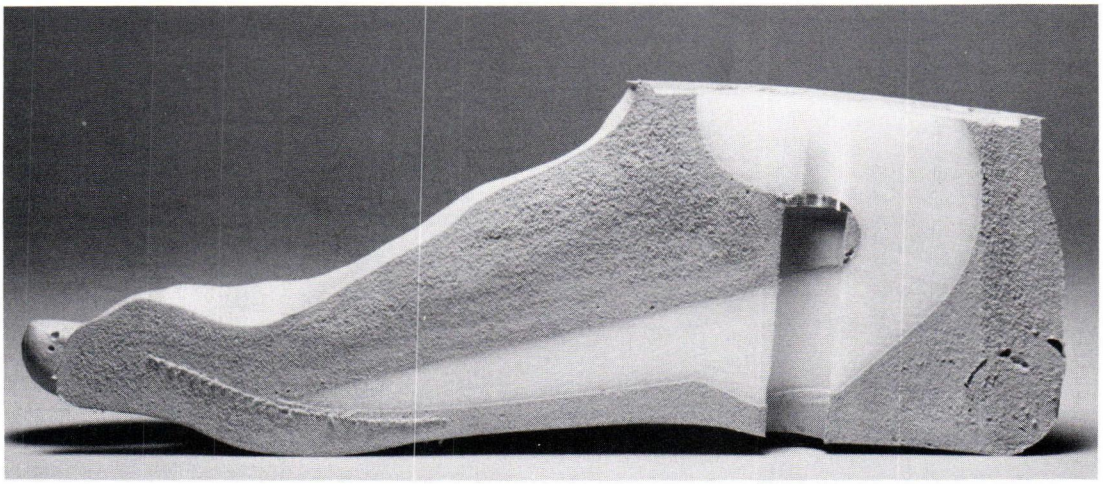

Figure 3. At present, the Seattle Foot™ has only three components: the keel, the external foam, and the toe reinforcement pad.

Several problems appeared during clinical evaluation and laboratory testing. Active patients were able to break the keel near the bolt hole. This problem was solved by reinforcing the keel near the bolt hole and by developing additional keel configurations designed to correspond to the weight and activity of the user. Secondly, the keel broke in the metatarsal area. This problem was met by eliminating the entire "toe" section of the keel, the thin upward flare at its anterior end (Figure 2). Also, when amputees ran without shoes on soft ground, the keel would punch through the bottom of the forefoot. This area is now reinforced with a Kevlar® pad. Currently, the Seattle Foot™ has only three components: the Delrin® keel, the external foam, and the Kevlar® reinforcement pad (Figure 3).

APPLICATIONS

As stated earlier, the Seattle Foot™ is designed to store and release energy, which it accomplishes with a specially designed keel that compresses during foot flat and extends during toe off. The keel aids the

patient by thrusting the prosthesis forward, simulating the natural push-off provided by the gastrocnemius and soleus muscles.

While the Seattle Foot™ was designed to provide the push-off required during running, it can also be used for walking and is not necessarily contraindicated for people who are less active. Gait studies show that because the foot is flexible in the metatarsal area it does not limit forward rotation of the tibia over the foot, allowing the prosthesis to roll smoothly between heel-contact and toe-off. This, combined with the increased forward thrust through the spring action of the keel, makes the foot easier to use because it requires less effort. Therefore, the Seattle Foot™ is suitable for both walking and running.

The Seattle Foot™ is designed to correspond to the patient's weight and activity level. Currently, there are 11 keel configurations, fitting patients weighing between 90 to 245 pounds. These feet are available in sizes 6-12 in men and 5-8 in women. Other keels and sizes will be added as the demand increases. Each keel configuration is designed to fit a specific weight range or activity level. To avoid premature breakage, it is suggested that an active or bilateral amputee select a relatively stiffer keel.

The foot is designed to be used with shoes with a ¾ inch heel. If the patient wants to wear shoes with a lower heel, a wedge should be added inside the shoe to compensate. Because the Seattle Foot™ is a cosmetic copy of a human foot, it is wider and thinner in the metatarsal area than other prosthetic feet. Some grinding of the lateral surface may be required to fit exceptionally narrow shoes. The Seattle Foot™ weighs just over a pound (with slight variance depending on the size) which is heavier than a SACH, but lighter than a SAFE or Greissinger foot.

Patients who frequently walk on uneven ground may still prefer the Greissinger or SAFE foot to the Seattle Foot.™ Patients interested in a prosthesis for running and the greatest possible reduction in weight should consider the Flex-foot, which offers more energy storage than the Seattle Foot,™ but is not compatible with existing components and is substantially more expensive. Although the Seattle Foot™ is somewhat more expensive than conventional feet, it is compatible with most standard components. It cannot be used, however, with Hydra-Cadence units, R.O.L. rotators, or on patients with unilateral Symes or partial foot amputations. It has, however, been used successfully by many above knee and hip amputees.

ALIGNMENT

Installation of the Seattle Foot™ on an existing prosthesis requires realignment, because the amount of socket flexion, anterior-posterior, and medial-lateral position of the foot with respect to the socket, differs for each type of foot and individual patient. The alignment of the Seattle Foot™ is closer to that of the SAFE or Greissinger foot than it is to that of the SACH foot. The manufacturer provides static alignment instructions with each foot. Dynamic alignment for below-knee and above-knee applications requires additional attention to several prosthetic principles.

BELOW-KNEE ALIGNMENT

As the Seattle Foot™ is plantar-flexed (the socket extended) the patient is aware of increased push-off. This increases the hyperextension moment at the knee during midstance, and considerable effort must be exerted to walk over the forefoot. This toe-lever effect also occurs as the foot is moved anteriorly with respect to the socket. The prosthetist therefore must find a compromise between the hyperextension moment at midstance and the amount of push-off required. The knee must not be forced into hyperextension during any phase of gait, either walking or running.

Prostheses made primarily for running should be toed-out two or three degrees farther than the appropriate position for walking, as the increased pelvic rotation during running tends to internally rotate the entire lower extremity. Increasing the toe-out of the prosthetic foot will tend to

compensate for this effect. An intermediate toe-out angle will usually work if the patient will be running and walking on the same prosthesis. This can be determined during the dynamic alignment.

Prosthetists have reported excessive anterior distal-tibial pressure when converting patients to a Seattle Foot.™ This is usually caused by too much socket flexion. To control excessive knee flexion, the patient needs to forcibly straighten his/her knee during foot flat, causing anterior-distal contact of the tibia inside the socket. The Seattle Foot™ should not be exchanged for an existing foot without a corresponding change in alignment.

ABOVE-KNEE DYNAMIC ALIGNMENT

When using a Berkeley alignment fixture, the pylon should be vertical during midstance. Since the keel of the Seattle Foot™ dorsi-flexes as it is loaded at stance phase, the pylon should be placed in two to three degrees of posterior tilt (plantar-flexion of the foot) during static alignment. This will allow the pylon to be vertical over the loaded foot. Since there is no plantar-flexion capacity built into the Berkeley fixture for alignment of an exoskeletal above knee prosthesis, it is suggested that the fixture be modified to allow this if the Seattle Foot™ is used. The Berkeley system also does not allow dynamic alignment using the definitive knee unit, which is suggested if optimal performance is to be evaluated. When using an Otto Bock endoskeletal system, the pylon does not need to be vertical during midstance, and no fixture modification is necessary; however, only a limited number of knee units are available.

If knee instability exists, the prosthetist may either plantar-flex the foot farther or move the knee center posterior. Too much plantar-flexion of the Seattle Foot™ may make it difficult for above knee patients to clear the toe during swing phase. This is especially a problem with Henschke-Mauch S-N-S knee units, which require a substantial toe level (plantar-flexion) to provide enough extension moment to trigger the swing mode.

AREAS OF CONCERN

The Seattle Foot™ has undergone a great deal of development and testing to ensure reliability, but there are some drawbacks.

Possibly the greatest drawback relates to the cosmesis of the foot; because the foot is natural in appearance, patients are inclined to walk and run barefoot. A number of feet have been returned (under warranty) due to foam failures on the plantar surface of the metatarsal area. In one documented case, a 40-year old amputee broke two Seattle Feet.™ This man walked barefoot, did push-ups barefoot, and had broken one of the feet by forcibly hyperextending the toes while cross-country skiing. Currently, the designers are experimenting with materials to minimize this problem. The manufacturer now includes a notice advising against barefoot ambulation.

Occasional cases of keel breakage have been reported, despite careful keel selection. In some cases, amputees have become much more active, and provision of a heavier keel is indicated. Some keel breakage is probably inevitable, since the prosthesis is designed for active patients, is light in weight, and must be flexible to function.

Wood or foam ankle blocks offer no purchase for the flat Delrin® keel when the foot is used with an exoskeletal system. The manufacturer recommends using hot melt glue to bond the foot and block, to prevent inadvertent rotation of the foot. A layer of Durite® screen between the block and foot is an alternative. Inadvertent axial rotation does not occur with endoskeletal components because of the serrated surface of the foot attachment plate.

Shaping the ankle block of an exoskeletal prosthesis can be difficult, because the contour of the lateral malleolus on some Seattle Feet™ can appear too dramatic. This is most apparent when the foot is used on

an overweight or geriatric patient. Another complication may arise when the foot is attached to an exoskeletal prosthesis; the foam lip on the proximal periphery of the foot has a tendency to protrude when the foot bolt is tightened. A small amount of foam can be removed from the superior edge to avoid the undesired protrusion of the foam.

CONCLUSION

The Seattle Foot™ utilizes a special keel design and advanced materials to provide a relatively inexpensive prosthetic alternative for lower extremity amputees. It combines smooth action with increased push off, through the storage of energy, to make running and walking easier. The Seattle Foot™ can be tailored to the individual, and is compatible with standard fabrication techniques and components. It is exceptionally cosmetic in appearance, is quite durable when appropriately used, and the foot is available in a wide range of sizes for both men and women. While practitioners need to weigh all the options before choosing the Seattle Foot,™ as with any other component, it is clear that for many amputees, the Seattle Foot™ will open up a whole new range of experiences.

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[2]Model and Instrument Works, Seattle, Washington.

ACKNOWLEDGMENTS

The design and development of the Seattle Foot™ was not the work of a single individual. It was the result of a team effort, directed toward a common goal over a number of years. Several people stand out in its development—without them, the Seattle Foot™ (and this paper) would not have been possible.

Special thanks go to: Jack Graves, C.P., for his initial ideas regarding a spring foot; the University of Washington Kinesiology Department, under the direction of Doris Miller, Ph.D., for the initial laboratory studies; Devere Lindh for his initial fiberglass keel designs; the staff at the Model and Instrument Works, Glen Austin, David Firth, Ray Pye, Shirley Poggi, and especially Donald Poggi, A.S.M.E., and David Moeller, I.D.S.A., for their monolithic keel concepts; Glenn Campbell, for his mold-making expertise; Ernest Burgess, M.D., for his direction and foresight; Margaret Giannini, M.D., Director of Rehabilitation Research and Development, Veterans Administration, for her support; the prosthetists who provided technical advice; Daniel Wing, M.D. and David Varnau, C.P.O., for their assistance in the preparation of this report; and lastly, to the patients, for their willingness to participate in testing and evaluation. This research was in part funded by V.A. contracts No. V663P-1667, V663P-1312, and V663P-1416.

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Head Positioner/Restraint for Children Undergoing Radiation Therapy

Laurene Beyer, B.S., RT(T)
Joe Baczkowski, B.S., C.O.

INTRODUCTION

Immobilization in the delivery of radiation therapy is one of the most significant problems associated with treating the pediatric oncology patient. Children under the age of three are often uncooperative and afraid, rendering strict immobilization necessary. This becomes critical in the head and neck region, especially when treating around the eye, where precise lead block placement is imperative to protect unaffected tissue. A number of head positioning devices or molds are commercially available, but we have found that they either require complete sedation of the patient, or are not reproducible on a day-to-day basis. Sedation often becomes a daily, time consuming process that must be carefully coordinated for the child's safety, and to ensure they arrive ready for their scheduled therapy. In an effort to treat this group of patients accurately and avoid or limit the use of sedation, a total body restraint system was developed, utilizing a combination of commercial devices and a custom molded face mask.

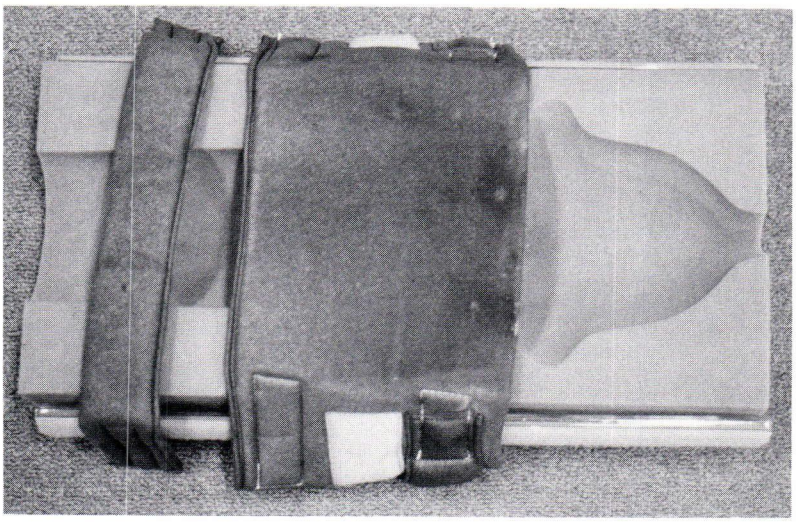
FABRICATION

During the initial visit, the child is fitted to the appropriate size commercial components and an impression is taken of the head, neck, and sternum. In order to ensure accuracy of such a procedure it was felt necessary to sedate the patient, using Chloral Hydrate, to the point of sleep.

The child is first strapped into a Hugger®* for immobilization from the chest down. The Hugger® is a pediatric positioning aid used for radiographic exams (Figure 1). It consists of an acrylic base, foam insert with body shape relief, and Velcro® straps to aid in restraint. It is available in infant and child sizes. Since the head portion of the Hugger® was too general a shape for our purposes, it was cut off to allow room for a vinyl covered, firm foam head and neck support** (Figure 2).

*The Hugger is manufactured by Contour Fabricators, Inc., Grand Blanc, Michigan 48439.
**Head and neck support manufactured by Timo Industries, Pittsburgh, Pennsylvania 15230.

Figure 1. (right) The Hugger.



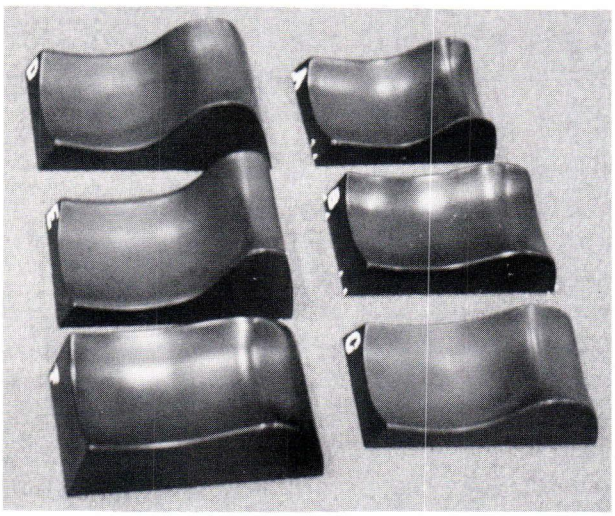
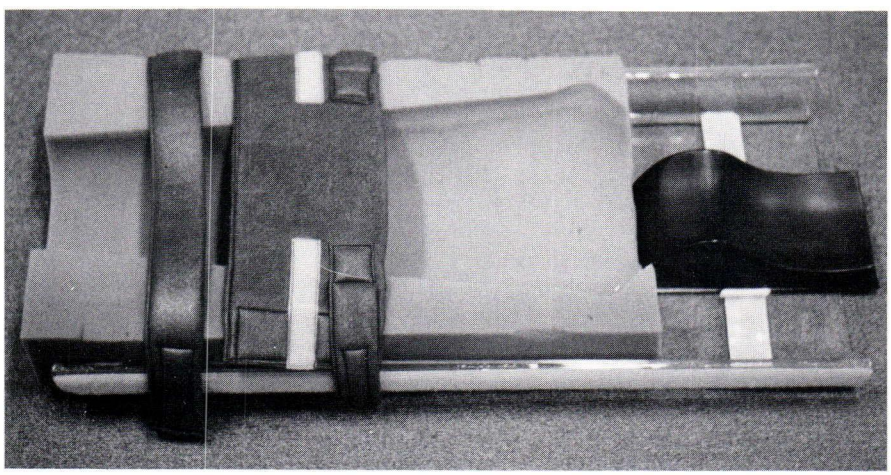


Figure 2. (left) Various sizes of head and neck supports.

Figure 3. (right) Modified Hugger with head and neck support in place with Velcro® straps.



Proper size should be utilized to insure accurate alignment of the head with the orbital meatal line perpendicular to the tratement table. The headrest should be at least as wide as the patient's head, otherwise removal of the impression is difficult. The base of the headrest is outlined on the acrylic base of the Hugger® and later secured with self adhering Velcro® straps to ensure consistent and secure positioning for every treatment (Figure 3).

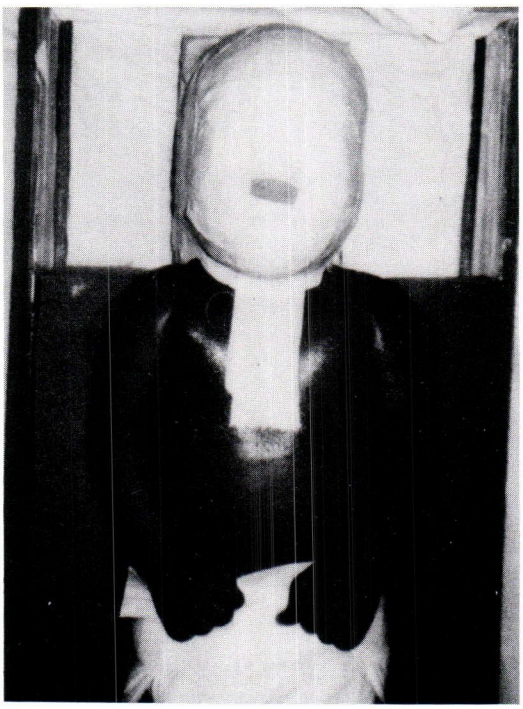


Figure 4. Sedated patient in position while impression is taken.

Once the head is resting in the desired treatment position, a detailed plaster of Paris negative impression is taken of the face, throat, and sternum (Figure 4) (other techniques, such as alginate or moulage might also be used).[1,2,3,4]

A nylon stocking is placed over the head to separate and protect the hair from the plaster. Petroleum jelly can be used on exposed skin and on the sides of the headrest. Details about the eyes, nose, and mouth are best molded by utilizing small strips of plaster bandage applied initially one layer at a time and carefully blended. A small air hole is left at the nostrils for breathing. To finish the impression, tangential strips of plaster bandage are run along the sides and crown of the head down to the acrylic base in such a manner that the sides of the headrest are intimately included. Care must be taken not to run the plaster around the posterior part of the head, but on a tangent from the head to the headrest, in order to facilitate easy removal of the negative impression without the need to cut it.

