SEPTEMBER 1974

Orthotics and Prosthetics

ERRATUM

To Amputee Survey, 1973-74: Preliminary Findings and Comparisons, *Orthotics and Prosthetics*, June 1974, the following correction should be made:

Beginning with line 2, page 30, the text should read as follows:

> Glattly's 40.5 percent. In females, amputations because of trauma show a decline from Glattly's 14.3 per cent to the current rate of 9.4 percent.

Orthotics and Prosthetics

VOLUME 28, NO. 3 SEPTEMBER 1974

Orthotics and Prosthetics is issued in March, June, September and December. Subscription price, payable in advance, is $10.00 a year in the Western Hemisphere. Rate elsewhere is $11.00 a year. Single issues, $3.00 each. Publication does not constitute official endorsement of opinions presented in articles. The Journal is the official organ of the publisher, The American Orthotic and Prosthetic Association in collaboration with the American Academy of Orthotists and Prosthetists, and serves as the U.S. organ for Interbor. All correspondence should be addressed to: Editor: **Orthotics and Prosthetics,** 1440 N St., N.W., Washington, D.C. 20005. Telephone, Area Code 202, 234-8400.

Orthotics and Prosthetics is indexed by Current Contents/ Clinical Practice.

INTERBOR

(US ISSN 0030-5928)

CONTENTS

Index to Advertisers

Advertisers shown in bold-face type are members of
The American Orthotic & Prosthetic Association.

THE AMERICAN ORTHOTIC AND PROSTHETIC ASSOCIATION

OFFICERS

President—**Robert V. Bush,** C.P.O.
Albuquerque, New Mexico

President-Elect—**Ralph R. (Ronney) Snell** C.P., Memphis, Tennessee
Vice-President—**Howard R. Thranhardt,** C.P., Atlanta, Georgia
Secretary-Treasurer—**Daniel G. Rowe,** C.P.O., St. Paul, Minnesota
Immediate-Past President—**Claude J. Lambert,** C.P.O., New Orleans, Louisiana

REGIONAL DIRECTORS

Region I—**Michael M. Amrich,** C.P.
Needham, Massachusetts
Region II—**Kurt Marschall,** C.P.
Syracuse, New York
Region III—**J. Donald Coggins,** C.P.
Berwyn, Pennsylvania
Region IV—**William Heath Harvey,** C.P.O.
Columbus, Georgia
Region V—**Eugene Filippis,** C.P.
Detroit, Michigan
Region VI—**Clyde E. Peach,** C.O.
Indianapolis, Indiana
Region VII—**Robert A. Brown,** C.P.
Minneapolis, Minnesota
Region VIII—**George E. Snell,** C.P.O.
Little Rock, Arkansas
Region IX—**Donald F. Colwell,** C.P.
Downey, California
Region X—**Walter M. Joslin,** C.P.O.
Albuquerque, New Mexico
Region XI—**Loren R. Ceder,** C.P.O.
Tacoma, Washington

THE AMERICAN BOARD FOR CERTIFICATION IN ORTHOTICS AND PROSTHETICS, INC.

President—**Robert F. Hayes,** C.P.
W. Springfield, Massachusetts

President-Elect—**William B. Smith,** C.O., Kansas City, Missouri
Vice President—**Wade Barghausen,** C.P., Columbus, Ohio
Secretary-Treasurer—**Loren R. Ceder,** C.P.O., Tacoma, Washington
Immediate-Past President—**Donald F. Colwell, Sr.,** C.P., Panorama City, California

DIRECTORS

Fred L. Hampton, C.P.
Miami, Florida
Paul R. Meyer, Jr., M.D.
Chicago, Illinois
Joseph H. Zettl, C.P.
Seattle, Washington
Robert E. Tooms, M.D.
Memphis, Tennessee
Robert L. Romano, M.D.
Seattle, Washington

THE AMERICAN ACADEMY OF ORTHOTISTS AND PROSTHETISTS

President—**Henry F. Gardner,** C.P.O.
New York City, New York

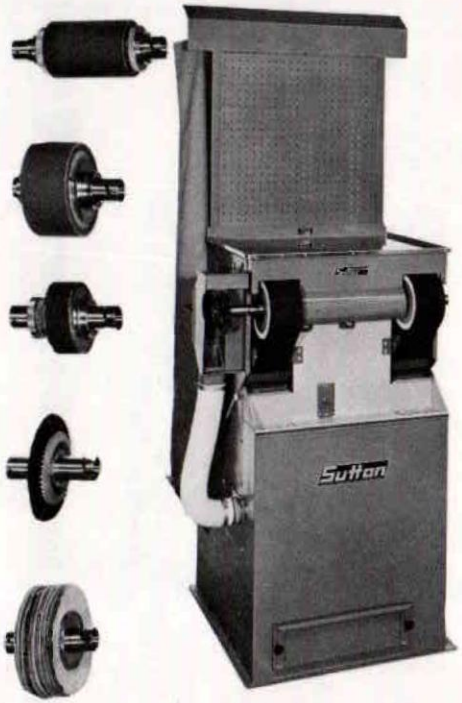
President-Elect—**Richard D. Koch,** C.O., Ann Arbor, Michigan
Vice President—**Joseph M. Cestaro,** C.P.O., Washington, D.C.
Secretary-Treasurer—**Thorkild Engen,** C.O., Houston, Texas
Immediate-Past President—**Arthur W. Guilford, Jr.,** C.P., Downey, California