Once the negative impression is set, the child is placed in a sitting position and the headrest is removed. The stocking is then cut posteriorly and the cast is removed. A positive model is then poured, set, and smoothed of irregularities. A 3/16" low density polyethylene sheet is then vacuum formed over the model and allowed to cool. The completed immobilization system before fine detail modification is shown in Figure 5.

Polyethylene was chosen because it is easily vacuum formed, is translucent enough to pick up trim lines, and is flexible enough to allow easy application to the patient. It is also quite rigid once fully contained by the head and secured with straps. Low density polyethylene can also be cut with a sharp knife for detailed trimming outside the laboratory (Surlyn® may be a good choice of material for future masks, since it shares many of the qualities of low density polyethylene, plus it is transparent).

The mask encompasses the head and headrest down to an intersection with the Hugger® acrylic base. Inferiorly, the plastic extends across the chin and throat and down the sternum. The sternal extension allows smooth continuity across the throat and provides a point of attachment for straps inferiorly. Vents are cut to allow breathing through the nostrils, and an opening outlining the lips is helpful as a reference for proper positioning within the mask.

Openings are made on both sides of the mandible to allow manipulation of the jaw while applying the mask, and Velcro®

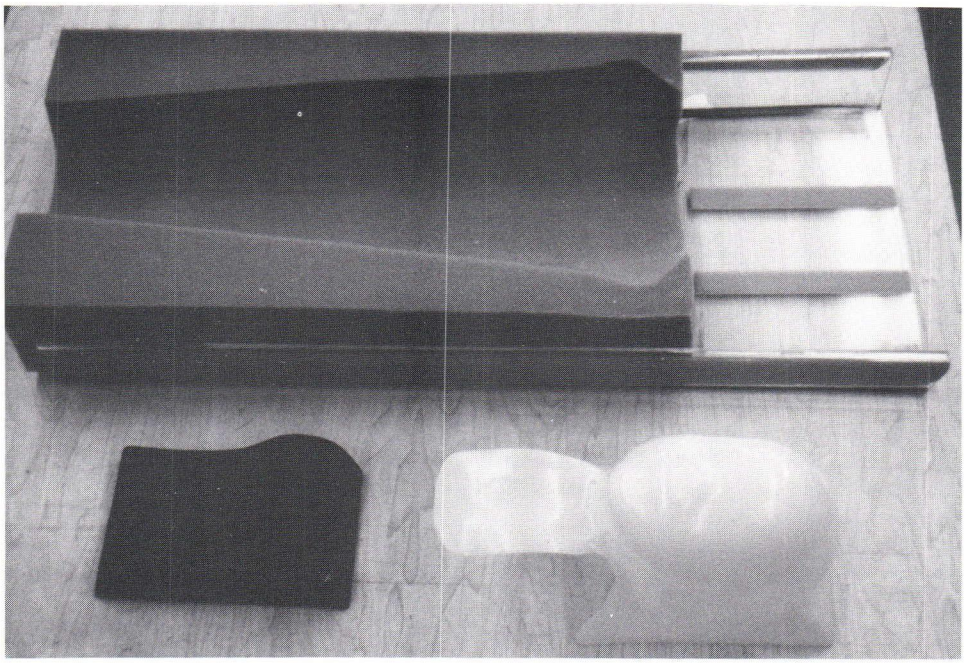


Figure 5. Three main pieces of the immobilization system before final fit.

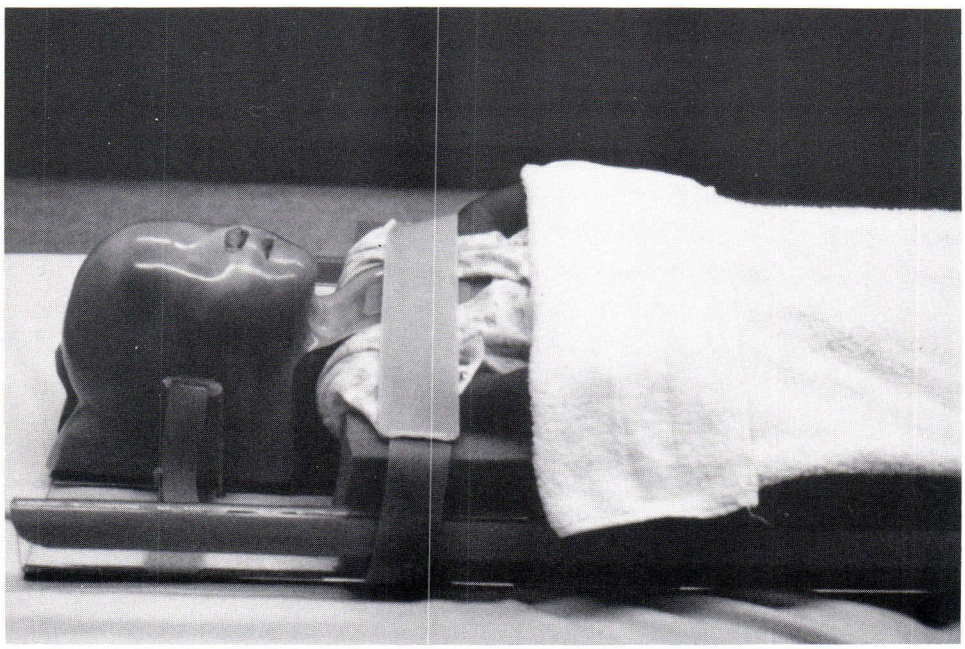


Figure 6. The positioning/restraint system on a patient.

straps are attached to the acrylic base and mask in such a manner as to firmly secure the two. Self adhering Velcro® can be used wherever necessary to maintain the integrity of the Hugger® and headrest for future normal use; metal fasteners are thereby avoided. The entire system in position on a child is shown in Figure 6.

With the restraint system fully constructed, the simulation and treatment planning process are initiated. Since these processes are lengthy, some sedation may be needed. Radiographs, measurements, and tumor volume are then defined. Normally, marks are placed on the skin to serve as consistent reference points; however, with the present system, these marks can be placed on the mask. Patient and family are thereby spared from a cosmetic and psychological point of view. This also helps in that patients do not lose their skin marks from perspiration or washing. When necessary, the shape of the treatment field is cut out of the mask to allow the radiation beam to pass through without losing skin sparing (Figures 7 and 8). After calculations and treatment planning are completed, the patient is ready to begin treatments. The treatments are re-created or set up exactly as outlined in the simulation.

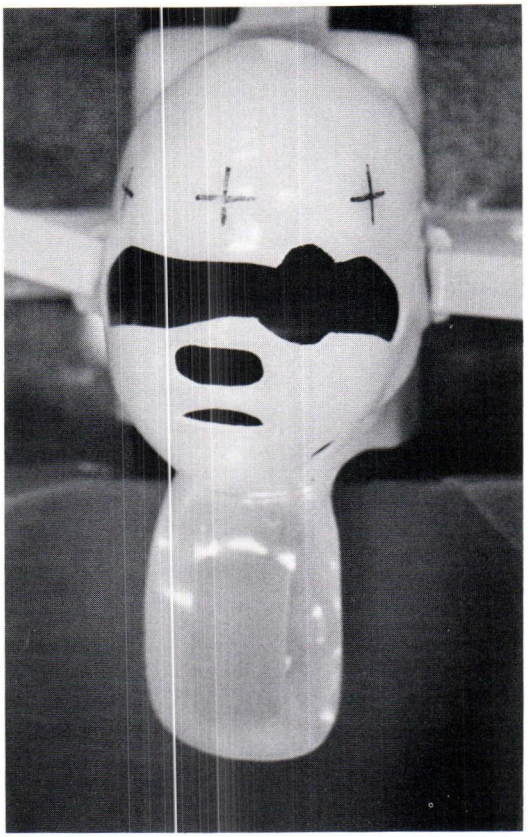


Figure 7. Close up of modified face mask.

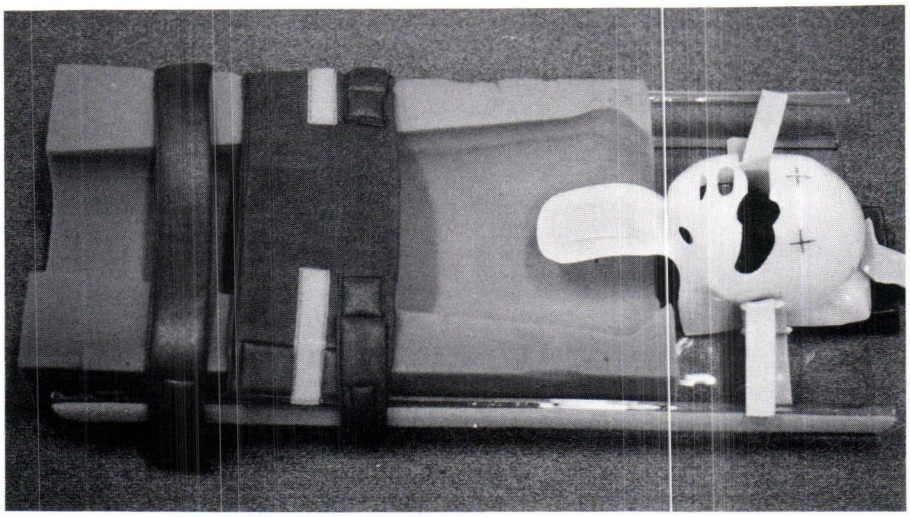


Figure 8. Immobilization system with treatment area cut out and reference marks on face mask.

DISCUSSION

Positioning/Restraint devices have been made for three children ranging in age from six months to two and one-half years. Two had the diagnosis of Ewing's Sarcoma, and the other had Retinoblastoma. All three children were very difficult to manage, afraid, and uncooperative.

Several advantages were noted throughout the course of treatments. Lateral opposed treatments could be utilized with ease due to the head being held in the straight supine position. Setup and treatment time was also minimal due to the patient's inability to move once positioned, thus avoiding any interruptions. In addition, in case of patient distress, the device can be easily and quickly removed, due to its simplicity and use of Velcro® straps. Portal films showed excellent reproducibility of the treatments with the use of the restraining system. The treated area needed mimimal adjustment, and, in all three cases, adjustments were needed only twice during the five and one half weeks of treatment. Each adjustment was 0.5 cm or less.

In summary, the total body restraint system with face mask is a practical and effective means of treating children undergoing radiation therapy. This is supported by the improved accuracy of delivering the radiation therapy and the need for minimal adjustments during the course of therapy. Marks made on the mask itself can be used for aligning the treatment beam instead of marking the patient's skin. Little or no sedation is necessary on a day-to-day treatment basis. Fewer interruptions saved a great deal of time and effort by everyone involved, thus making the system very cost effective and less traumatic to the patient and family.

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ACKNOWLEDGMENTS

The authors wish to acknowledge the support and constructive criticism of Paul Lattin, D.O., Joe Wanchik, C.O., O.T.R., Jim Spicka, M.S., Lenore Andres R.T.(T) and Colin Orton, Ph.D.

Orthotics and Prosthetics, Vol. 40, No. 3, pp. 30–37.

A Clinical Evaluation of an Ultralightweight Polypropylene Below-Knee Prosthesis

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INTRODUCTION

This paper presents the results of a clinical evaluation of an ultralightweight polypropylene below knee prosthesis recently completed at the National Centre for Training and Education in Prosthetics and Orthotics, Strathclyde University, and its prosthetic clinic at the Southern General Hospital in Glasgow. The evaluation was funded by the Scottish Home and Health Department. The ultralightweight polypropylene prosthesis will be referred to as UP in subsequent discussion; similarly, the amputees' previous resin laminated prosthesis will be referred to as OP (original prosthesis) for brevity.

The concept of UP was developed at Moss Rehabilitation Hospital[1] and at Rancho Los Amigos Hospital.[2] A report of an evaluation in Philadelphia of a UP was published in *Orthotics and Prosthetics*, Vol. 33, No. 2, June, 1979.[3] Information from questionnaires completed during this evaluation indicated an overall preference for the UP by the amputees compared with their previous prosthesis, although half of the amputees disliked the rigid polypropylene foot of this type of prosthesis. A revised fabrication manual was subsequently produced, recommending an external keel foot.

The design utilized in this evaluation incorporated a supracondylar suspended polypropylene socket with a soft Pelite liner® (Pelite is the trade name of a closed cell polyethylene foam material). The socket is welded to a hollow polypropylene calf and keel, which is bonded to the flexible soleplate of an external keel Otto Bock SACH foot. A stockinette cosmetic cover is applied.

In the early stages of the Glasgow evaluation of a UP, manufacturing problems—resulting from particular combinations of materials and handling techniques—were encountered, resulting in loss of alignment. Techniques to compensate for these difficulties were identified and reported in *Prosthetics and Orthotics International,* Vol. 8, No. 1, April, 1984. The clinical evaluation was delayed until such time as the clinician and prosthetists were satisfied with the UP alignments and that differences between UP and OP were minimized. A detailed manual of the manufacturing method adopted is available from the National Centre for Training and Education in Prosthetics and Orthotics, in Glasgow, Scotland (Ballantyne et. al., 1983).[4]

- The five aims of the Glasgow evaluation were to
  - —Monitor amputees' response to this modified UP via questionnaires similar to the Philadelphia evaluation
  - —Assess activity level changes with a step counter
  - —Note comments of the clinic team
  - —Record the weights of the UP and the OP
  - —Note the manufacturing times and material costs of the UP

A total of 24 active male amputees were supplied with a UP. Figures 2 and 3 provide amputee demographics.

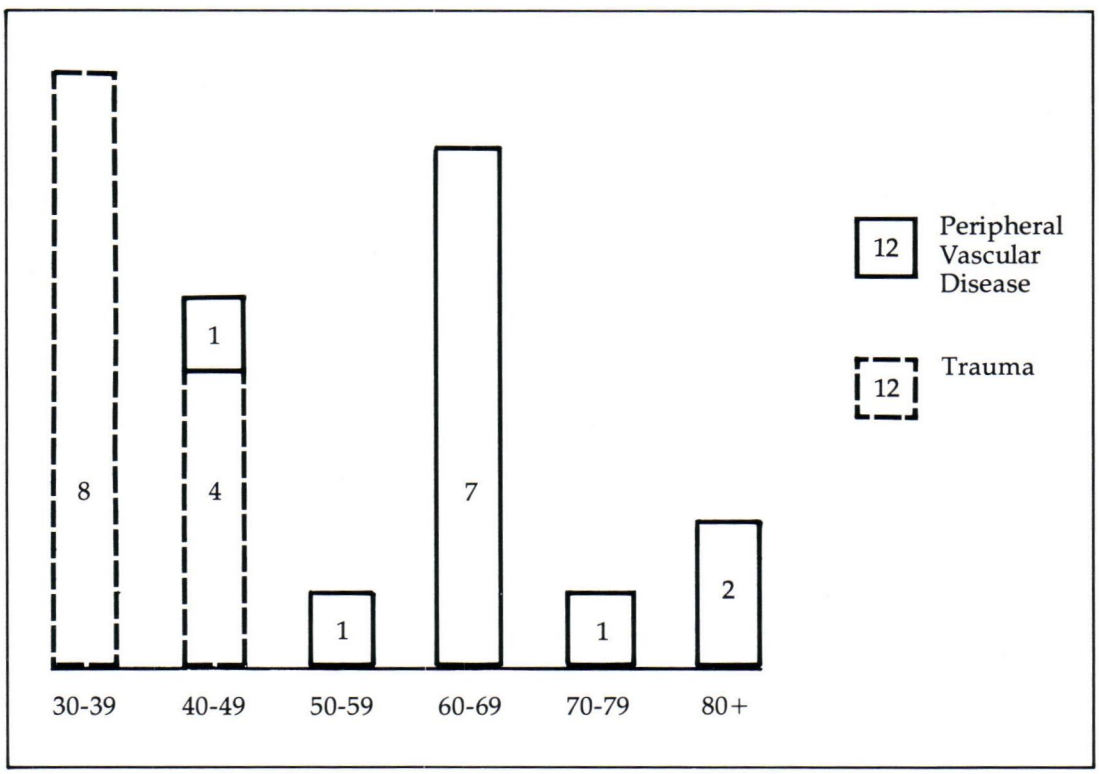

Figure 2. Amputees' Age Groups (years)

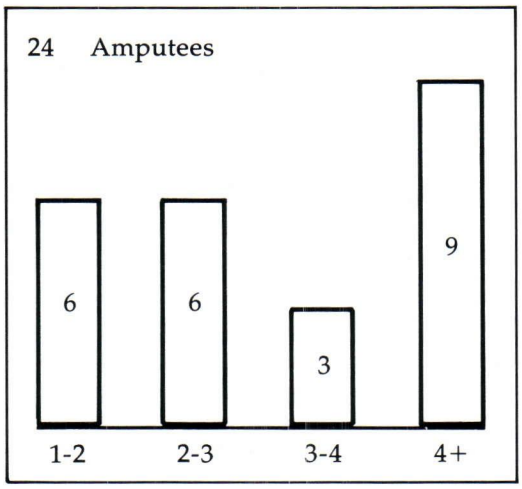

Figure 3. Years Wearing Prostheses

The 24 amputees all previously wore a resin laminated prosthesis with a soft Pelite® liner and SACH foot. Twenty-one of the OP had supracondylar suspension, the other three OP were cuff suspended. Two prosthetists were involved in the fittings.

RESULTS OF CLINICAL EVALUATION

• Monitoring Amputee Response

The amputees were informed that the material of the prosthesis was changed and their comparable views of the OP and the UP were required. Questionnaires were completed by the amputees and clinic team at periodic intervals. During the first visit, when a negative impression was taken for the UP, the amputee was asked his opinion of his current prosthesis (OP) (Table 1).

	Good	Acceptable	Poor
Socket Fit	16	7	1
Suspension	17	7	
Cosmesis	17	7	

Table 1. Amputees' opinion of old prosthesis

The amputees were also asked how many hours per day they wore their OP and also how far they walked. The wearing time ranged from seven to 16 hours, with an average of 14 hours. The walking distance ranged from 200 yards to four miles, with an average of 1½ miles per day. The information from this first questionnaire provided data that constituted a starting point.

The second and third questionnaires were completed two weeks and three months, respectively, after delivery of the UP. The amputees were asked to compare their OP and UP with respect to a number of factors.

• Questions

—Do you wear your polypropylene prosthesis *less/same/more* hours per day than your original prosthesis?
—Compared with your original prosthesis, do you walk *less/same/more* with your polypropylene prosthesis?
—Are you *less/same/more* tired walking with the polypropylene prosthesis vs. original prosthesis?
—Do you have *less/same/more* control of the polypropylene prosthesis vs. original prosthesis?
—With the polypropylene prosthesis, what activities do you participate in?
—Is the socket fit of polypropylene prosthesis vs. original prosthesis *worse/same/better*?
—Walking comfort of polypropylene prosthesis vs. original prosthesis: *worse/same/better*?
—Do you think your polypropylene prosthesis is *heavier/same/lighter* than your original prosthesis?
—Overall, which prosthesis do you prefer: *original/no preference/polypropylene prosthesis*?

The final questionnaire was completed by the amputee one month after reverting to his OP. This procedure enabled the amputee to familiarize himself with his OP again before being asked to compare both prostheses.

—Which prosthesis do you prefer *original/no preference/polypropylene*?

Amputees' Response

Question	Time since ultralightweight prosthesis (UP) delivery			
		Less	**Same**	**More**
Wearing time of UP vs. old prosthesis (OP)	2 weeks	1	18	1
	3 months		14	4
Walking distance UP vs. OP	2 weeks		19	1
	3 months	2	12	4
Energy expenditure UP vs. OP	2 weeks	9	10	1
	3 months	3	15	
Control of UP vs. OP	2 weeks		10	10
	3 months	2	10	6
Social activities UP vs. OP	2 weeks		18	2
	3 months	1	15	2
		Worse	**Same**	**Better**
Socket fit UP vs. OP	2 weeks	5	5	10
	3 months	1	3	14
Walking comfort UP vs. OP	2 weeks	4	3	13
	3 months	1	5	12
		Heavier	**Same**	**Lighter**
Weight UP vs. OP	2 weeks		3	17
	3 months		3	15
		OP	**No Preference**	**UP**
Overall preference UP vs. OP	2 weeks	3	4	13
	3 months	2	1	15
Overall preference UP vs. OP	One month after reverting to OP	2		16

Table 2.

Table 2 represents the amputees' response to specific questions comparing the UP and OP. Some amputees did not complete all questionnaires due to either the rejection of the ultralightweight prosthesis, failure to attend specific clinics, illness, or death during the evaluation. Twenty amputees completed the two week questionnaires and 18 amputees completed the three month questionnaire and the final questionnaire.

Sixteen of the 24 amputees preferred their UP. This may have been due mainly to a better fitting socket and a general improved feeling of comfort.

Five of the 24 amputees rejected their UP for the following reasons:

- One amputee considered the UP socket brim to be too flexible. This created a feeling of insecurity. The clinic team considered this amputee to be "confused."
- One UP was rejected due to loss of alignment detected by the clinic team at delivery. A quality control check had been conducted during the manufacture of this prosthesis, but this did not detect the problem.
- One amputee experienced excessive pressure within the socket at the tibial tubercle. This problem was also experienced by two other amputees, but minor socket rectification produced acceptable sockets in their cases. This socket pressure discomfort was thought to be due to socket distortion during manufacture.
- One amputee complained of excessive pressure on the lateral aspect of his residual limb with the UP. The prosthetist had attempted alignment compensation in the UP to correct a poor gait observed with his OP.
- One amputee experienced discomfort with the supracondylar suspension of the UP and complained that the foot of this prosthesis was "too rigid." This amputee's OP was cuff suspended.

The views of the remaining three amputees are inconclusive. One amputee failed to attend clinics after delivery of his UP, one amputee became a bilateral amputee during the evaluation, and the other amputee died during the evaluation.

Activity Level Assessment Results

In parallel with the questionnaire approach, a quantitative assessment of walking activity was carried out by fitting a pressure switch and step counter between the prosthetic foot and shoe. Subjective assessments of walking distance via questionnaires are unreliable. The pressure switch was positioned on the heel or ball of the foot, dependent on the fit of the prosthetic foot within the shoe. The pressure switch and step counter were worn for a two week period when wearing both types of prostheses to monitor the number of steps taken during these periods.

Failure of the pressure switch during the two week period or failure of the amputee to attend appropriate clinics prevented a comprehensive study. Step count data relative to both types of prostheses was recorded for eight amputees. The average active amputee accumulated 4,800 steps/day (2½ miles) whereas the average inactive amputee accumulated 1,500 steps/day (<1 mile). No increase or decrease in step count with these amputees could be attributed to activity level changes introduced by either the OP or UP.

Summarized Comments of Evaluation Team

No detailed comments from the prosthetists were reported in the Philadelphia evaluation report. The role of the clinic team was to assess this type of UP compared with the laminated prosthesis supplied at present.

- The cosmesis of the UP was considered to be unsatisfactory. This would have been particularly important for females. Specifically, a relatively larger calf diameter and a tendency to damage the cosmetic stockinette were noted. The calf diameter was found to increase by 2.5 cms. on average when using the techniques inherent in the

UP design. The amputees—all males—participating in the study did not appear to be concerned about cosmesis.

- Compared to a resin laminated prosthesis, more minor socket adjustments of the UP were necessary. This was thought to be due to slight local distortion of the polypropylene. A particular problem area would appear to be the tibial tubercle. Socket discomfort problems were not detected at delivery of the prosthesis, but were identified at the review stage. Concern was expressed that if supply of such prostheses were conducted on a nationwide scale, with many prosthetists involved, then potential residual limb problems could pass undetected.
- A favorable impression of the UP may have been created by the new socket which provided a better fit. This could have been avoided by supplying the amputee with a laminated prosthesis whose socket could have been duplicated from a master to provide the UP with an identical socket. This would have extended the evaluation period considerably as amputees became accustomed to their new laminated prosthesis.
- The soleplate attachment to the polypropylene keel was considered unsatisfactory, as it was susceptible to failure.
- Different technician skills were needed than those required for the manufacture of the laminated prosthesis designs. The technician compensated for the shrinkage of Pelite,® polyurethane foam, and polypropylene during manufacture. New skills were needed to perform the polypropylene welding.
- No skin reactions were noted.
- The prosthetists noted that the inner surface of the polypropylene socket is rougher than that of a resin laminate socket. The result of this rough surface was that some of the elderly subjects had difficulty in withdrawing the residual limb and Pelite® liner from the socket when doffing the limb.
- The technician recommended that some form of alignment "quality control" should be used before the UP is supplied to the prosthetist for delivery. This is needed because the method of manufacture creates an increased likelihood of alignment loss compared with lamination methods. Significant loss of alignment occurred during manufacture of some UPs in the early stages of the evaluation. These manufacturing problems were overcome by the introduction of modifications to the manufacturing technique. However, the prosthetist continued to have a reduced confidence in the prosthesis. The prosthetist's confidence in the UP would be restored with more experience.
- Children's growth spurts may be more difficult to accommodate with the UP.

Weights of the Ultralightweight Prostheses

The weight of the 24 OP ranged from 2.6 lbs (1180 gm) to 4.4 lbs (2020 gm) with an average of 3.2 lbs (1450 gm). The weight of the 24 UP ranged from 1.9 lbs (884 gm) to 3.0 lbs (1370 gm) with an average of 2.2 lbs (1005 gm). This represents a typical weight reduction of 30 percent.

The weight of presently available designs of modular below knee prostheses is approximately 4.4 lb (2000 gm).

Manufacturing Costs

The times for manufacture were noted for each of the 24 UP. The first UP to be manufactured was completed in a total of 22 hours. Approximately six hours were required to manufacture the prosthesis to the fitting stage and a further 16 hours were needed to complete it. The manufacturing time, which steadily decreased during the supply of subsequent prostheses, averaged 13 hours—consisting of 4½ hours to the fitting stage and a further 8½ hours to completion.

The typical manufacturing times in the same workshop for a resin laminated prosthesis—3½ hours to the fitting stage and a further 4½ hours to completion—demonstrate the significant increase in manufacturing time required to complete the UP when compared with a lamination approach. The amount of time required by the prosthetist would be comparable for the UP and the laminated prosthesis.

The material cost of the UP was £78 ($116*) compared with £76 ($113) for a laminated prosthesis. The minimum cost of equipment necessary for the manufacture of the UP is approximately £1600 ($2,380), based on production by one technician.

RECOMMENDED DEVELOPMENTS

Polypropylene has been widely used in orthotics for several years. Experience gained during this evaluation identified that shrinkage and distortion of polypropylene after draping does occur. This is not such a major problem in orthotics, where the orthosis does not encapsulate the limb and the interface forces are smaller. It can, however, present a major problem in prosthetics, since the polypropylene encapsulates the limb and an accurate fit is important to minimize interface forces.

In the manufacture of the UP it must be recognized that shrinkage occurs when hot polypropylene is formed over a rigid model. Tests with polypropylene on conical plaster casts confirmed that shrinkage occurs. The hot expanded polypropylene formed over a solid model cannot contract on cooling, creating stresses in the polypropylene. These stresses are relieved and shrinkage occurs when the polypropylene is removed from the model. A shrinkage of 1.5 percent could be anticipated in a socket resulting in circumference shrinkage of ¼ in. and socket length shrinkage of approximately ⅛ in.

*based on exchange rates of late August, 1986.

The external keel SACH foot was not designed for the UP, and, as a result, the soleplate of this foot is difficult to mate with the polypropylene keel of the UP. In particular, the adhesive bond at the interface between the flexible soleplate and the polypropylene keel is susceptible to failure. The incompatibility of these materials and the cyclic compressive load, applied during walking, results in the adhesive extruding between the surfaces.

The excessive calf diameter of the UP was noted by the prosthetists and consultant. This problem cannot be solved with the current UP design. The appearance of the cosmetic cover could be improved, however. During this evaluation the male amputees expressed little interest in cosmesis and no major effort to improve it was undertaken. Therefore, further research and development of the UP is deemed necessary before it is acceptable for routine supply.

DISCUSSION

Twenty-four amputees were fitted with a prosthesis, which was on average 30 percent lighter than their previous prosthesis. The majority of the amputees noticed that the UP was lighter and stated a preference for it. Care must be taken in interpreting the reason for this preference. The weight reduction was not the only factor which changed in supplying the UP. Amputees for this evaluation were selected from those attending review clinics. As a result, although the amputees were satisfied with the socket of their laminated prostheses, the clinic team might have recommended a socket change irrespective of the type of prosthesis supplied. The time since delivery of their laminate sockets varied from four months to four years, with an average of 14 months. These amputees may have been stating a preference for the improved fit of the new socket rather than the UP in general. It is suggested that an amputee supplied with a prosthesis which is comfortable with a well fitted socket will consider the prosthesis to be lighter than his previous poor fitting prosthesis, even if

both prostheses are of similar weight. This pitfall should be avoided in future evaluations of lightweight prostheses. Standard fitting procedure was followed. After alignment, the prosthesis was manufactured for immediate delivery. No intermediate alignments were undertaken with the amputee.

The response of the amputees were similar to those involved in the Philadelphia evaluation, apart from the Philadelphia amputees' dissatisfaction with foot function. In practice, the UP did not extend the range of activities of the amputees involved in the evaluation. There was no significant increase in the amount of time the amputees wore the UP or significant change in their activity patterns. This may be because this group of established amputees have adopted a lifestyle which is not influenced by the weight of the prosthesis. The weight of shoes worn by normal subjects does not affect their lifestyle. The UP might, however, provide an increased potential which would benefit the very inactive amputees.

Following the completion of the clinical evaluation, all amputees were supplied with comfortable resin laminated prostheses.

Questionnaires, irrespective of careful phrasing of questions, are not an ideal way to undertake a clinical evaluation. Extensive scientific studies of energy consumption and activities need to be completed to confirm the philosophy of a lightweight prosthesis.

Field trials of a UP have been completed satisfactorily in England. This particular UP differs in manufacturing procedure from the UP evaluated in Glasgow and also in that cuff suspension was adopted. There have been no published detailed comments from the clinic teams involved in these field trials.

CONCLUSIONS

Two conclusions are evident:

- The amputees preferred the UP
- The clinic team considered the UP inferior to the resin laminated prosthesis.

The second conclusion may have been influenced by the significant manufacturing problems encountered at the start of this evaluation. The clinic team considers the obvious weight reduction of the UP and acceptability to the amputee overshadowed by its poor cosmesis, possibility of socket shrinkage, poor attachment of flexible soleplate to the polypropylene keel, and general lack of confidence in the repeatability of production.

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Orthotics and Prosthetics, Vol. 40, No. 3, pp. 38–42.

A Case History: Orthotic Management After Extensive Chest-Wall Resection

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INTRODUCTION

Partial chest-wall resection is unusual. The primary reason for performing such a resection is the presence of a malignancy or an infection with osteomyelitis of the ribs.

In most cases, surgical reconstruction of the chest-wall is possible. However, after an extensive resection, reconstruction is possible only with non-biological materials such as steel-wire or a Marlex mesh.[1,2,3]

The advantage of reconstruction of the chest-wall is the restoration of solidity. This solidity gives protection to vital organs and is necessary to build up negative inspiratory pressure. Loss of solidity of the chest-wall results in a decrease of ventilation capacity.

Surgical reconstruction with non-biological materials is not always possible in the event of an extensive chest-wall resection caused by infection. In this case, reconstruction is not possible. An orthotic device is necessary for protection of the vital organs.

PATIENT BACKGROUND

The patient is a 30 year old male, who has a medical history that includes several thoracotomies with lunglobe resection for recurrent pneumothorax by chronic adhesive pleuritis e causa ignota. Finally, rethoracotomy was performed, with resection of the left lung and the third to the eleventh rib. There is a residual cavity in the left thorax, with a permanent drain in situ (Figures 1, 2, 3).

Secondarily, a left convex thoracolumbar kyphoscoliosis has developed during mobilization after surgery. The curvature starts at C5 and ends at L1. The lateral curvature is 20 degrees, using the Cobb-method of measurement.

Problems for the patient are the unprotected position of the heart and discomfort in sitting and lying.

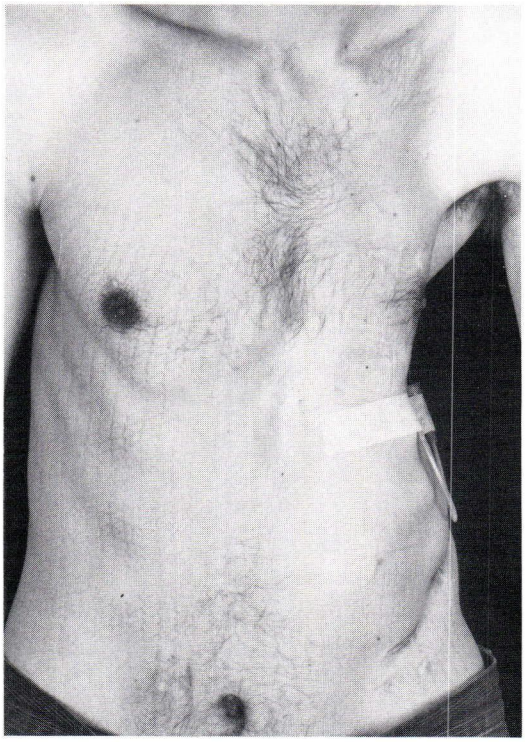


Figure 1. Front view of patient.

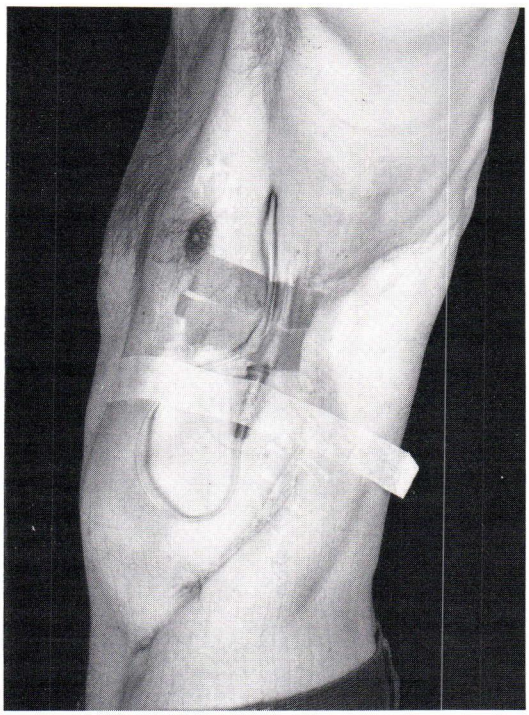


Figure 2. Left side of patient.

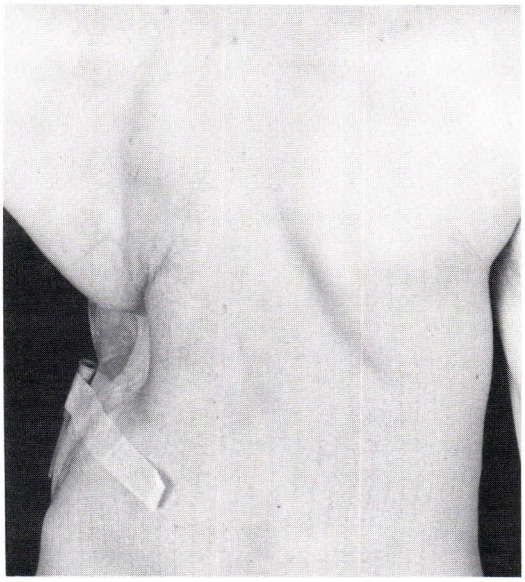


Figure 3. Back view of patient.

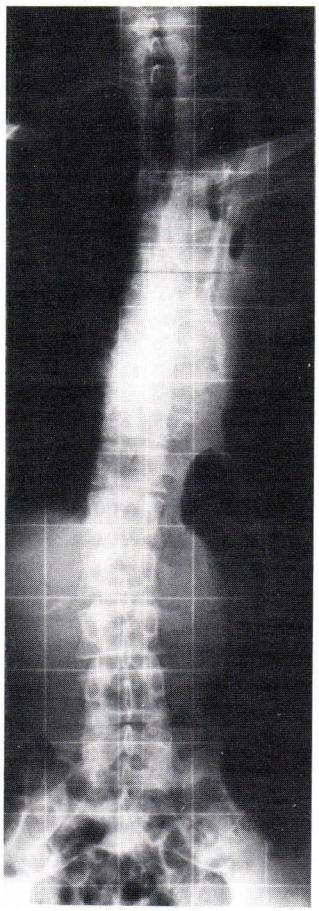


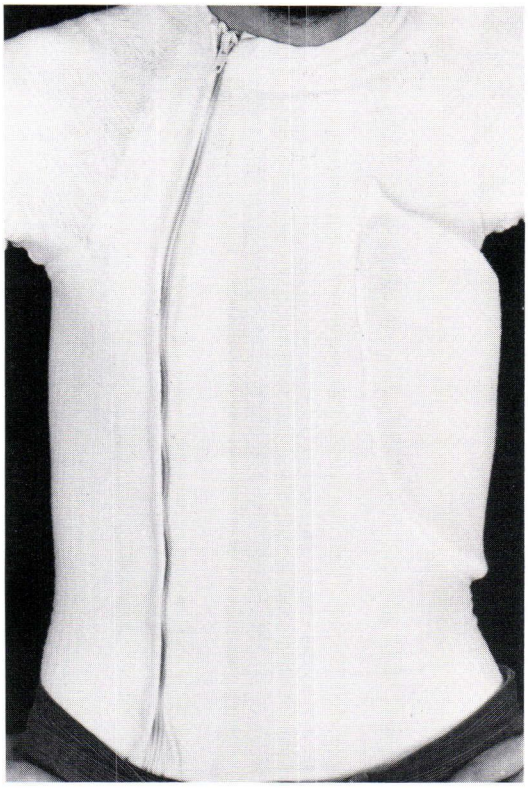
Figure 4. A.P. roentgenogram of the thoracolumbar spine.