DIRECTORS

H. Blair Hanger, C.P.
Chicago, Illinois
Howard E. Thranhardt, C.P.
Orlando, Florida

NATIONAL OFFICE

David A.H. Roethel, Executive Director



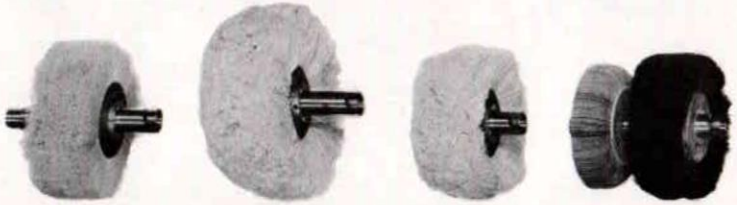
Sutton's SJ/4 Jack Sander . . .
YOU'LL HAVE AN ATTACHMENT FOR IT!

Or maybe 23 optional attachments. Sutton is an old pro at making jack sanders. They know what limb & brace makers want and need, and you can get it all in the SJ/4. Two 4″ x 60″ fast cutting, quick-change belts; a great dust collector; front-opening dust drawer; 1½ hp motor; big shelf. Use full belt width for faster leveling. Three other models available. Write today!

Sure we take trades

Financing may be arranged

MADE IN USA



Sutton Shoe Machinery Co.

P. O. BOX 9940 • ST. LOUIS, MO. 63122 • (314) 225-5255

☐ Send dope on SJ/4 and other jack sanders

☐ Send complete Sutton catalog

Name_____

Shop_____

Address_____

City_____ State_____ Zip_____

Telephone_____

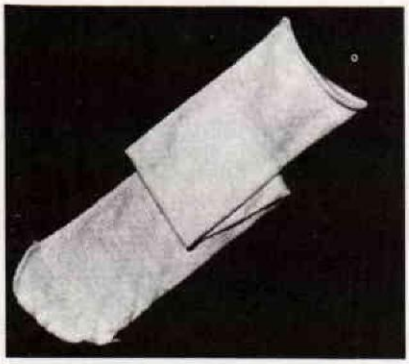
KNIT-RITE MEETS YOUR NEEDS

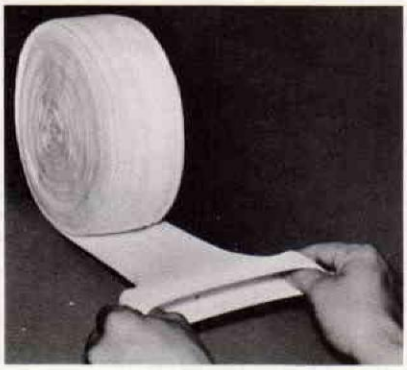
STYLE 7395
GARTER LENGTH UNDERHOSE

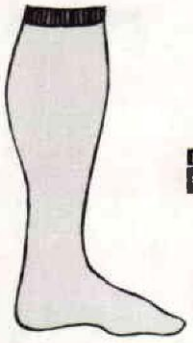
Ideal for B/K endoskeletal prosthesis Seamless 100% Stretch nylon, dusk flesh color.

2H-7395-LG Large, 10½-12

2H-7395-KG King size, 12-13







STYLE 7390
LADIES' COSMETIC UNDERHOSE

SEAMLESS 100% STRETCH NYLON DUSK FLESH COLOR
SUGGESTED RETAIL 3.95 PER PAIR
BOX OF 3 PAIR 3.75 PER PAIR

PRODUCT CODE Sect. / Catalog No. / Color Size	
2H-7390-SM	Small, 8½-9½
2H-7390-MD	Medium, 9½-10½
2H-7390-LG	Large, 10½-11½
2H-7390-XL	Extra Large, 11½-12½
2H-7390-LL	Extra Large, Extra Long, 11½-12½

KNIT-RITE CAST SOCKS

Tubular knitted from natural cotton yarn.

Approximately three inches in width. Suitable for use in casting B/K Amputations. Stretch stitch seam at toe end. Extra length 36 inch cast sock for Symes. **These are not recommended for wearing.** Priced per dozen or per gross.

PRODUCT CODE Sect. / Catalog No. / Color Size	
6S-7927-BK	B/K Width, about 24 inches long
6S-7927-BX	B/K Width, about 36 inches long

STRETCH NYLON STOCKINETTE

Flat knit construction (no ribs). Recommended for final layer(s) in layup for lamination of orthotic and prosthetic devices. Eliminates pronounced ribbed effect created when rib knit stockinette is used.

A SUGGESTION FOR USE: Before pulling over the article to be laminated, roll the stockinette two or three turns. This will help to reduce runs. A disadvantage of flat knit construction is a greater tendency to run as compared to the rib knit type construction. Also note that the tendency for running is slightly less from one end of the stockinette than from the opposite end.