ORTHOTIC MANAGEMENT

At first we prescribed a thoracolumbar orthosis for protection of the vital organs and "correction" of the scoliosis. The left side, from axilla to the iliac crest, was made of polypropylene, the right side, fixing the orthosis, of elastic cotton.

This orthosis was efficient in protecting the vital organs, but produced too much discomfort in sitting and lying.

Finally, we ordered a plastic protective shield, molded on a plaster of Paris positive model of the left residual chest-wall. The shield is fitted in a pocket, attached to a Tubigripp® shirt (Figures 5, 6, 7). The shield is made of unpadded polyethylene, with a thickness of four millimeters (0.16 inch) (Figures 11, 12). The size is 25 × 30 cm (10 × 12 inch). The pocket is closed with a groove, the shield is exchangable, and the shirt is washable.



Fgure 5. Front view of patient in orthosis.

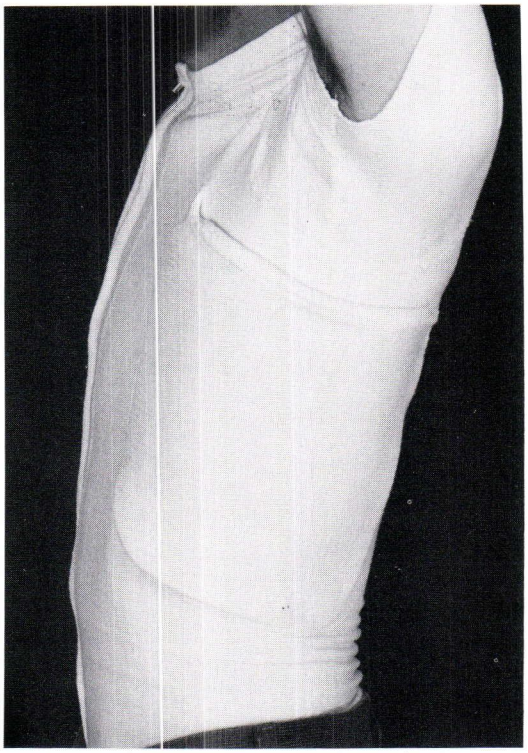


Figure 6. Left side of patient wearing orthosis.

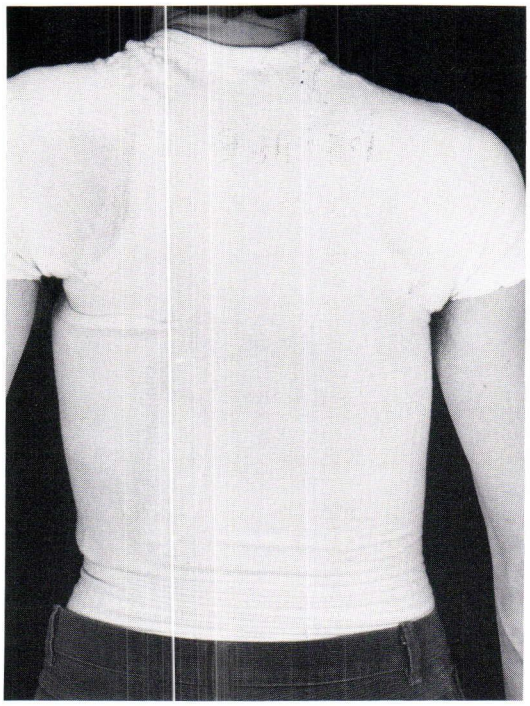
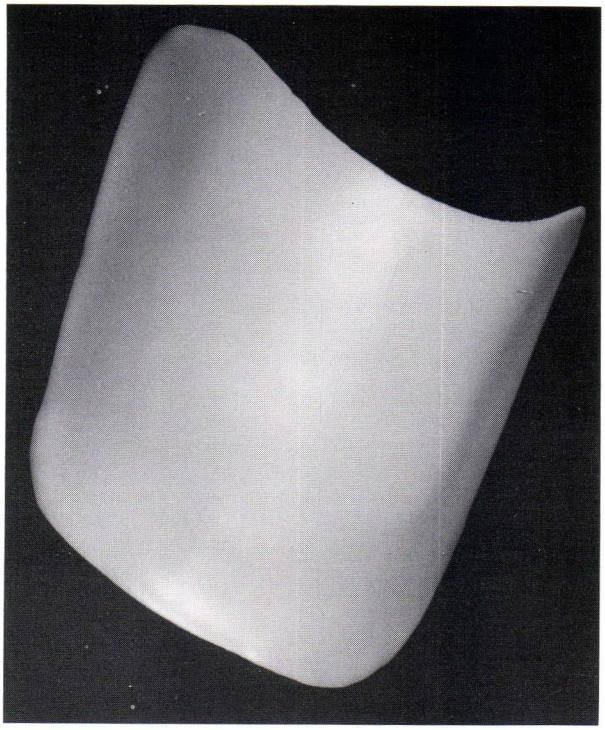


Figure 7. Rear view of patient in orthosis.

Figure 8. Protective shield, outside.



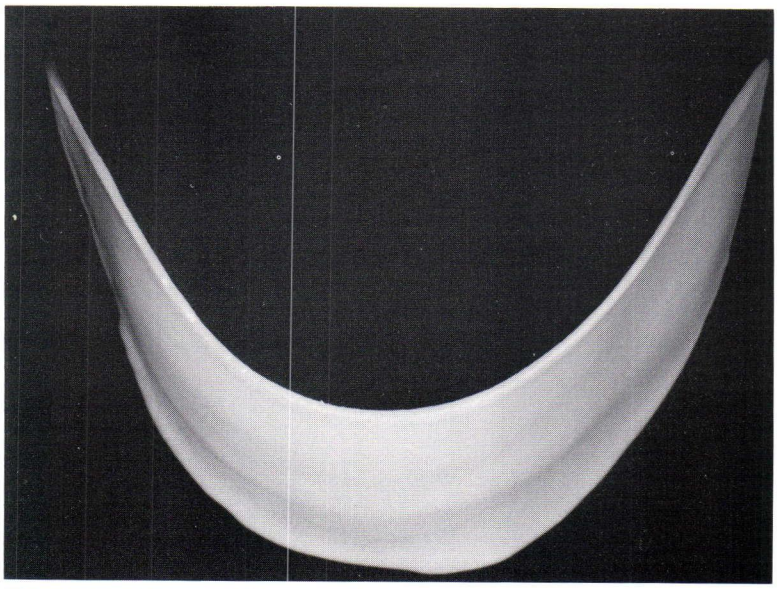


Figure 9. Protective shield, upper side.

With this device, the patient feels safe for social outdoor life, without discomfort in his daily activities. Regular x-ray control of the spine shows no progression of the scoliosis during a three year follow-up.

SUMMARY

Orthotic management is described for a patient after an extensive left chest-wall resection. An orthosis to protect the vital organs was fabricated, which allows the patient to feel safe in social, outdoor activities without any discomfort. No progression of the initial scoliosis is noted in a three year follow-up.

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ACKNOWLEDGMENT

Grateful acknowledgment is made to Hetty Tonneijck, O.T., for delivering the idea of the final orthosis.

Orthotics and Prosthetics, Vol. 40, No. 3, pp. 43–47.

Technical Note: An Alternative Design for a High Performance Below-Elbow Prosthesis

Robert Radocy, M.S., T.R.
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INTRODUCTION

Upper extremity prosthetic design for below-elbow amputees has continually evolved in an attempt to improve suspension and comfort without sacrificing range of movement and function. The advent of electro-mechanical (myo-electric) prostheses which do not require harnesses has led to improved "Muenster" style socket type suspension systems which can be applied to conventional prostheses as well.[1] The development of lower-extremity flexible socket systems also opens up some intriguing possibilities for upper extremity prostheses at the same time.[2] New materials are constantly evolving, which also lead to improved socket technology and fabrication techniques.

CASE STUDY

The project began as an effort to construct a relatively lightweight, strong, below-elbow prosthesis with a high comfort range, specifically designed to function with a GRIP[3] voluntary closing terminal device system. The amputee was an experienced prosthesis user, for more than 13 years, with a four inch, below-elbow amputation. This patient pursued a variety of rigorous activities which required bilateral strength and coordination. Past hard socket prostheses, with varying designs and styles, had not provided a sufficient range of comfort to protect the bony prominences of his residual limb. The condyles, olecranon, and the distal end of the residual limb suffered constant stress and aggravation resulting in redness, soreness, and tissue degradation during rigorous activities.

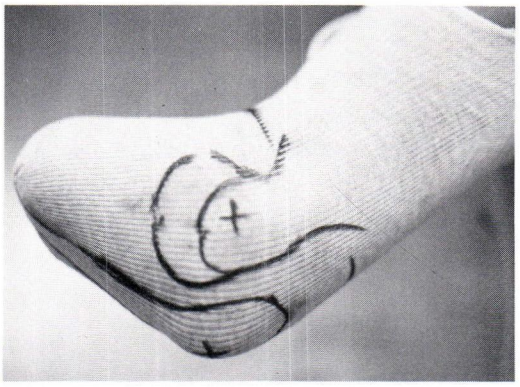

Figure 1. Outlines for bony prominences.

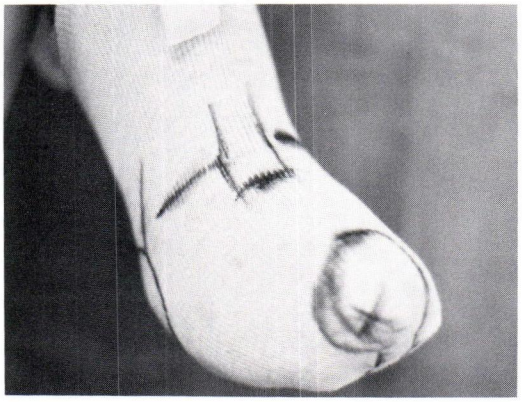

Figure 2. Note the markings around the condyles and distal end of the ulna and radius.

Prior to fabrication, a full socket liner concept was considered but rejected because of the heat build up and anticipated increased perspiration. The chosen design was a two-piece partial liner which used padding to protect the distal end, condyles, and olecranon.

MEASUREMENT AND FABRICATION

While outlining bony prominences for the cast (Figure 1), the prosthetist paid special attention to the sensitive areas around the condyles and distal end of the ulna and radius (Figure 2) because of the high forces generated by the amputee's activities. "Muenster" type socket casting and modifications were used, and a check socket made of rigid acrylic resin was fabricated.

During positive model modification, large reliefs were provided for the biceps tendon in order to achieve full flexion. The posterior brim was extended proximally to spread out the otherwise concentrated forces proximal to the condyles during full extension of the prosthesis. The amputee found this modification necessary to avoid tissue breakdown during rigorous activities, such as weight lifting and rock climbing. The check socket was adjusted to create as much tension as possible on soft tissues, to achieve better prosthetic control and improve proprioception.

With the elbow extended, pushing the arm into the check socket yielded very little tissue displacement. However, the distal ends of the ulna and radius came into slight contact with the distal end of the socket. At this point, the location of the distal and proximal pad for the condyles and olecranon was outlined, after which the socket was bivalved, and outlines for the pads were transferred to the positive mold.

After considering and trying a variety of materials for the pads,[4] Pelite® was chosen because of its simplicity, durability, and cleanliness. The Pelite® was formed and trimmed to fit within the bony outlines. With the pads in place (Figure 3), the definitive socket was laminated, after which the positive model was broken out and the pads saved. Foam was then applied preextending the socket three to five degrees, and cut to length. The socket was refitted and the patient put it through some lightweight maneuvers, at which time an optimum alignment was found.

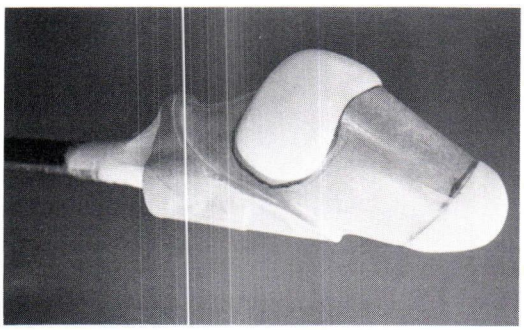

Figure 3. Socket with pads in place.

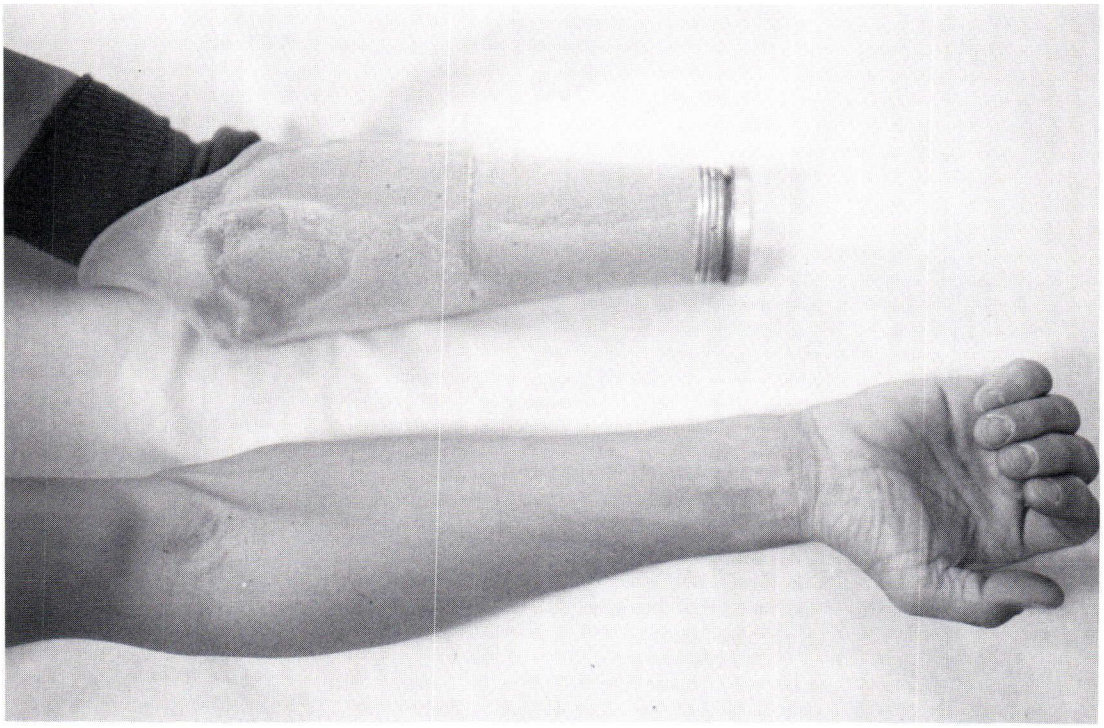

Figure 4. Comparing forearm socket with patient's sound extremity.

The foam was shaped to match the patient's sound forearm (Figure 4). The color of the resin was matched to the patient's skin pigment, and carbon fiber and acrylic resins were used in the lay-up to increase strength.

RESULTS

After approximately one month of use, the distal end pad of Pelite® was replaced with a "T" foam insert for more cushioning. The primary Pelite® pad, which protected the condyles and olecranon, was modified. Modification involved slightly extending the pad edges proximally at the condyles and olecranon while correspondingly relieving the socket to accept the larger pad. The modification proved successful and satisfied the patient's needs.

Almost a year later, the patient reports that heat and perspiration factors are comparable to a hard socket. The patient's residual limb has remained in excellent condition since the fitting and he does not experience the negative effects that were induced with a hard socket.

The final design resulted in a prosthesis (Figures 5 & 6) which required no break-in period and was reported as "the most comfortable prosthesis" that the patient had ever worn. To date, the prosthesis has been exposed to such activities as mountaineering (including technical rock climbing), windsurfing, and both snow and waterskiing, with excellent results. The padding has also provided a form of thermal insulation for additional cold weather comfort.

Some unusual aspects of this prosthesis need to be emphasized. First, the socket is designed to be pre-extended, not pre-flexed, allowing total arm extension. This design limits flexion of the prosthesis to within five inches of the face, but is preferred by the patient, who is a unilateral amputee. The extended posterior brim at the rear of the socket distributes distal prosthetic loads to the back of the humerous and removes the load from the distal

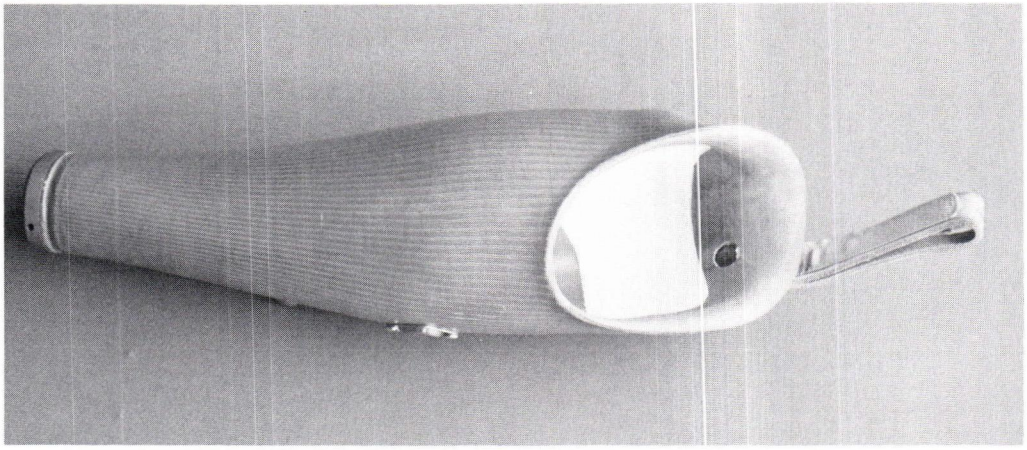

Figure 5. Finished prosthesis.

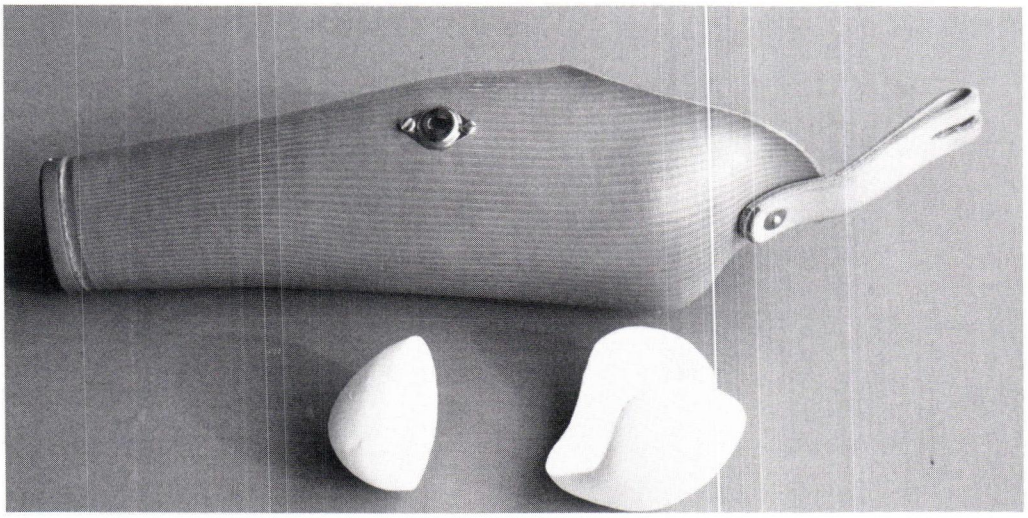

Figure 6. Finished prosthesis and pads.

end of the residual limb. This cantilever effect allows for the handling of heavy loads with a short limb and relieves the pain usually associated with loads applied to the distal end of the prosthesis. The prosthesis' length was aligned to finger tips and not the thumb of the patient's sound hand. This was preferred even though the residual limb is only four inches below the elbow.

Finally, the harness is extremely simple but very effective. A triceps cuff is not present, and the design utilizes a modified Northwestern Figure 9 harness. A ring and rapid adjust buckle are used to adjust cable excursion three to four inches, which can enhance the use of voluntary closing terminal device systems.[5] A leather cross bar strap is riveted to the back of the socket, and supports the cable, keeping it off the triceps area. Interference with dress shirts is not apparent (Figure 7). The harness rides low across the back, but can be slipped up over the shoulder for improved range holding above the head. With amputees rejecting conventional prostheses due to the complex harness systems (such as Figure 8 harnesses), this design offers a much less cumbersome, comfortable, yet very functional, alternative.

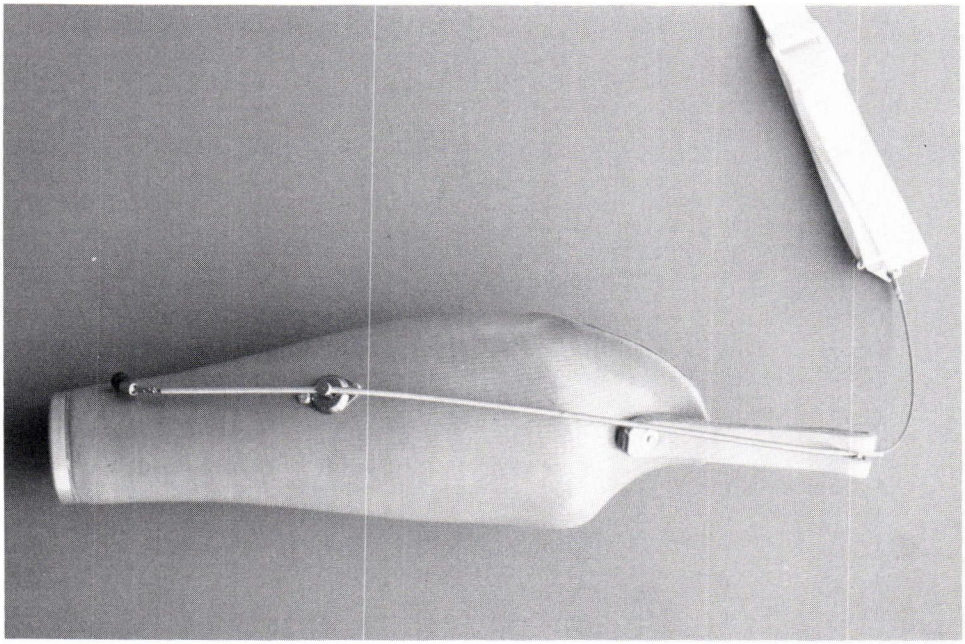

Figure 7. Prosthesis with cable attachment.

CONCLUSION

It is the authors' contention that this prosthetic design is a viable alternative for the active below elbow amputee with a short to mid-forearm limb absence. The self suspending socket design, when it can be tolerated, reduces cumbersome harnessing, allowing for the application of simple, efficient, lightweight cable control systems. The added comfort and simplicity can only encourage more active use of the prosthesis, a primary rehabilitation goal.

AUTHORS

Robert Radocy, M.S., T.R., is President of T.R.S., Inc. of Boulder, Colorado, and Randall D. Brown, C.P., is with Thornton Orthopedic Inc. of Boulder, Colorado.

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[3]Trade name for terminal device from T.R.S., Inc. of Boulder, Colorado.

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Technical Note: Application of a Prosthetic Sheath in Orthosis Fabrication

David C. Showers, C.P.O.
Laird David, R.T.(OP)

INTRODUCTION

During the early 1970's, vacuum forming high temperature sheet plastics was introduced and subsequently promoted as an effective fabrication process for orthotics and prosthetics. Forming the hot plastic over a modified positive mold is not a problem in most cases, when vacuum is utilized to complete the process. Nor is forming the hot plastic over small sections of soft plastic pads, such as plastizote, a difficult task.

However, when attempting to vacuum form the rigid plastic over a continuous soft interface (Aliplast 4E,® plastizote) the problem of total contact and adherence of the rigid plastic to the soft interface may arise. This article will suggest an alternative technique utilizing the Nysert Sleeve® in the vacuum forming process placing the sleeve between the rigid sheet plastic and the closed cell polyethylene foam interface (Figure 1).

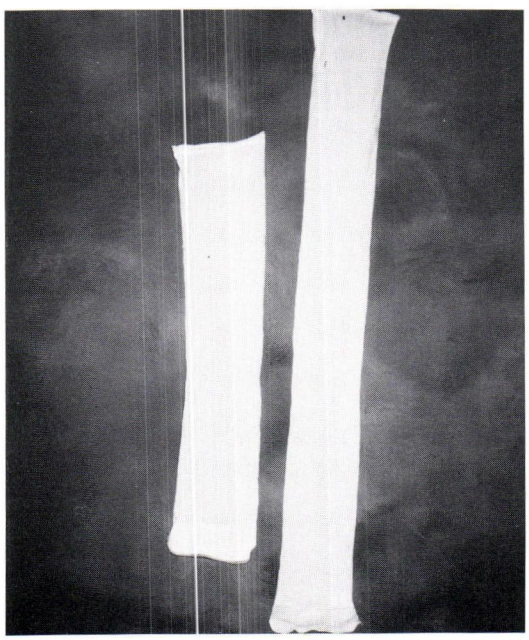

Figure 1. Below knee and above knee Nysert® Sleeve.

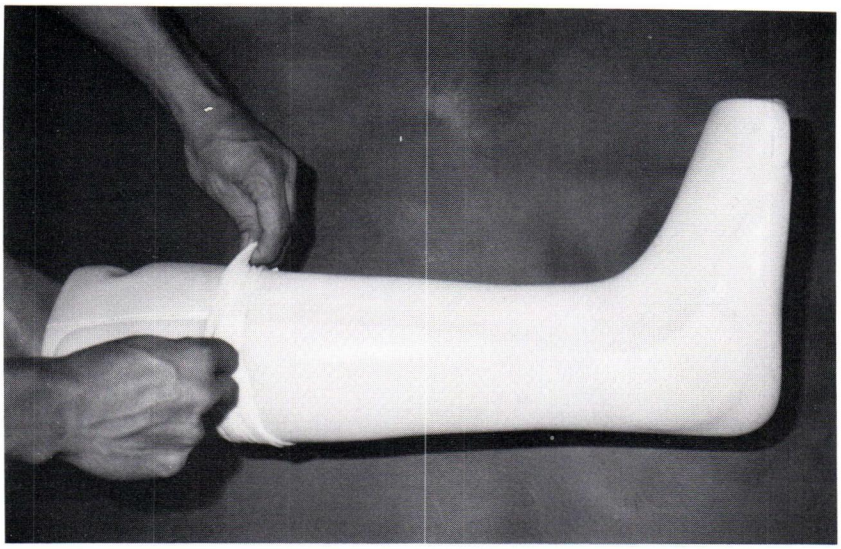

Figure 2. (left) First, the below knee sleeve aids in holding posterior section on the positive model. A second sleeve aids in the vacuum-forming process for the anterior Aliplast® liner.

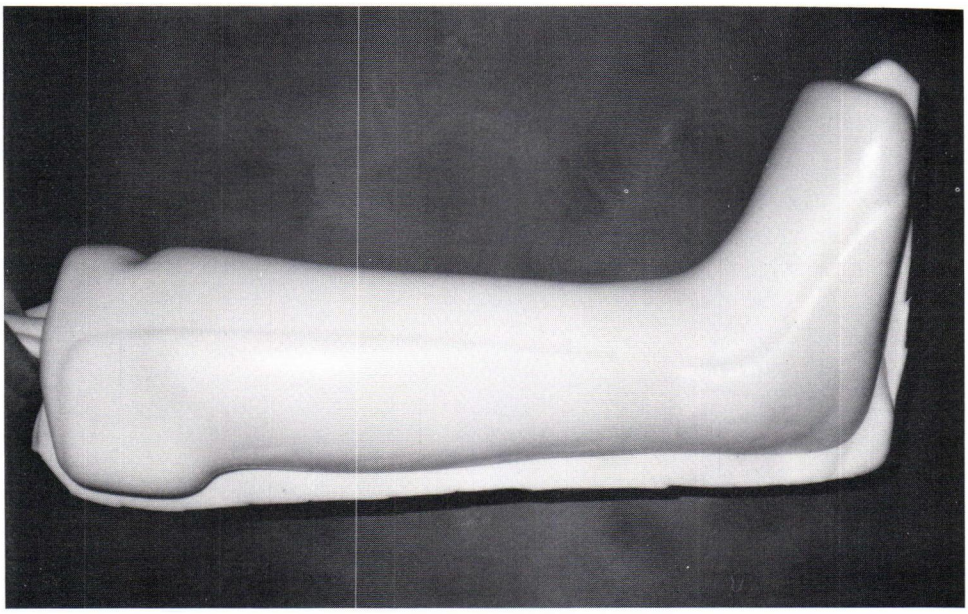

Figure 3. Vacuum is used to complete forming process.

PROCEDURE

The following are recommended steps in fabrication of a PTB non-articulated total contact fracture orthosis using the Nysert Sleeve®:

- Prepare model for posterior polypropylene vacuum forming (note: it will be assumed by the reader that all processes described in the article refer to the use of the hand drape molding process).
- After the plastic has cured adequately, the posterior section is removed for the finishing process and placed back on the positive model when completed.
- Place one Nysert Sleeve® over the posterior polypropylene section on the model (Figure 2).

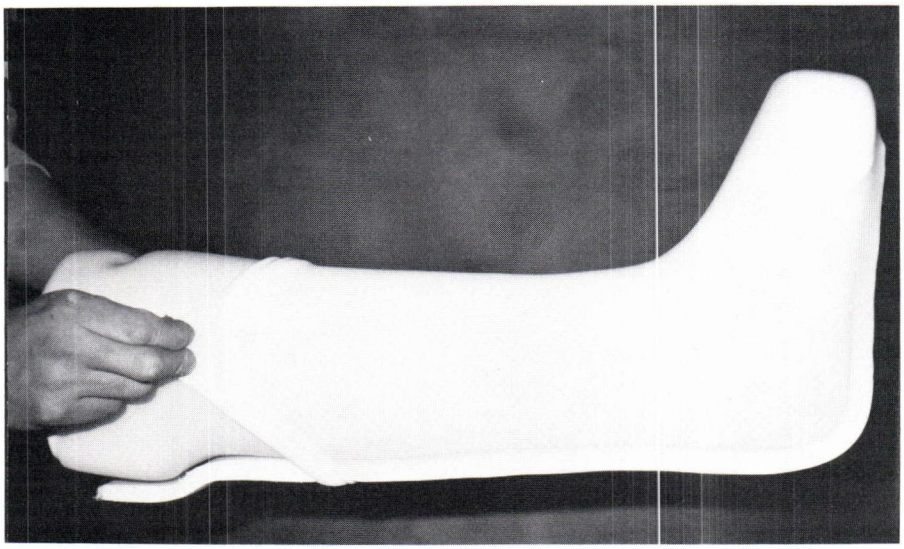

Figure 4. Placing the second sleeve should be accomplished by applying considerable tension so the anterior liner and posterior strips are securely held in place.

- Form the anterior Aliplast® 4E, or similar material, liner over the model (vacuum is optional). A $^{3}/_{16}$" or $^{1}/_{4}$" thickness is recommended for the liner (Figure 3).
- Remove the Aliplast® liner and trim excess material, according to the practitioner's criteria.
- Place the anterior liner back on the model (note: do not glue the foam liner on to the model[1]).
- Simultaneously place a second Nysert Sleeve® over the Aliplast® liner and posterior protective strips (Figure 4). Plastizote or Aliplast scraps may be used as protective strips.
- Vacuum form either polypropylene or polyethylene over the liner (note: plastic should be heated two minutes longer than normal to assure permanent adherances between the soft interface and the polypropylene or polyethylene) (Figure 5).
- After the anterior form has adequately cured, the anterior section is removed from the model. Excess sheath mate-

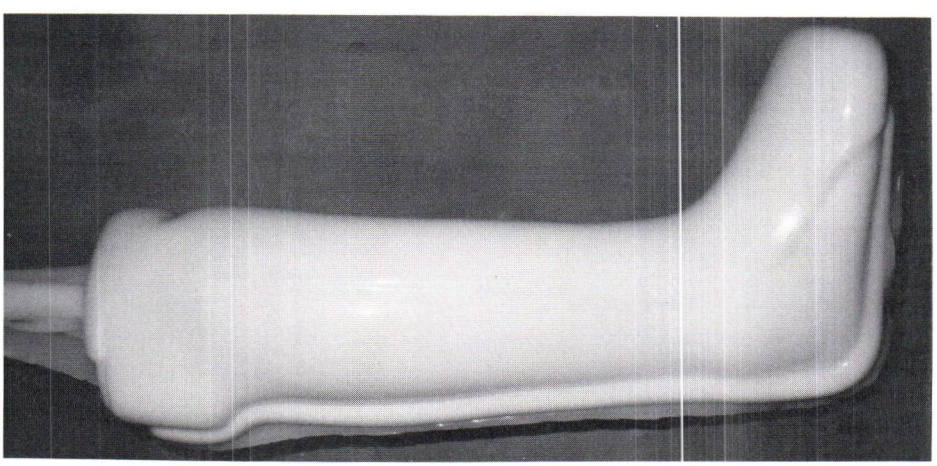

Figure 5. The process is completed without fear of air pockets between the liner and rigid plastic.

rial is removed along the edge of the liner (Figure 6), and the anterior section is finished by smoothing the plastic edges, thereby completing the process.

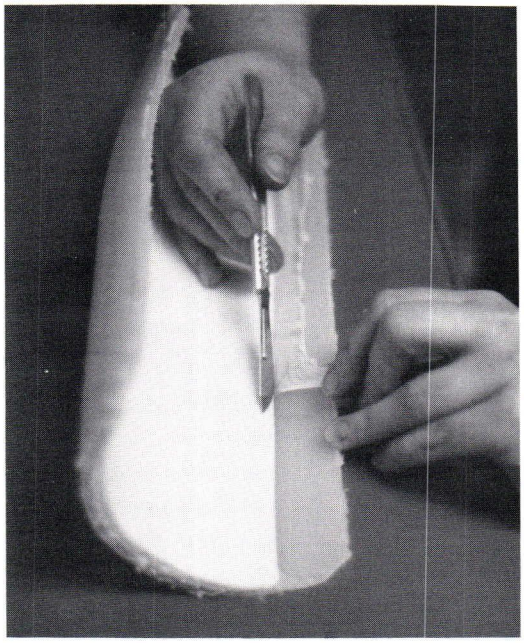

Figure 6. An extremely sharp knife is required to remove excess material neatly.

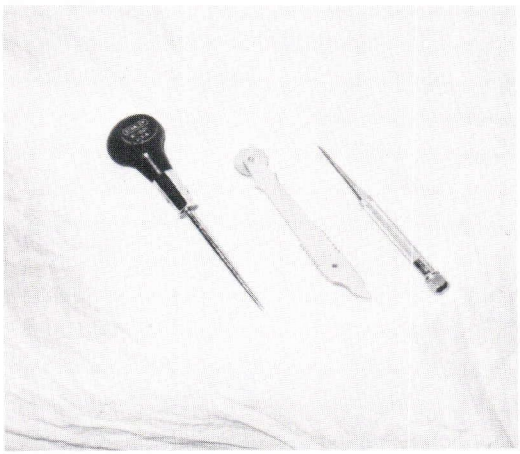

Figure 7. Awls, scribes, and rollers do not have to be used in this process.

ADVANTAGES

- Holes do not have to be punched through the closed cell polyethylene interface to allow for air flow.[1] (Figure 7).
- The soft interface does not have to be glued to the model.[2]
- Potential air pockets are eliminated between the soft interface and rigid plastic.
- Time is saved in fabrication.
- Cosmesis and quality are improved.

DISADVANTAGES

- There is a slight increase in cost due to the purchase of the sleeves.
- Vacuum must be used during the forming process.

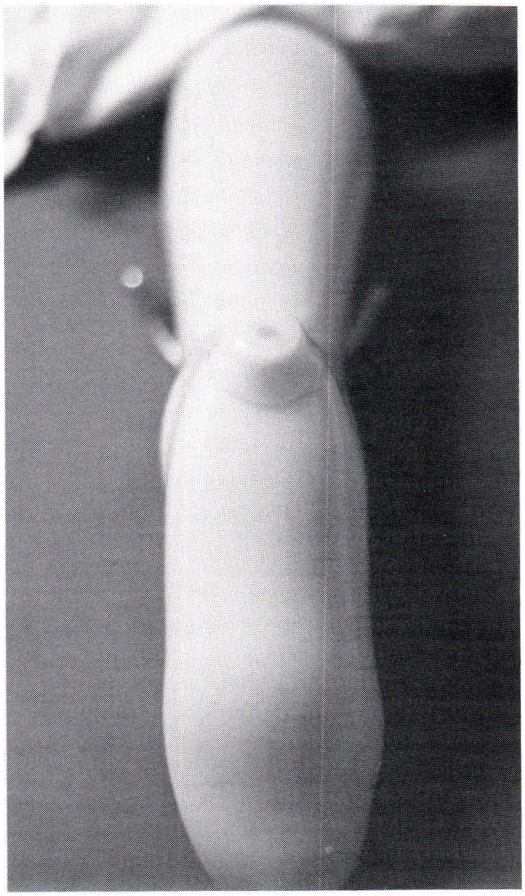

Figure 8. BK Nysert® sleeves may be used in fabricating the "lively orthosis." Finishing the edges has not been a problem.