PRODUCT CODE Sect. / Catalog No. / Color Size	Width	Approx. Circumference Range
6S-7500-03	3 inch width	6 inch to 16 inches

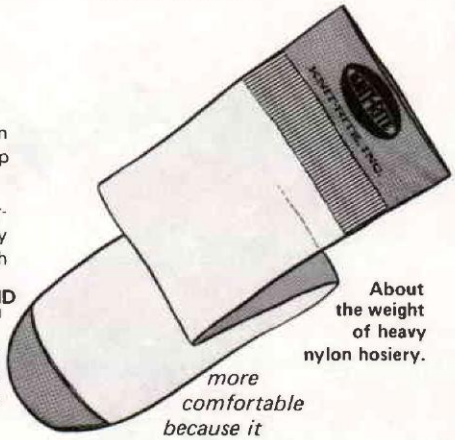
PROSTHETIC SHEATH

A sheath type prosthetic stump hose especially knitted for amputee wear. Worn next to the stump, friction will tend to be absorbed between the sheath and stump sock.

A quality, serviceable product, companion item to the Style 7390 Cosmetic Underhose. Many prosthetic facilities routinely provide a pair of underhose when they deliver a ladies prosthesis. We suggest this for the Prosthetic Sheath as well, for both men and women.

PRODUCT CODE Sect. / Catalog No. / Color Size	**2HP-BK1-SH** B/K Sz No. 1 Short	**2HP-BK1-MD** B/K Sz No. 1 Medium	**2HP-BK1-LG** B/K Sz No. 1 Long	**2HP-AK1-MD** A/K Sz No. 1 Medium
Fit Lengths:	10" to 14"	16" to 20"	22" to 26"	14" to 18"
Top Circumferences:	12" to 20"	12" to 20"	12" to 20"	16" to 24"
Toe Circumferences:	7" to 12"	7" to 12"	7" to 12"	9" to 14"

B/K sizes may be worn on small A/K Stumps



About the weight of heavy nylon hosiery.

more comfortable because it

S-T-R-E-T-C-H-E-S

KNIT-RITE, INC.
1121 GRAND AVENUE, K. C., MO. 64106
PHONE: 816-221-0206

Freeman 4-Star service

Built on the Principle That a Late Shipment Benefits No One

Model 512
Dorso-Lumbar
Support for Women

Model 521
Sacro-Lumbar
Support for Men

Freeman operates four warehouses strategically placed throughout the United States. When a dealer needs merchandise he calls the nearest Freeman warehouse (toll free) and his order is on its way in 24 hours, or less. Transportation costs are less, dealers need not carry large inventory, free order service, on time delivery...all part of Freeman's 4-Star Service.

Above all else are the finest surgical support garments... over 80 years experience reflected in every Freeman product.

Write for details. There are Freeman dealerships available in selected areas.

FREEMAN WAREHOUSES:

Ephrata, Pennsylvania *17522, P.O. Box 277, phone 717-733-4261*
Sturgis, Michigan *49091, P.O. Box J, phone 616-651-2371*
Anniston, Alabama *36201, P.O. Box 1791, phone 205-237-0611*
West Covina, California *91790, 1148 E. Garvey, phone 213-338-1618*

freeman

FREEMAN MFG. CO.
Box J, Sturgis, Mich. 49091

Orthotics and Prosthetics, Vol. 28, No. 3, p. 1, September 1974

WORDS

In Lewis Carroll's classic *Through the Looking Glass,* Humpty Dumpty remarked "When I use a word, it means just what I choose it to mean—neither more nor less." This approach doubtless has its uses but clarity of communication is not one of them. And in a world of increasing complexity clear communication is becoming progressively essential.

Through the years much has been written concerning the value of effective communication and indeed the need for this commodity seems self-evident. Nevertheless, because the meaning of the spoken or written word so frequently and so obviously fails to come through, it is apparent that we should constantly remind ourselves of the need for efficiency in communication.

Glenn Jackson, a long-time Executive Director of AOPA, recognized this need years ago and made every effort to ensure that in meetings, conferences, and similar occasions, people talked to one another in language that each understood, whether the problems under consideration were technical or administrative.

For many years one of the most glaring communications problems among practitioners in prosthetics and orthotics, and extending from them to others involved in these fields, such as employees in government bureaus, has been the names given to various types of braces (?), splints (?), orthoses (?), assistive devices (?), prostheses (?), artificial limbs (?). There was no agreement even on the names to be given to the general classes, much less to the subclasses and the divisions within the subclasses. In 1965, AOPA appointed a committee, the members of which were John Glancy, *Chairman,* William Bartels, Charles Fryer, Loren Jouett, Richard Lehneis, Kenneth Palm, Fred Eschen, Basil Peters, Ralph Storrs and LeRoy Wm. Nattress, Jr., to consider the problems of nomenclature in *orthotics,* a term that itself had only recently achieved general acceptance.

In 1965, the AOPA committee issued its report which was presented to the Committee on Prosthetics and Orthotics of the American Academy of Orthopaedic Surgeons for consideration and advice.

It so happened that at that particular time the AAOS committee had under consideration the possible revision of Volume 1 of the *Orthopaedic Appliances Atlas.* The committee was also trying to develop a method of relating patients' needs to available devices and found the AOPA committee's approach most helpful in that functional nomenclature was stressed rather than the commonly employed eponyms, i.e., identifying orthoses with the names of people or places.