OTHER APPLICATIONS

The Hospital of the University of Pennsylvania (HUP) Orthotics/Prosthetics lab uses this technique in the fabrication process of other projects such as the "lively orthosis" (Figure 8), full liners for knee orthoses, KAFO's with full or partial liners, upper extremity EWHO's, WHO's which require full liners (Figure 9), and occasionally for the plastic thigh sections of below knee prostheses with knee joints. Virtually any project which requires a soft closed cell foam (e.g. Aliplast®) interface can benefit by utilizing this technique, especially when the surface area to be covered is increased. The greater the surface area, the more advantageous is this technique.

An exception to this practice may be in the fabrication of the plastic TLSO. We have limited experience in applying this procedure at the present time, since our plastic TLSO's are fabricated utilizing Surlyn® plastic.

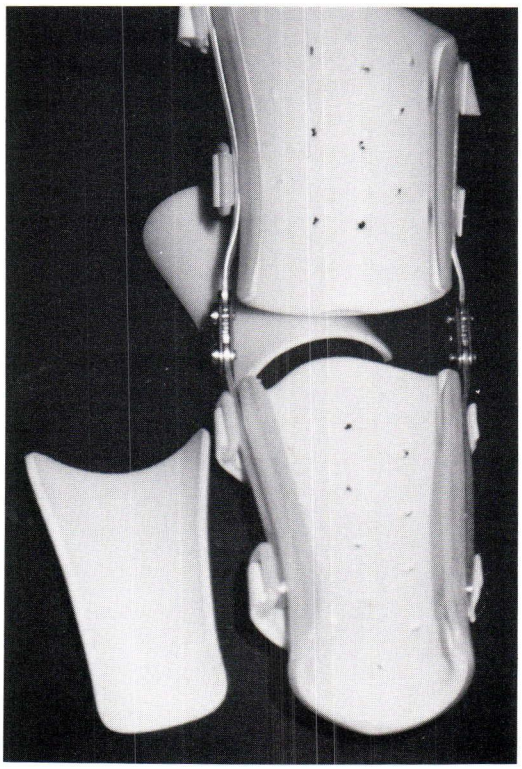

Figure 9. An elbow fracture orthosis with a full anterior and posterior liner.

CONCLUSION

The HUP Orthotics/Prosthetics lab has used this technique for five years. We feel that cosmesis has been improved and errors in the forming process have almost been eliminated. Occasionally the rigid plastic does not adhere to the Aliplast® foam; however, this happens when the rigid plastic is not heated for the proper length of time. For those practitioners and technicians who work extensively with sheet plastic and soft interface combinations, this technique is recommended as an effective way to improve product quality and patient care.

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ACKNOWLEDGMENT

The authors would like to thank Ralph Galati, M.P.A., for his assistance and for the use of his computer.

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Technical Note: A New Technique for the Fabrication of a Shoulder Prosthesis

R.L. Engelmeier, D.M.D., M.S.

INTRODUCTION

Perhaps the greatest difference between prosthetics and other specialties involved with the treatment of cancer patients is the fact that prosthetic practitioners deal almost completely with rehabilitation and very little with the treatment of the patient's disease. Rehabilitation refers to the restoration of the patient to a useful life through therapy and/or education. Those involved in rehabiliation take a different approach and often see and address problems overlooked by other specialists. The surgeon's treatment is aimed at eradicating the patient's disease and usually ends when the surgical procedure is over. Prosthetic treatment however, is often involved with intense follow-up of these patients for the duration of their lives. In other words, prosthetic efforts are aimed not at saving the patient's life, but at increasing the quality of that life.

Everyone has seen amputees, who, for one reason or another, have not restored their missing extremity with a prosthesis. Even though the loss of the limb was apparent, it could for the most part be hidden under clothing to the point where it was socially more acceptable. In the case of a four-quarter amputee, however, where both the arm and shoulder mechanism are amputated, it is not possible to hide this defect under clothing. The patient is left with only a rib cage on the side of the amputation, and none of his clothing fits anymore (Figures 1 & 2). This makes his clothing look as though it is falling off that side.

In an effort to enable these patients to adequately support their clothing with a prosthesis, which is easy for them to handle as well as being easy and inexpensive to fabricate, the following technique was developed.

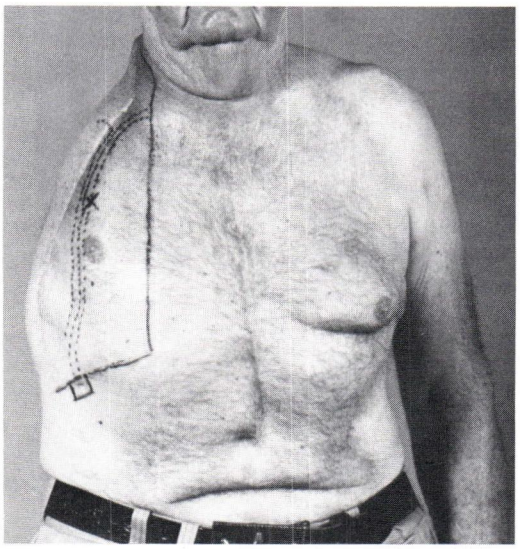

Figure 1. An anterior view of patient, showing extent of surgery performed.

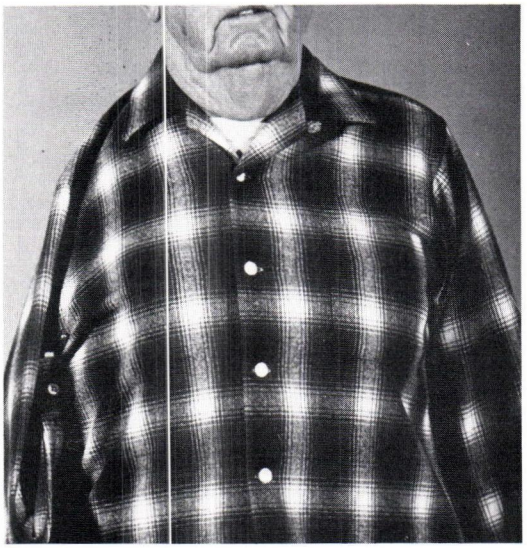

Figure 2. Anterior view of patient, demonstrating inability to disguise disability without a prosthesis.

MEASUREMENTS AND MODIFICATION

Before making any impressions, appropriate guidelines are drawn on the patient with an indelible ink pencil. These will transfer to the negative impression and will act as reference lines (i.e.; midline, clavicle, and the level of the opposite axilla) during the sculpture phase (Figure 3). Then, body impressions, of irreversible hydrocolloid,[1] guaze, and accelerated dental plaster,[2] are made of the shoulder to be treated and the remaining normal shoulder. The impressions should be kept as thin and light as possible so as not to distort the skin any more than necessary. The patient should be sitting upright during this procedure, and the impressions should extend from the front midline to the back midline and from just above the clavicles to just below the axilla.

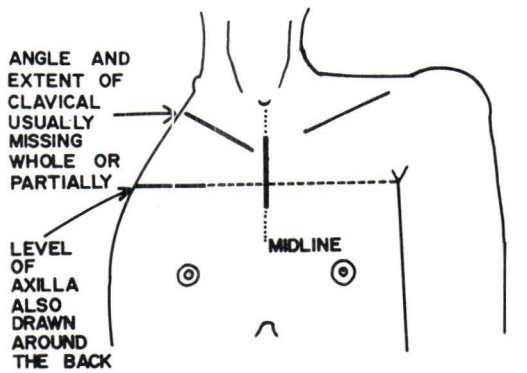

Figure 3. Diagram illustrating the areas to be outlined prior to making the negative impression.

The sculpture is then developed from base plate wax[3] on the positive model. The wax sculpture is hollow rather than solid to save materials and make it easy to remove the sculpture from the model to try it on the patient (to check fit, extension and contours) (Figure 4). After the trial fitting and any modifications to the wax-up, the margins are luted to the cast and finished down. The exposed plaster of the positive model is painted with separating medium.[4] Cardboard (e.g., a manila folder) and paper tape can be used to box the model so that the top half of the mold can be poured over the wax-up. After the top half of the mold has set, the wax-up is eliminated in boiling water and both sides of the mold are painted with a tin foil substitute[4] (Figure 5).

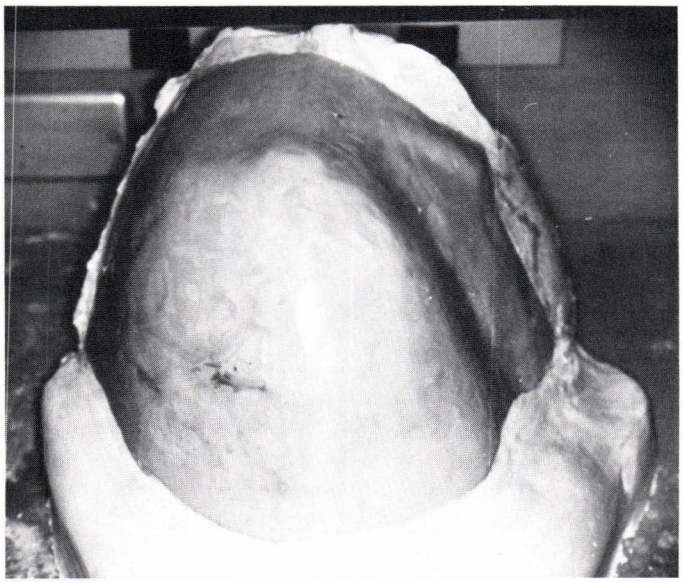

Figure 4. (right) The hollow base plate wax sculpture ready for trial fitting.

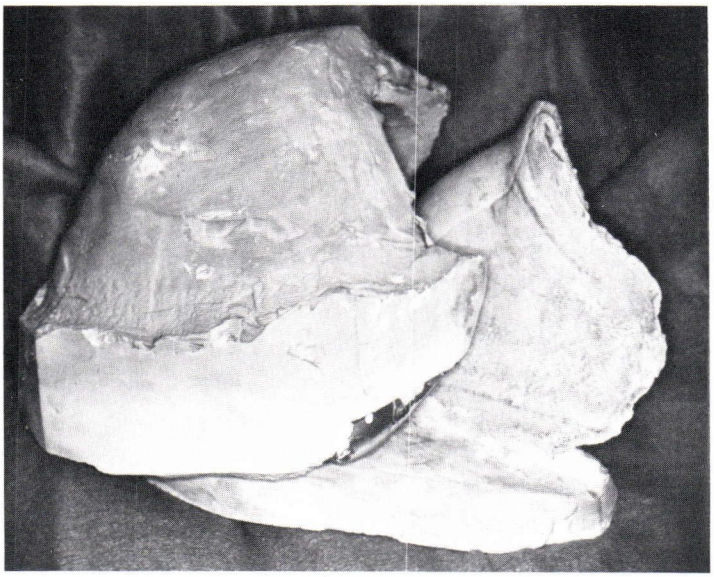

Figure 5. (left) Top and bottom of the mold are separated after the wax is boiled off, prior to tin foil substitute preparation.

Since it is desirable to have a very light weight prosthesis (i.e., a shell), initially only the top half of the mold is used. Auto-polymerizing Acrylic[5] is adapted to the inner surface of the top half of the mold by means of a sprinkle-on technique in a patchwork fashion to prevent over-heating and excessive porosity of the curing acrylic. The patches are no bigger than two inch squares, and are joined after adjacent patches have cured. The thickness of the acrylic should be approximately 1/8" overall. The entire inner surface of the top half of the mold is covered except for a border 1" wide short of the margins. Finishing of the inner surface of the prosthesis can be minimized by wiping the surface of the curing acrylic with monomer (the liquid portion of the acrylic) to smooth it.

Once the shell is adequately cured, the border is added by using a closed mold technique (i.e., top and bottom halves of

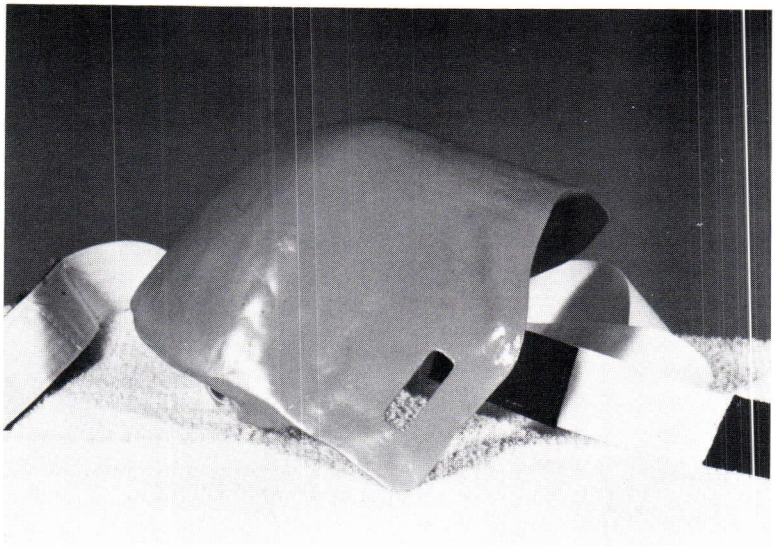

Figure 6. (left) A view of the finished prosthesis, showing straps.

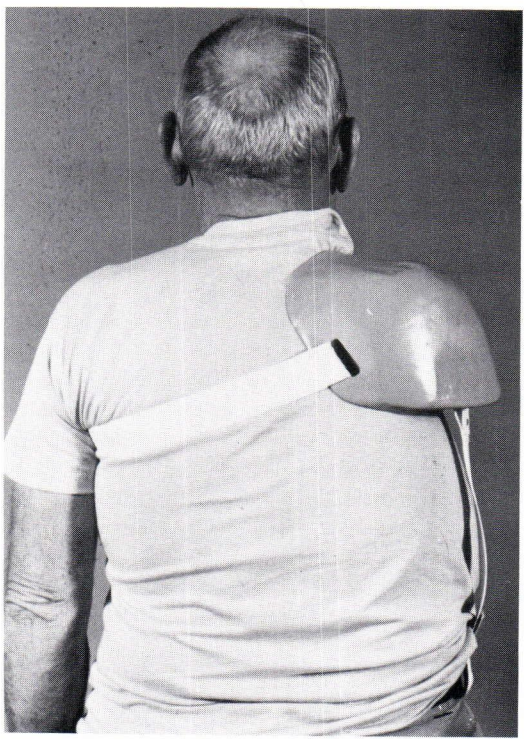

Figure 7. Posterior view of the patient wearing the shoulder prosthesis.

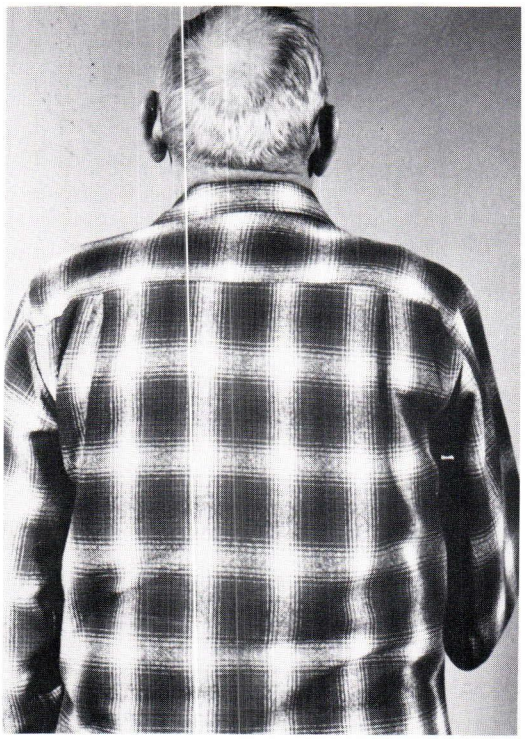

Figure 8. The patient, with the finished prosthesis under clothing.

the mold are put together). A mix of auto-polymerizing acrylic is prepared and applied to the border area left in the top half of the mold. A slight excess of acrylic is applied and both halves of the mold are reassembled and pressed together. The size of the mold prevents it from being placed in a conventional laboratory press, but large rubber bands can retain them after they have been pressed together with hand pressure.

After the acrylic has set, the prosthesis is recovered from the mold, flash trimmed both inside and out, and finished only with pumice on a polishing machine.

The prosthesis is retained by nylon straps with Velcro® fasteners. Slots for the chest strap are positioned slightly above the level of the opposite axilla. An additional strap from the inferior lateral aspect of the prosthesis to the patient's belt can act to prevent the prosthesis from riding up on the neck. Figure 6 shows the finished prosthesis while Figures 7 and 8 show a patient wearing the shoulder prosthesis. These prostheses can be painted to match skin tone or underclothing (which also hides any porosity), by using Krylon[6] enamel after first priming with Krylon primer (paint is quick drying and durable).

SUMMARY

A technique has been presented for the fabrication of an acrylic shoulder prosthesis. This technique not only achieves better contours than the cloth padding which has been used in the past, but is rigid, strong, and light in weight (entire prosthesis weighs less than a pound).

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[2]e.g., Dental Modeling Plaster; Whip-Mix Corp., Louisville, Kentucky 40217.

[3]e.g., NeoWax: Dentsply/York Division; York, Pennsylvania 17405.

[4]e.g., Modern Foil: Columbus Dental; St. Louis, Missouri 63188.

[5]e.g., Repair Material: Dentsply/York Division; York, Pennsylvania 17405.

[6]Borden Ind., Columbus, Ohio.

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The opinions expressed herein are the personal views of the author and do not necessarily reflect the views of the United States Air Force.

Orthotics and Prosthetics, Vol. 40, No. 3, pp. 58–63.

Technical Note: The Use of Low Heat Thermoplastics in Vacuumforming

James W. Barnes, AA, BBA, C.O.
Audwin Darrell Harwell

INTRODUCTION

During the past few years, many new plastics have been introduced to the rehabilitation field, many of which have proven applications for the field of orthotics and prosthetics. The majority of interest by professionals in our fields has been directed first toward the types of rigid high temperature plastics, such as polypropylene, various types of co-polymers, orthoplene, Surlyn,® etc., used in definitive prescription items such as ankle foot and knee ankle foot orthoses, TLSO's, prosthetic check sockets, and similar devices. A lesser occasional interest has been directed towards a class of low temperature plastics used generally in temporary prescription items, such as those in the Orthoplast® and Warm and Form® categories.

The types of low temperature plastics in this second category have another application that has been used to some extent by our fellow professionals in occupational therapy. Many of these plastics lend themselves to low heat forming in the adaptation of many items used by the severely handicapped in an attempt to restore as many of the independent living skills to the patient as possible. This technique has limitations, and the end results are sometimes affected by a lack of technology and equipment available in patient care environments.