This approach set in motion the idea that the problems of many of the patients might be analyzed biomechanically and expressed graphically. From this concept came the so-called Technical Analysis Forms and Procedures developed by Newton C. McCollough, III, of Miami, Florida. These forms and instructions for their use will be included in the revised *Atlas.*

In 1970, Herbert Warburton, Executive Director of AOPA, requested the assistance of the Committtee on Prosthetic-Orthotic Education (CPOE) in developing a system of "standardized" nomenclature in prosthetics and orthotics to meet the many needs of AOPA. CPOE responded by establishing the Task Force on Standardization of Prosthetic-Orthotic Terminology which held its first meeting in January 1971. Since then the task force has met periodically and has developed a system of nomenclature in orthotics which is becoming accepted rapidly, both in North America and abroad. On behalf of the task force, a preliminary report on the new orthotics nomenclature was prepared by E. E. Harris, Staff Surgeon of CPRD/CPOE, and was published in the June 1973 issue of *Orthotics and Prosthetics*. The mission of the task force in the area of orthotics is now essentially finished. A comprehensive report based on experience during the interim is in preparation and will be published in *Orthotics and Prosthetics* in the near future.

Although the problems of communication among people involved with amputees have not been as critical as was the case in orthotics, a number of recent developments offer promise of even more effective interchange, particularly at the international level:

- At an international workshop held in Dundee, Scotland, during the summer of 1973, agreement was reached on a system of nomenclature and classification for congenital limb deficiencies. A preliminary report on this new system was published in the June 1974 issue of *Orthotics and Prosthetics*.
- The Task Force on the Standardization of Prosthetic-Orthotic Terminology (CPRD/CPOE), at its two 1974 meetings, agreed to accept the nomenclature for the transverse category of congenital limb deficiencies to designate amputation levels in traumatic and surgical cases; and the prosthesis types for corresponding levels. A report describing these agreements has been written and will be published shortly.

So it seems that progress is being made. Perhaps we are approaching a point where if any of us use a word *everybody* will know what we mean. Even to approach this "golden age," however, it behooves us all to keep abreast of the rapidly unfolding developments in prosthetics and orthotics nomenclature.

"You cannot teach an old dog new tricks" may not be entirely true inasmuch as many of the senior members of the professions are using the new orthotics terminology without difficulty. However, it takes time and effort to change from the old familiar names, and we must expect the older terms to be used in daily practice by many of the older generation, but they should themselves encourage the newer generation to use the new language.

A. Bennett Wilson, Jr.

Orthotics and Prosthetics, Vol. 28, No. 3, pp. 3-7, September 1974

ADDING STRENGTH TO THE SYME PROSTHESIS

C. H. Dankmeyer, Jr., C.P.O.[1],
R. Doshi, Certified Prosthetist-Orthotist[1],
and C. R. Alban, Certified Prosthetics Assistant[1]

The contemporary prosthetist realizes the importance of durability in all phases of his practice.

The attachment point between the socket for a Syme amputation stump and the prosthetic foot has been the weakest link in Syme prostheses, and consequently there have been many techniques developed in an attempt to overcome this problem. Leather-socket, metal-frame Syme prostheses seemed to break with alarming regularity despite the large heavy bars used in their construction. Plastic Syme prostheses with SACH feet tend to break at the attachment between the socket and the foot. Of all the maintenance difficulties that confront a prosthetist, none probably causes more headaches than a Syme case in which the socket has separated from the foot. A Syme prosthesis in this condition requires a complete new fitting to effect repair, and therefore a new foot must be modified to the proper depth to prevent length discrepancy, after which the prosthesis must be aligned dynamically and refinished.

For the past two years, we have been using a finishing system on all Syme, Chopart, and long-below-knee prostheses which has virtually eliminated breakage of the prosthesis.

A standard socket lay-up is used, its thickness depending upon the prosthesis type—long-below knee, Syme, or Chopart, and the type of use—heavy, average, or light duty. Laminac 4110 modified by 5 percent Laminac 4134 polyester resin[2] is used in the socket fabrication.

The exact composition of the lay-up, which commonly consists of nylon stockinette with fiberglass cloth sandwiched between each nylon layer at the distal end of the socket, is determined by the use anticipated. Fiberglass roving is sometimes incorporated at the proposed trimline for the medial or posterior opening to provide additional strength at the corners of the window. The lay-up is laminated under 15 psi vacuum.

A SACH foot is carved out to the proper depth, and the socket is attached to the foot with two No. 6 wood screws, 1 in. long, through the socket and into the keel of the foot in order to maintain bench alignment. The commonly used adaptor and bolt are not used. A small amount of fast-setting epoxy resin (Ciba DP116 and Araldite 6020)[3] is placed between the socket and the foot to assist in maintaining the bond during dynamic alignment.

Once the prosthesis has been fitted, a mixture of slow-curing eposy resin (Ciba #502 Araldite and #951 Hardener)[3] and chopped glass cloth is packed between the socket and the SACH foot. It is important that this mixture completely fill the areas between the socket and foot and that no voids are left.

For the most part, the procedure described so far is very similar to fabrication techniques used

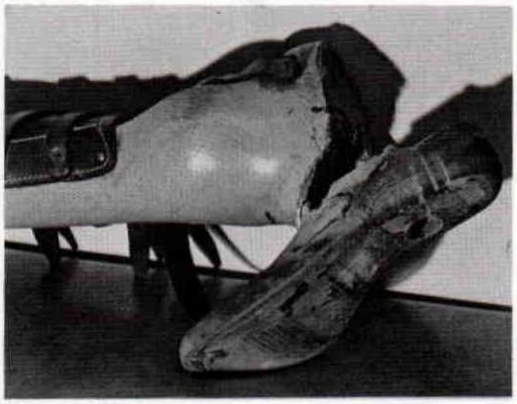


Fig. 1. Typical failure between socket and foot in posterior-opening Chopart prosthesis of standard construction.

[1] Dankmeyer, Inc., 2010-14 Maryland Avenue, Baltimore, Md. 21218.

[2] Available from Specialty Plastics, Baltimore, Md.

[3] Available from Ciba Products Corporation, Resins Department, Ardsley, New York.

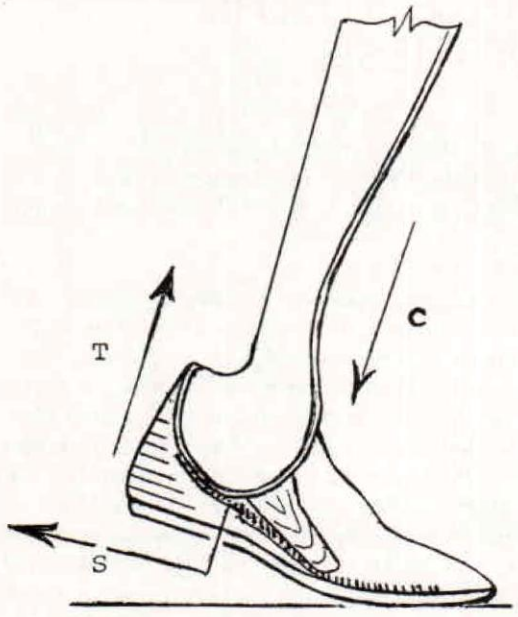


Fig. 2. Schematic diagram showing types of stress involved in Syme prosthesis during stance phase of walking. *T* - tension; *C* - compression; *S* - shear.

by most prosthetists. However, once the bonding resin has cured between the socket and the foot, the prosthesis is considered to be completed.

Figure 1 illustrates the Chopart prosthesis with a posterior opening that has failed at the junction of the socket and the SACH foot. This particular failure is typical in that the posterior tension force generated during push-off is quite large.

The loads on a Syme prosthesis during push-off are shown diagrammatically in Figure 2. Compression is developed in the anterior section, tension in the posterior section; and shear along the socket-foot bond. The shear force is critical

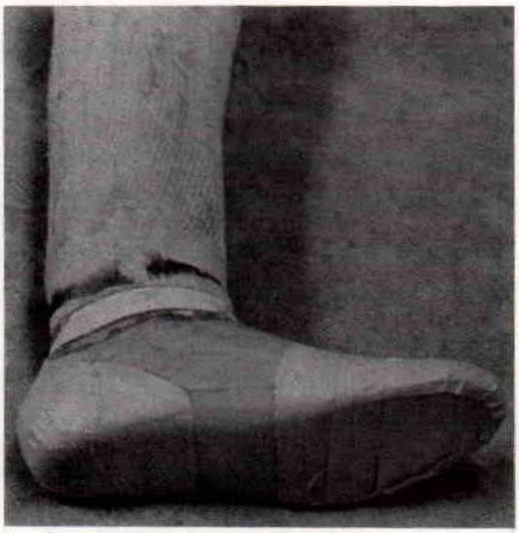


Fig. 3. Prosthesis for long-below-knee amputation. The glaze on the socket has been removed by sanding. The SACH foot has been prepared for final lamination by covering the heel wedge and forefoot with masking tape to protect them from the resin.

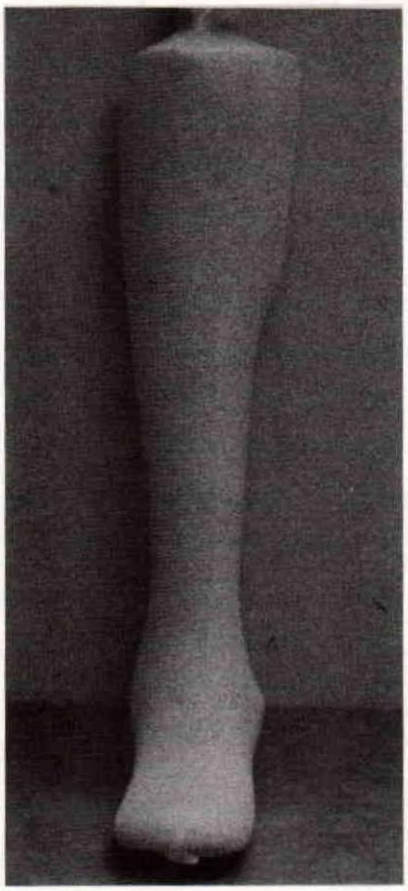


Fig. 4. Medial-opening Syme prosthesis, with two layers of nylon stockinette over entire socket and foot, ready for final lamination. Note that the sewn section of stockinette is in the forefoot trim-out area.

because different materials are being held together by the bond. A procedure to improve the mechanical bonding of the dissimilar materials, to alter the load force on the socket-foot bond, and to make the overall prosthesis more homogenous in the force-absorbing areas, has been developed.