DISCUSSION

Due to our in-house facility caseload, we were faced with the problem of designing and fabricating many orthotic and prosthetic devices in the laboratory without devoting a disproportionate amount of time to each item. To solve this problem, it was discovered that by using a modified vacuum forming technique and low temperature plastics, there existed a quick, efficient method of adapting such devices as

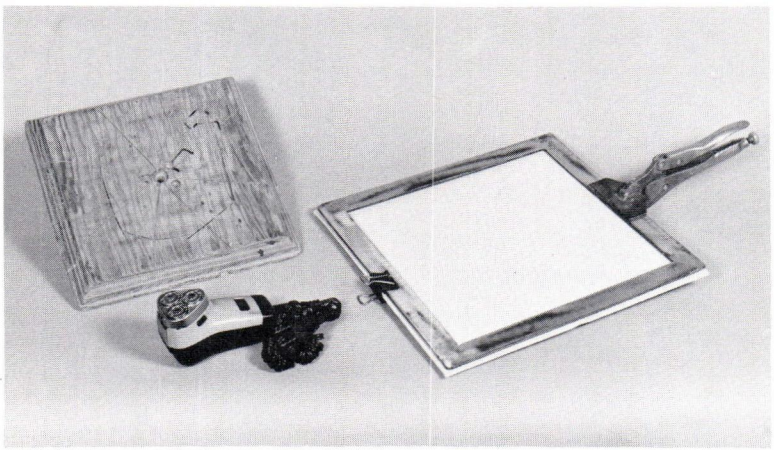


Figure 1. (left) Forming table, metal frame, Polyform.®

Figure 2. (right) Preparation of razor and vacuum table.

electric and manual razors, large handles on self care items, electric toothbrushes, blow dryers, larger kitchen utensils, extended hand reachers, writing devices, and molds of the hand and fingers.

METHOD

We currently use the Orthomedics* vacuum forming system, with the only necessary change being a specially constructed frame and worktable that attaches to the system. These can be specially ordered or fabricated in any laboratory. A much smaller size table is easier to work with and is more economical, especially with the cost of these plastics being much higher per square foot than those of the high temperature plastics commonly used in orthotic and prosthetic facilities.

For instructional purposes only, the example for this article will be an electric razor, and the plastic used will be ⅛ inch non-perforated Polyform, A-292-1,® available from Rolyan. Many other types of low temperature plastics are also adaptable to this method (Figure 1).

The item to be formed must be prepared by removing any parts that can be filled in with plastic, such as the blade slots, switches, or lights on this electric razor. If open holes lead to internal working parts, cover them with masking tape (tape can be removed after molding). Next you must remove all electrical cords and attachments, and make sure the item is clean. Support the item on the forming table with a small block of wood, felt, or other material that will ensure that most of the item to

*Orthomedics, Inc., 2950 E. Imperial Highway, Brea, California 92621.

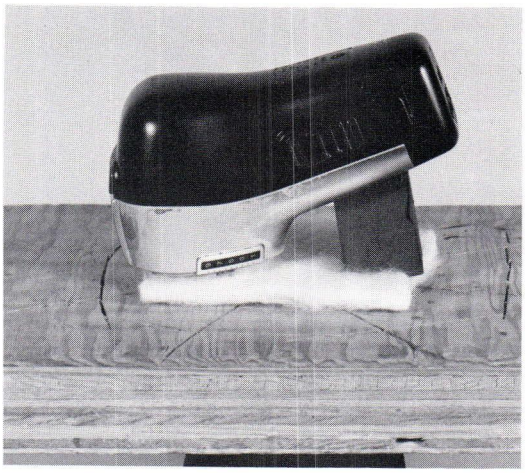
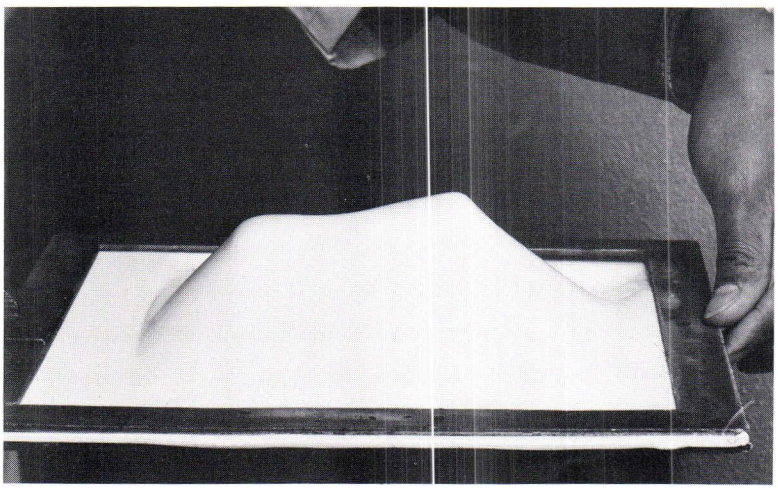


Figure 3. Razor mounted on vacuum table.

be formed is up and the area not to be formed is down on the vacuum table; place directly over the vacuum opening leading to the pump (Figure 2).

Prepare the vacuum table by cleaning it of all dust and debris. Then place a small piece of dacron felt or similar material over the vacuum hole to prevent plastic from clogging the opening (Figure 3). Adjust the vacuum pressure in the range of 10-15 pounds. Select the proper size frame for the item being formed (with smaller items a frame may not be needed). A ten inch frame is suitable for an item the size of an electric razor. Next, cut the Polyform® and

Figure 4. (right) Polyform® draped over razor.



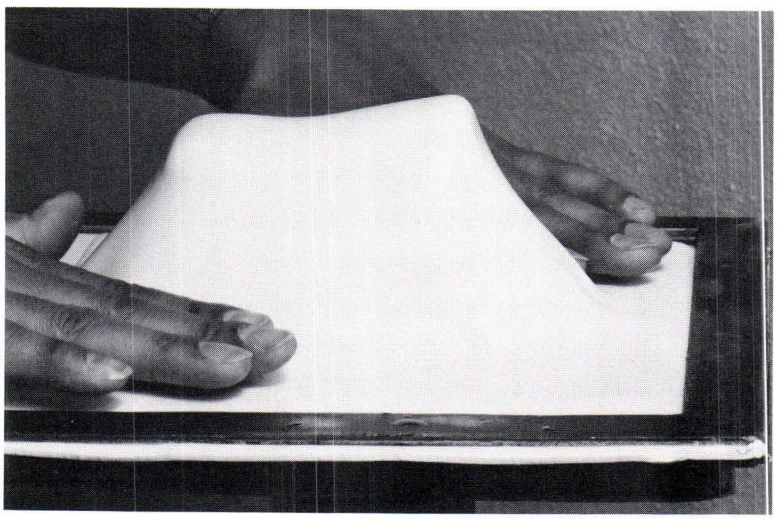


Figure 5. (left) Vacuum incorporated over table.

clamp in the frame with spring clamps (as the plastic heats, the clamps are needed to keep constant pressure on the frame). The plastic can be held by hand after heating, if necessary. The time needed to reach working temperature is about 60 seconds. After the plastic is heated to working temperature, remove the frame from the heat source (e.g., hydrocollator), and form over the item, ensuring a good seal. If the vacuum is too high or the plastic is stretched too much, punctures can be sealed easily before loss of an integral fit or working time.

It is important to use a source of moist heat, as dry heat from a heat gun or oven tends to cause the plastic to stick to the item being molded. Dip the plastic in the hydrocollator at 160 degrees until the plastic begins to sag (approximately 60 seconds). Remove the plastic, and place over the item to be formed, allowing the plastic to sag approximately ¼ inch above the table and completely around the item (Figure 4). The plastic can be pushed down by hand, but care should be taken not to leave fingerprints on the mold or punch holes in the plastic. Turn the vacuum on after the plastic stops sagging (Figures 5 & 6). Vacuum pressure can be turned off after two minutes, and the plastic should cool completely before removing the negative plastic im-

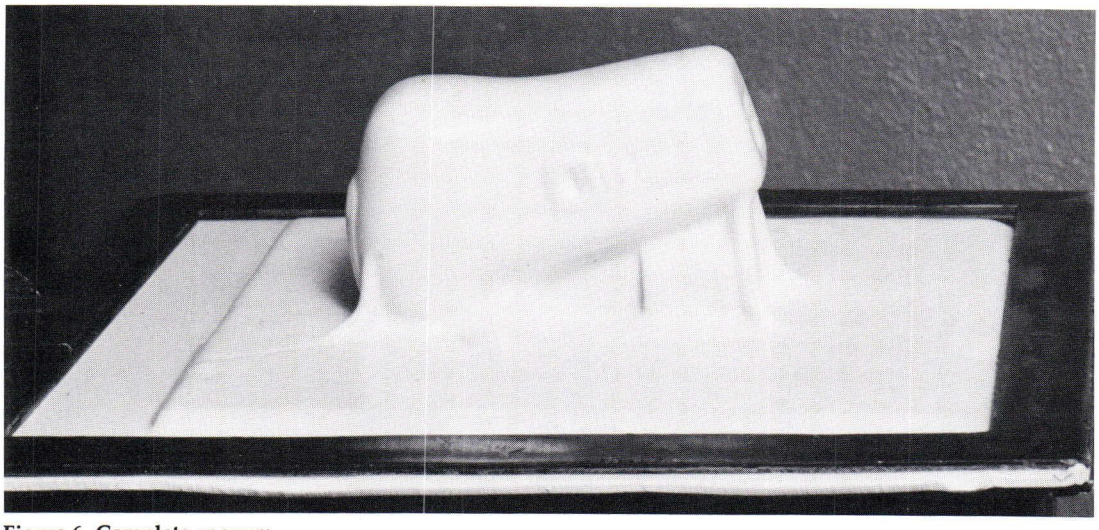


Figure 6. Complete vacuum.

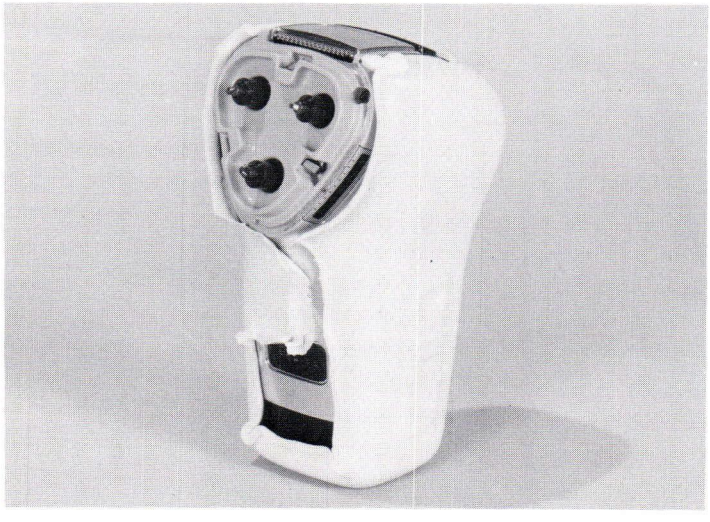


Figure 7. (left) Rough trim lines.

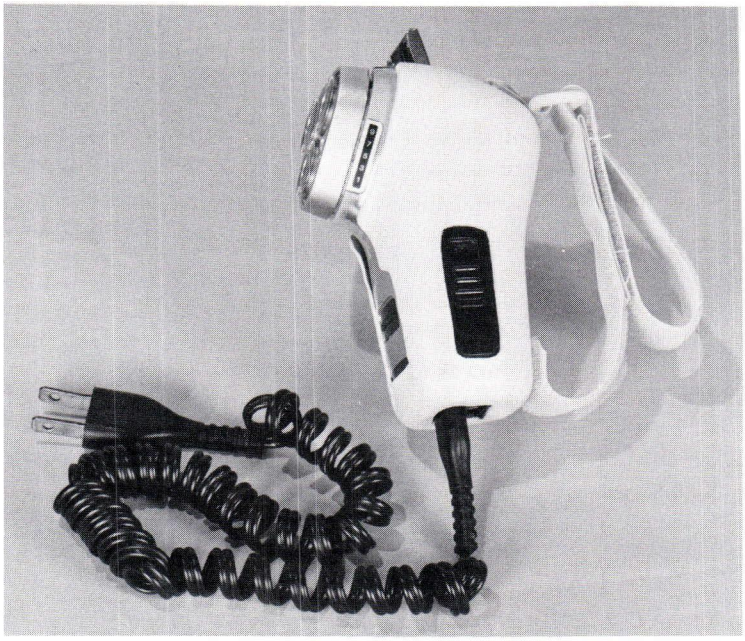


Figure 8. (left) Finished trim lines.

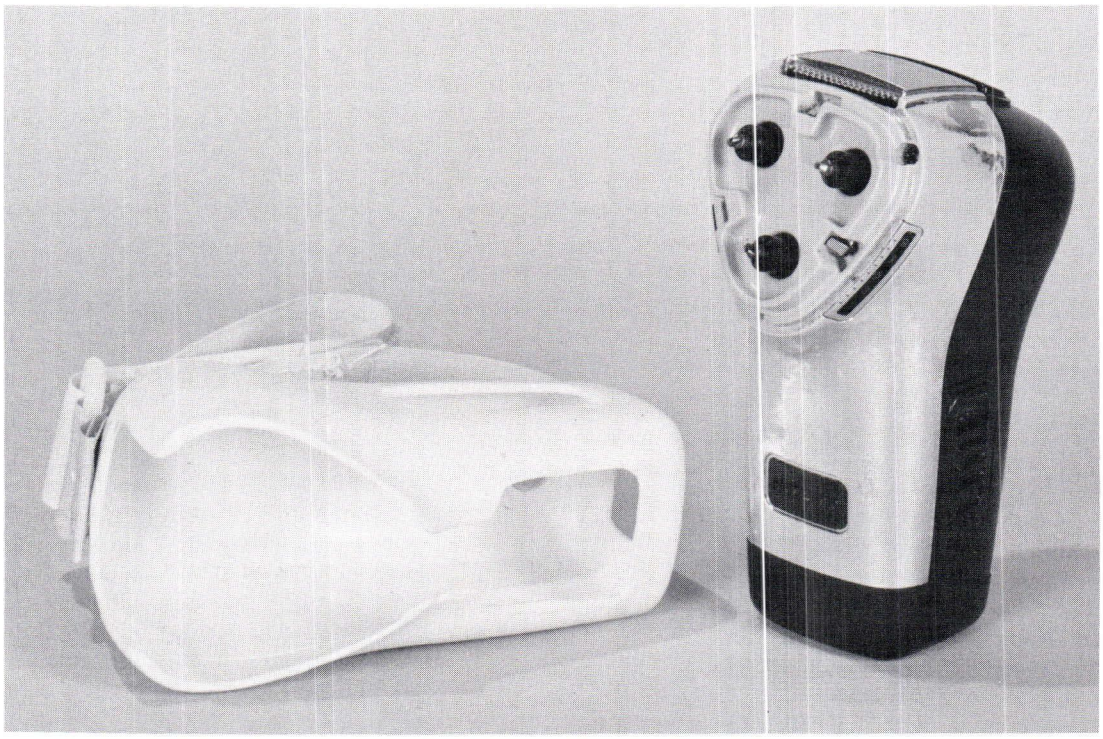


Figure 9. Completed razor holder.

pression from the item. Quick cooling can be achieved by cool water or air gun. Open the molded plastic just enough to remove the item (Figure 7), and trim the plastic, leaving as much material as possible for a more secure fit. Attach any Velcro® straps with small speedy rivets, ensuring that all interior surfaces are flush and non-invasive on the molded item (Figure 8). Wrist supports can be incorporated during the vacuum forming process, or attached later if needed (Figure 9).

CONCLUSION

This method is quick, efficient, and highly cosmetic for the patient. In addition, due to the higher technology available in orthotic and prosthetic laboratories, it should prove very useful to those practices involved in serving the severely disabled.

AUTHORS

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BOOK REVIEWS

Charles H. Pritham, C.P.O.

Understanding and Using Your Myoelectric Prosthesis, R.N. Scott, R.R. Caldwell, E.R. Sanderson, and Z. Wedderburn, Bio-Engineering Institute, University of New Brunswick, P.O. Box 4400, Fredericktown, New Brunswick, Canada. E3B-5A3.

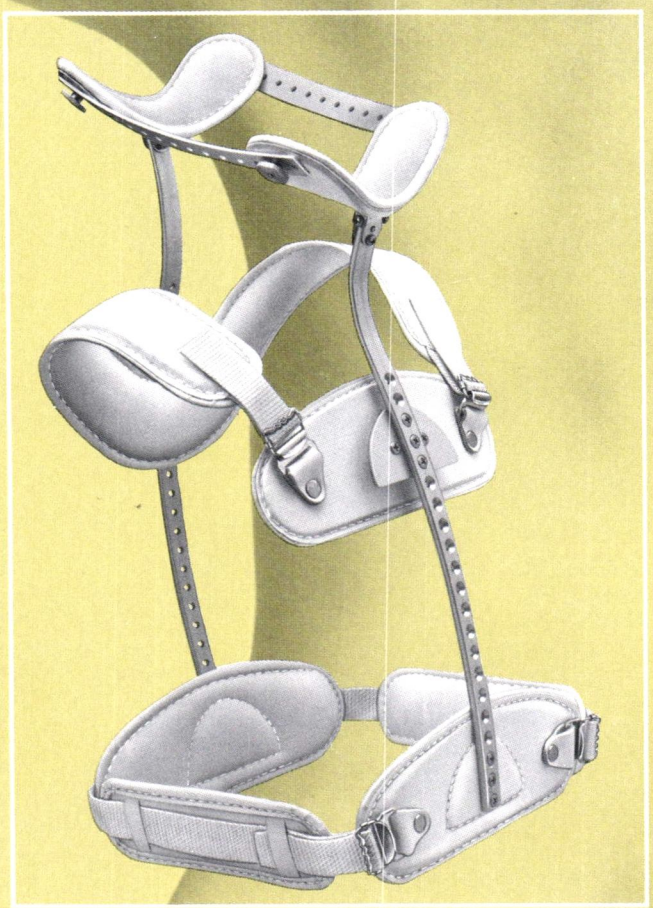
This brief monograph is written as a guide to the patient (child or adult) and his family. As such it is simply and clearly written with a minimum of technical jargon. Where technical terminology is used, it is printed in bold face, and there is a glossary in the back of the booklet.

A review of the Table of Contents summarizes the material covered:

—Basics (description of myoelectric prostheses including theory, advantages, and disadvantages)
—The Prosthetics Team
—Fitting the Myoelectric Prosthesis
—Learning to use the Myoelectric Prosthesis
—Care of your Myoelectric Prosthesis
—Problem solving: When to seek help
—Glossary

This monograph is well thought out and carefully prepared. While avoiding a lot of extraneous detail, it provides a patient with the basic facts to be considered concerning a myoelectric prosthesis (concentrating on BE's). As such it fulfills a useful function.

Charles H. Pritham, C.P.O.