A long-below-knee prosthesis which has been assembled as described above is shown in Figure 3. The socket has been sanded completely so that no glaze remains on the surface to prepare it to receive another, or finishing, laminate. The SACH foot has been prepared for lamination by using masking tape on the heel wedge and the forefoot section. The tape does not cover the entire base of the foot, but leaves exposed the area from the attachment bolt hole to a point within 1 in. of the end of the keel. The tape protects the areas of the foot which are not to be included in the final laminate. Its edges represent the trimlines for the final lamination.

A length of stockinette long enough to cover the entire prosthesis twice is sewn across at the center, and pulled over the entire prosthesis to provide a double layer. When the sewn segment reaches the bottom of the foot, it is pulled snugly to the base of the foot and in front of the end of the keel so the sewn part can be trimmed off. The second half is reversed and the ends of both tied to the mandrel (Fig. 4).

A PVA bag is pulled over the lay-up and the laminating procedure is carried out using 2 psi of vacuum. Prior to the gelling of the polyester resin (Laminac 4110) pressure-sensitive tape is placed over the PVA along the edges of the intended trimlines (Fig. 5).

After the resin has cured, it is trimmed along the edge of the pressure-sensitive tape. Final trimming is completed by cutting back to the edge of the masking tape that was placed on the SACH foot to protect the heel wedge and forefoot.

Figures 6, 7, and 8 show a Syme prosthesis after the initial trimming. It is obvious that the finish-

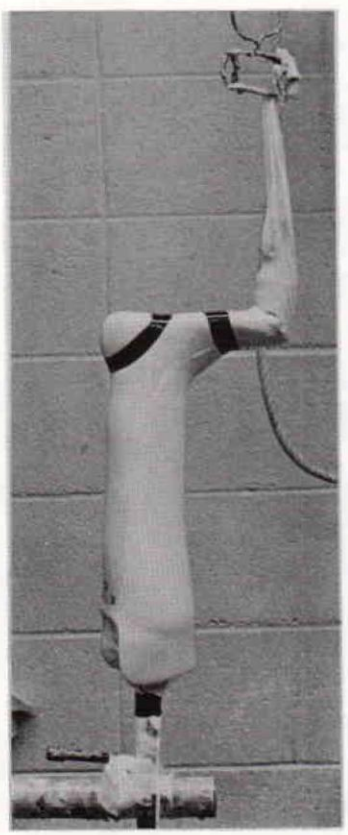


Fig. 5. Prosthesis for long-below-knee amputation undergoing final lamination. Pressure-sensitive tape is placed over the PVA at the intended trimlines on the foot.

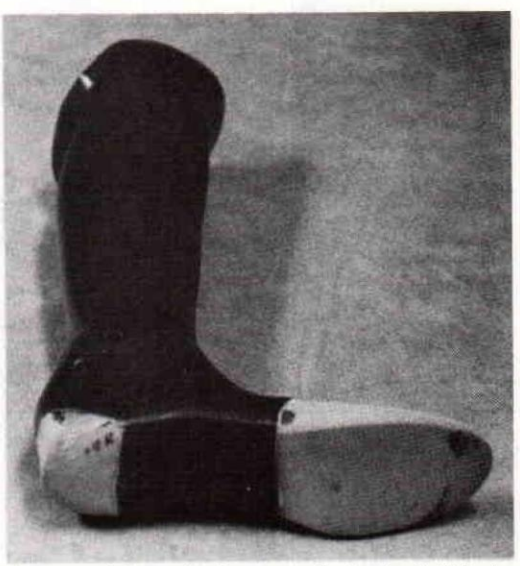


Fig. 6. Medial-opening Syme prosthesis after initial trim of final lamination. Plantar surface of SACH foot from bolt attachment hole to within 1 in. at end of keel has been encased by final lamination.

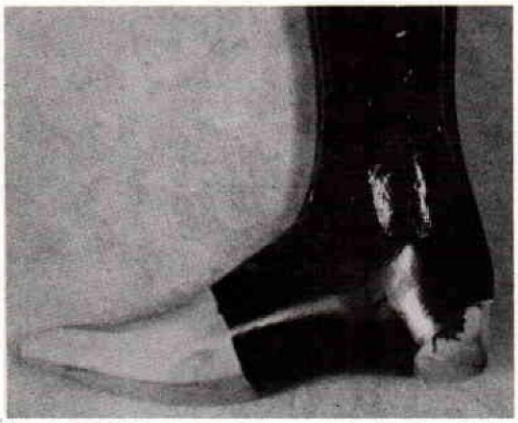


Fig. 7. Medial-opening Syme prosthesis after initial trim of final lamination. Medial view illustrates continuous fiber of stockinette from socket onto SACH foot.

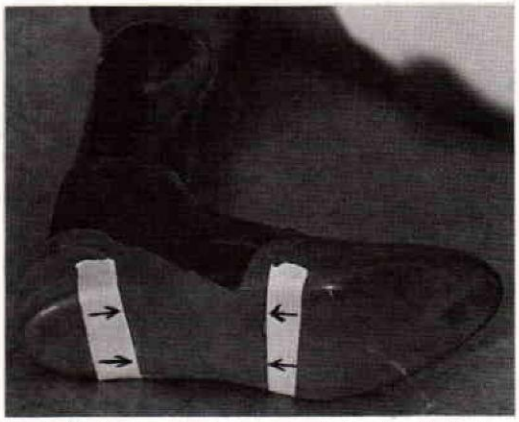


Fig. 9. Medial-opening Syme prosthesis after final trimming and application of Kingsley Kover Kote on the SACH foot. Arrows indicate length of plastic on plantar surface on finished prosthesis.

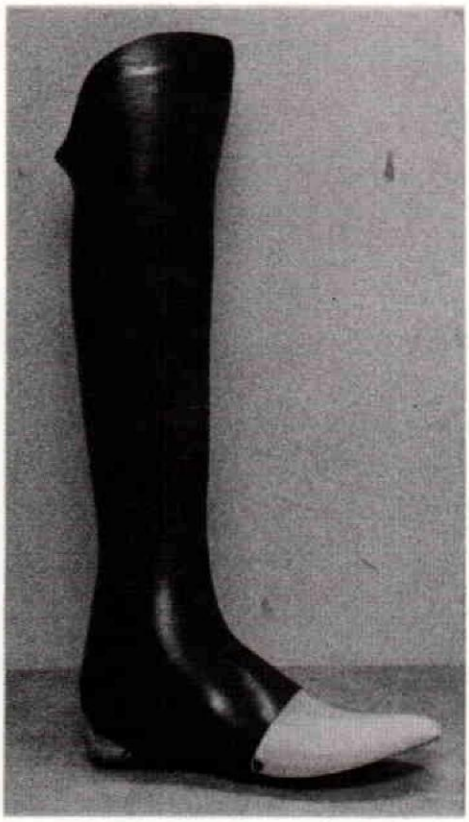


Fig. 8. Medial-opening Syme prosthesis after initial trim of final lamination. Lateral view illustrates a large area of foot which has been bonded by final lamination. Heel and forefoot are trimmed to allow normal foot function.

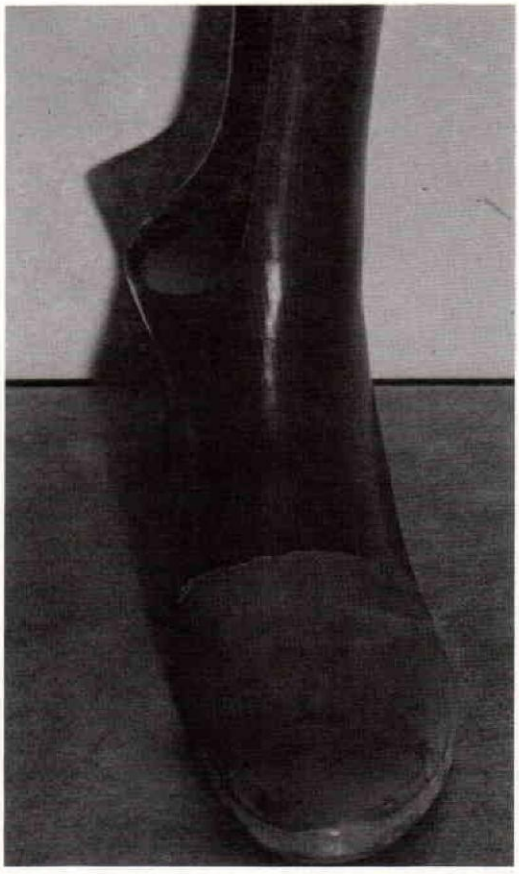


Fig. 10. Finished medial-opening Syme prosthesis. The SACH foot and approximately 1/2 in. of the plastic trim edge has been painted with Kingsley Kover Kote.

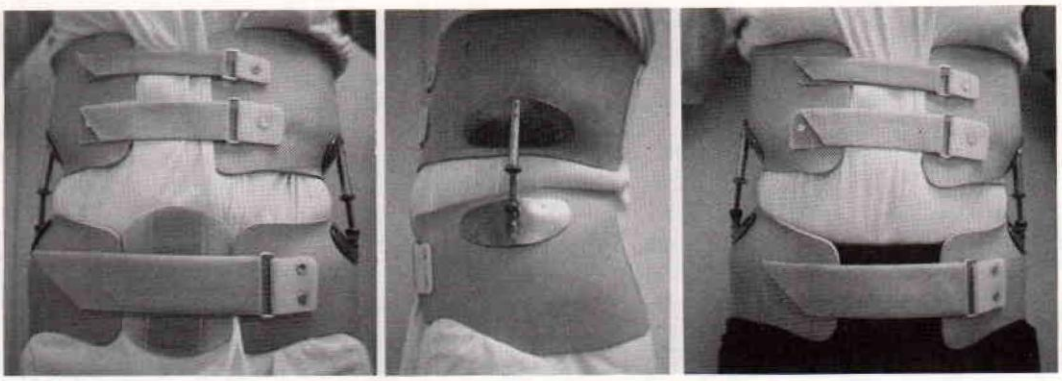
ing lamination creates a bond between the socket and foot which covers much larger areas on both units as well as taking advantage of the strength provided by the continuous fiber structure of the stockinette. The continuity of the fibers on the top, sides, and base of the foot creates a mechanical "vise" which assists in maintaining socket-foot attachment. Figures 9 and 10 show the completed prosthesis.