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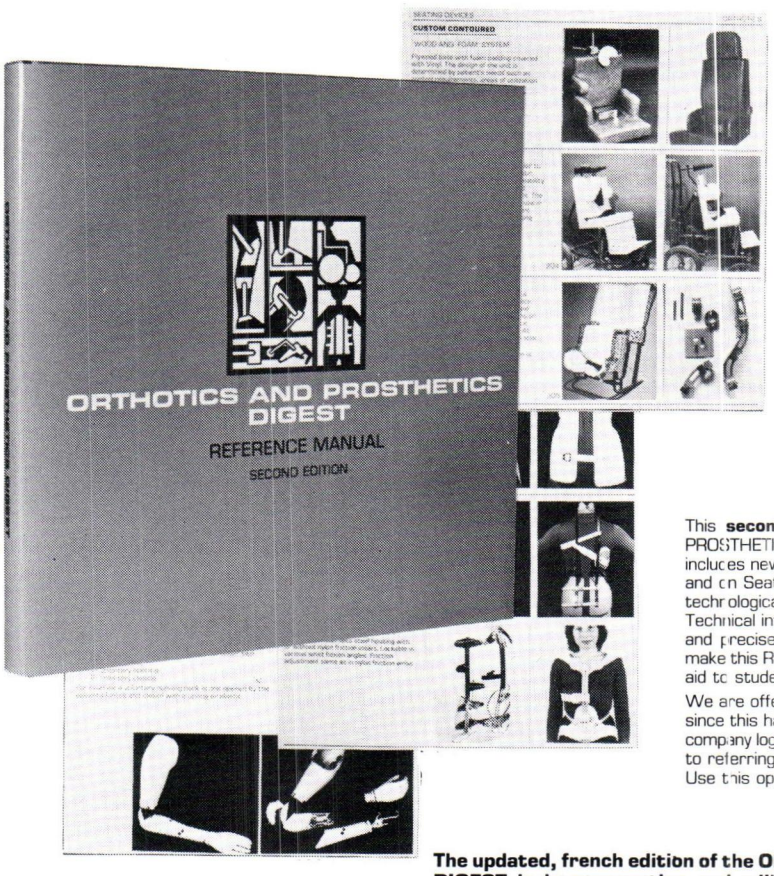

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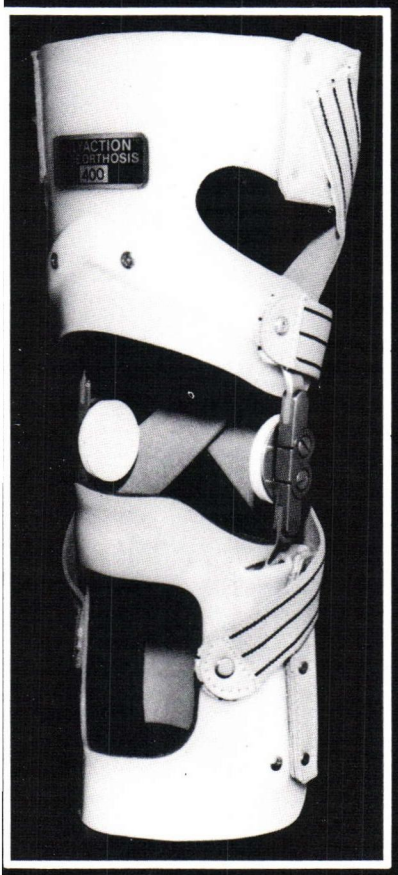

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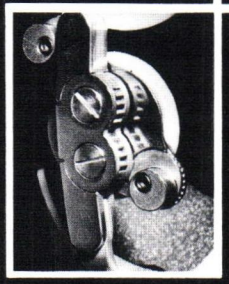

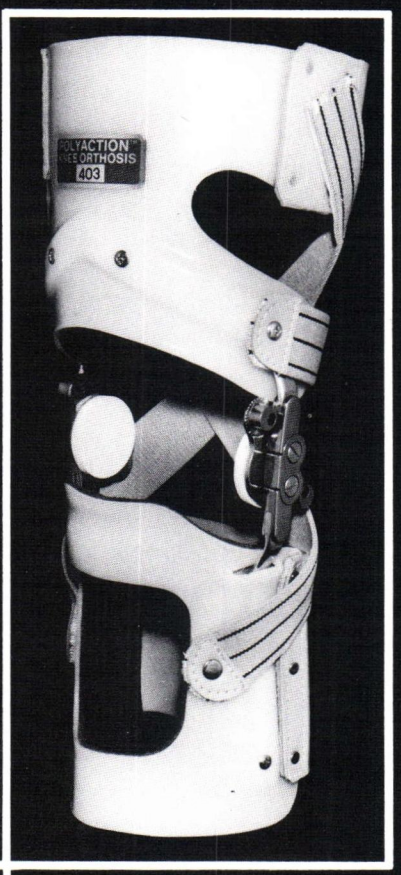

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CPO—or approaching Board Eligibility: Immediate opportunity available in a progressive firm located in Salt Lake City. Professional environment and future advancement potential. Excellent company benefits and working conditions in a modern facility. Send resume and salary requirements:

Earl V. Shields, CPO
Shields Orthotic Prosthetic Services, Inc.
1027 East 2100 South
Salt Lake City, UT 84106

Orthotic Technician experienced in evaluation, casting and fabrication of foot orthoses. Midwest facility works primarily with Sports Medicine. Reply to:

FOOT TECHNOLOGY, INC.
2012 S. Mission
P.O. Box 609
Mt. Pleasant, MI 48858

PROSTHETIC-ORTHOTIC TECHNICIAN

Full or part time position available for individual experienced in plastic O&P fabrication. NYC Area. Contact:

TMR Orthotic & Prosthetic Services
24-18 Ditmars Boulevard
Astoria, NY 11105
(718) 726-8477

METAL LONG LEG BRACE LEATHERING

Send me your LLMB with thigh & calf measurements, & I'll send it back COD, tastefully leathered in 7-10 days. I use only top grade Smoked Elk, Cream Cow & Wool felt, *ALL NATURAL!* 15 yrs. custom leather working exp. Thigh corset $85, Calf cuff $35, Knee pad $25. For Quality & Efficiency, send brace to Brennan's Shoes, 34 Defreest Avenue, Troy, NY 12180; call (518) 794-8104.

Immediate opening in Progressive Pediatric Orthopaedic Facility.

Asst. Director—CO or CPO with knowledge of pediatric orthotics and love of children a *MUST.* Management experience helpful; or
Staff Orthotist—CO or Board Eligible with good experience. Good salary and benefits.

Contact: Lou Ekus, CPO—Director, Shriners Hospital for Crippled Children, 516 Carew Street, Springfield, MA 01104; (413) 787-2078.

PROSTHETIST—Need CP or CPO for a hospital owned affiliate orthotic/prosthetic facility. Individual will assume full responsibility for prosthetic services. Accept a challenge and join our professionals at El Paso's finest medical facility. Please send resume or call: PROVIDENCE MEMORIAL HOSPITAL, Human Resources Department, 2001 N. Oregon, El Paso, TX 79902; phone (915) 542-6662.

Orthotist, Certified or Board Eligible—Good salary and benefits, permanent position, requires some experience in bracing scoliosis and post operative spinal fusion. Contact: Isadore Zamosky, Inc., 608 S. Main Street, Spring Valley, NY 10977; (914) 352-2148 or 352-2397.

MICHIGAN

CO for well established modern O&P Facility with two Satellite Offices. Excellent opportunity for professional Orthotist. Live and work in Beautiful Traverse City. All replies held in strict confidence. Send resume and Salary requirements to:

Ed Teter, CP
Teter Orthotics & Prosthetics, Inc.
3507 W. Front Street
Traverse City, MI 49684
(616) 947-5701

DIRECTOR, ORTHOTICS–PROSTHETICS

The Rehabilitation Institute of Chicago, a private, non-profit health institution concerned with the total rehabilitation of physically disabled persons, is seeking a Director of Orthotics - Prosthetics. The individual must be a certified Prosthetist or Orthotist with five years of progressive experience in a hospital or rehabilitation center. A Bachelor's Degree and supervisory experience are required.

The Director is responsible for planning, implementing, and evaluating prosthetic and orthotic services at the Institute, and managing an operating and capital budget for the department. The position is also responsible for hiring and supervising a staff of nine professional and technical staff members.

The Institute is a member of the McGaw Medical Center of Northwestern University and is a federally designated medical rehabilitation research and training center for brain trauma and stroke patients.

Interested candidates should submit a letter of application, resume and 2 letters of reference to: **Sharon Tuzik, Senior Personnel Representative, Rehabilitation Institute of Chicago, 345 E. Superior Street, Chicago, IL 60611. (312) 908-7016.**

Rehabilitation Institute of Chicago
Equal Opportunity Employer

CO/CP/CPO

Would you like to own your own business in San Diego? We will help you develop your own practice to complement ours, using our facility. Draw from our physician referrals. Respond to AOPA Box 98603, 717 Pendleton Street, Alexandria, VA 22314.

PROSTHETISTS AND ORTHOTISTS

(certified or board eligible)

J.E. HANGER, INC. has experienced excellent growth in both its **Washington, D.C.** and **Philadelphia, Pa.** offices opening up positions for qualified practitioners. We are a highly successful and well known corporation with 125 years of experience and can offer outstanding advancement opportunities. Relocation assistance, excellent fringe benefits including retirement plan, car allowance, and continuing education are all part of the package.

If you are qualified, there is an outstanding opportunity to join a progressive team and grow with a leader in the profession.

For further information contact:

J.M. Cestaro, CPO
c/o Washington Prosthetic Supplies
(a division of J.E. Hanger, Inc.)
40 Patterson Street, N.E.
Washington, D.C. 20002
tel. (202) 789-0052

CPO

Immediate opening for experienced practitioner in a progressive modern facility located in the South Shore of Boston and easily accessible to all seasonal activities from Cape Cod to New Hampshire. Benefits, salary commensurate with experience and background. Send resumes to: Bay Orthopedic Services, Inc., 790 West Chestnut Street, Brockton, MA 02401; (617) 586-7700.

MINERVA CERVICAL BRACE

Minerva Cast—Historical Perspective
Minerva casts have been used for years to immobilize the cervical spine. While providing excellent immobilization, the cast was hot, heavy and uncomfortable.

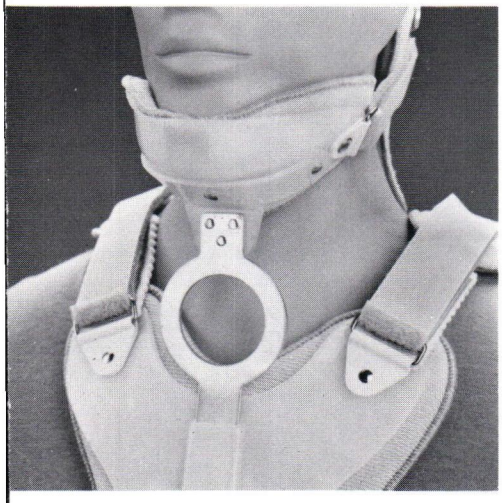
Comfortable Immobilization
The Minerva Cervical Brace weighs a scant 33 ounces and encompasses the occiput, mandible, upper thorax and forehead.

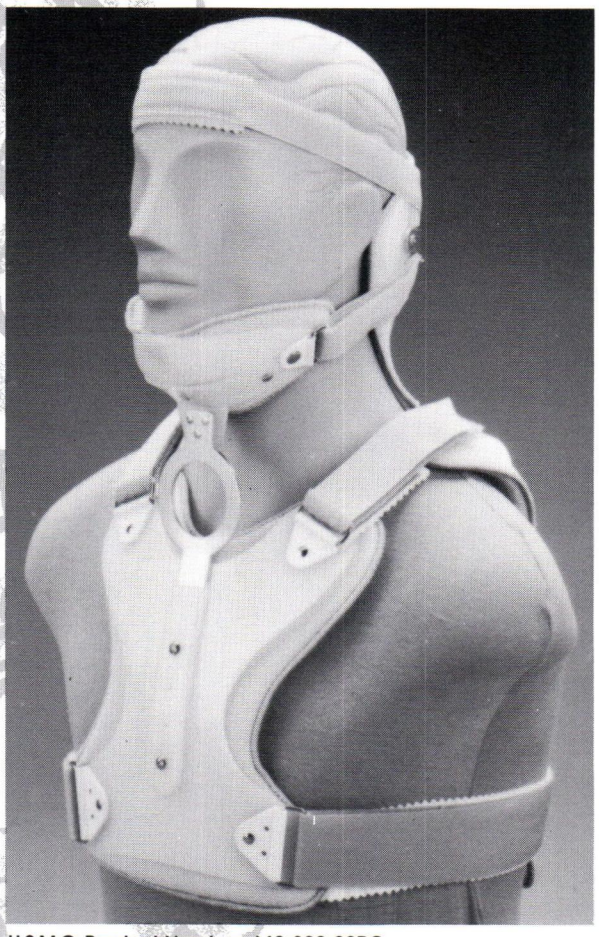
Soft velour is used as an interface between body jacket and skin. The open cell foam liner allows the jacket to "breathe" and remain cool against the patient's skin. The brace may thus be worn for extended periods of time with little discomfort.

All velour material is attached to the polyethylene superstructure with Velcro® for easy removal when fitting or cleaning the brace.

Easy Application and Fitting
The Minerva Cervical Brace consists of a pre-fabricated, flexible polyethylene body jacket with reinforced aluminum anterior and posterior uprights. For easy fitting, and to correctly unload the spine, overall height adjustment points may be quickly set according to prescribed treatment. The body jacket is easily contoured to patient anatomy and firmly attached with an "over the shoulder" suspension strap system.

Indications
The Minerva Cervical Brace immobilizes the cervical spine from C1 to T1 and may be used post-surgically including post-halo applications for severe cervical lesions. A circumferential head band provides additional control of flexion, extension and rotation.





U.S.M.C. Product Number: A19-300-00RG

Features

- **Lightweight**—33 ounces complete
- **Comfortable**—Velour-covered, open-cell liner "breathes" for patient comfort even during long periods of rehabilitation.
- **Easy to Adjust and Fit**—one size for all adult patients.
- **Compatible with Tracheotomy Procedures**—50 mm diameter aperture provided in anterior upright.
- **Circumferential Head Band**—increases control of flexion-extension-rotation and maintains immobility when mandibular plate is removed.

USMC™

United States Manufacturing Company
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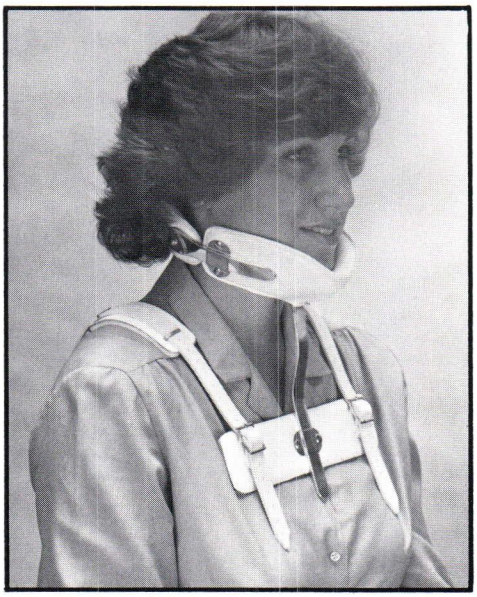
Pasadena, California 91107 U.S.A. (818) 796-0477
Cable: LIMBRACE, TWX No.: 910-588-1973, Telex: 466-302

C.D. Denison

Two Poster Cervical Collar

The **C.D. DENISON TWO POSTER CERVICAL COLLAR** was originally designed as a post-cervical fusion orthosis.

The basic design features rigid mandibular-occipital pad connectors with safety latches. This innovation permits a more positive control of the head and cervical spine than is provided with flexible-strap type connectors.



Time has proven the value of the **C.D. DENISON TWO POSTER CERVICAL COLLAR,** not only as a post-operation support, but also in non-surgical application, when a more positive positioning control is desirable.

The **C.D. DENISON TWO POSTER CERVICAL COLLAR** with thoracic extension possesses all the qualities of the basic Two Poster. In addition, it provides an even greater stabilizing support of the cervical and upper thoracic spine.

C.D. Denison Orthopaedic Appliance Corp.

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The **C.D. Denison Two Poster Cervical Collar** is available through your local orthotist on request.

Prosthetic Socks Since 1923 By KNIT-RITE And Now...

The KNIT-RITE

STUMP SHRINKERS™

Taper Knit, Full Fashion Stock Sizes and Made to Measure

The full fashion, taper knit, construction insures proportion fit and compression, with greater pressure distally. Use of core construction yarn results in a softer fabric, better fit and permits stretch over the compression range. The Knit-Rite Stump Shrinker better accommodates irregularities and may be tailored or altered to meet special fitting problems.

*Double Taper***

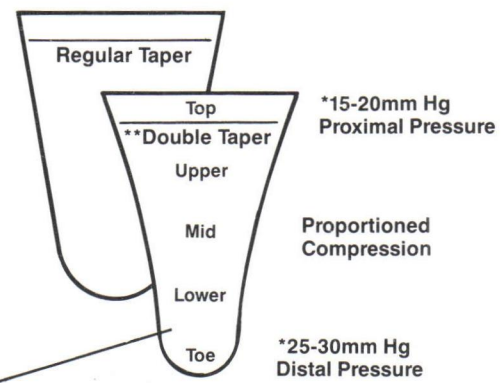
Fashion knit with gradual taper distally, flaring to a wide top. The mid-point flat width of the "Double Taper" model is slightly less than the corresponding mid-point flat width of the regular taper model.

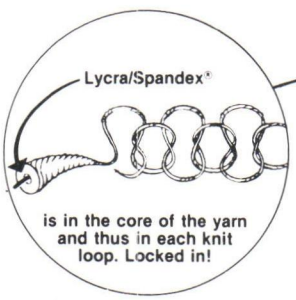
Unique Construction

Made from Avril rayon Lycra®/ spandex core yarn. Softer, more comfortable, easy to put on, and may be machine washed and dried, (warm temperature, no bleach).

*Compression when fitted according to directions for heavy compression stump shrinkers. Direct pressure reading on CDC 250 instrument calibrated to a manometer. Bladder type measuring devices may read as much as 15-20mm Hg higher, for the same pressure, due to distension of the elastic fibers over the bulge of the bladder.

Heavy Compression (green top) 25-30mm Hg at 50% stretch
Medium Compression (gray top) 10-15mm Hg at 50% stretch
CAUTION: Compression proximally should not be greater than compression distally.





Rounded Shape and Elastic to the Very End Assures Compression and Better Control Distally

Specify the KNIT-RITE Stump Shrinker™ and Companion Products

- **SUPER-SOCK®** 100% fine virgin wool, easy care prosthetic sock resists shrinkage and felting. Consistent through its life.
- **PP/L SOFT-SOCK®** made from Polypropylene/Lycra®. Dry because it wicks moisture. May be worn as a liner, filler, or spacer.
- **PROSTHETIC and ORTHOTIC SOCKS** in other fibers include Super-Sock®, "Old-Style" wool, Orlon/Lycra®, polypropylene/Lycra®, cotton, silkolene.

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