We have used this procedure as standard practice on all prostheses requiring the setting of the socket into the SACH foot or very near the top of the foot. Since adopting the technique, we have experienced no breakage in our Syme, Chopart, and long-below-knee prostheses. There has been no separation of the socket-foot bond. We have used standard SACH feet at all times with this technique and find it unnecessary to use SACH feet manufactured specifically for Syme prostheses only. An improved cosmetic appearance is also obtained as a result of the concealment of the two segments of the prosthesis.

Orthotics and Prosthetics, Vol. 28, No. 3, pp. 9-22, September 1974

THE VAPC LUMBOSACRAL ORTHOSIS

Gustav Rubin, M.D., F.A.C.S.[1],
Werner Greenbaum, C.P.O.[2], and
Dave Molack[3]



Long-established principles and new concepts have been combined in the design of the Veterans Administration Prosthetics Center's lumbosacral orthosis, which provides a stimulus to withdrawal and is classified as an A-P and M-L control orthosis.

The orthosis is recommended for use in "salvaging" cases in which all other attempts to provide comfort have failed. It is prescribed for any one of the following conditions:

- Unsuccessful disc surgery
- Unsuccessful disc surgery followed by fusion (nonunion)
- Unsuccessful conservative therapy (in situations where surgical intervention is medically contraindicated or rejected by the patient)

It is not recommended for the patient whose discomfort is alleviated by a fabric-type or a "chairback" orthosis, such as the Knight Spinal, because it is more restrictive than either of those devices. The patient who has chronic pain in spite of all previous therapy will readily accept increased restriction of motion in lieu of the pain.

DESIGN PRINCIPLES OF PREVIOUS ORTHOSES

All of the low-back orthoses available today are fabricated to provide forces that are directed anteriorly and posteriorly. The abdominal pressure provided in this manner has the effect of partially unweighting the lumbar and lumbosacral discs, as Bartelink (*1*) suggested and Nachemson and Morris (*4*)

[1]Senior Physician, Veterans Administration, and Consultant in Orthopedics, VA Prosthetics Center, New York, NY 10001.

[2]Chief, Patient Care Service, VA Prosthetics Center, New York, NY 10001.

[3]Orthotist (retired), Orthotics Laboratory, VA Prosthetics Center, New York, NY 10001.

demonstrated[4]. The posterior elements of such orthoses as the Knight Spinal add support to this area. This support is added to the rigidity provided by the patient with *severe* low-back pain who spontaneously "splints" his own lumbosacral junction by squatting to reach down rather than bending the spine.

The combination of relative immobilization plus unweighting of the lumbar spine through the agency of abdominal pressure is the basis for the relief obtained by the use of existing orthoses. When pain is mild and the patient can bend over, the effect of the immobilization component is reversed. Under such circumstances, stresses on the lumbosacral junction are increased by the longer lever provided by the rigid orthosis. But we are concerned here only with patients with severe back problems, and they do not flex their trunks.

Specific Features of the VAPC Orthosis

The VAPC orthosis includes the features outlined above plus others unique to it. They are:

- Improved end-point fixation, achieved by contouring the upper plastic band beneath the rib cage or alongside the flexible lower ribs, and contouring the lower band over the iliac crests.
- Externally applied vertical support to the thoracic cage to complement the effect achieved internally by abdominal pressure and thus provide uplift of the diaphragm, the thoracic cage, and the lumbar spine. The external force to provide the uplift is achieved by adjusting the metal uprights to provide slight distraction.
- Introduction of a stimulus to withdrawal, empirically introduced to mimic the "Milwaukee Brace."
- Provision of a socket in which to rest the rib cage in slight distraction. The socket is contoured in a manner somewhat similar to that of the hemipelvectomy socket.

Improved fixation is obtained by fitting plastic bands (Prenyl) over the iliac crests distally in the manner of the Milwaukee Brace, and, at the proximal level, beneath and around the lower thorax in the manner of a hemipelvectomy socket. The stimulus to withdrawal is obtained by introducing a mild upward pressure on the rib cage, which can readily be relieved intermittently by deep inspiration and elevation of the rib cage away from the upper plastic band. Threaded struts are employed to provide sufficient separation (about 3/8 in. to 1/2 in.) of the plastic bands to introduce the mild upward pressure on the lower ribs. This is *not* a continuous pressure. The patient can, at any time, withdraw his rib cage away from the upper Prenyl band. Any localized areas of discomfort, usually over a prominent rib or the anterior iliac crest, will manifest themselves in a day or two at which time appropriate relief can be provided.

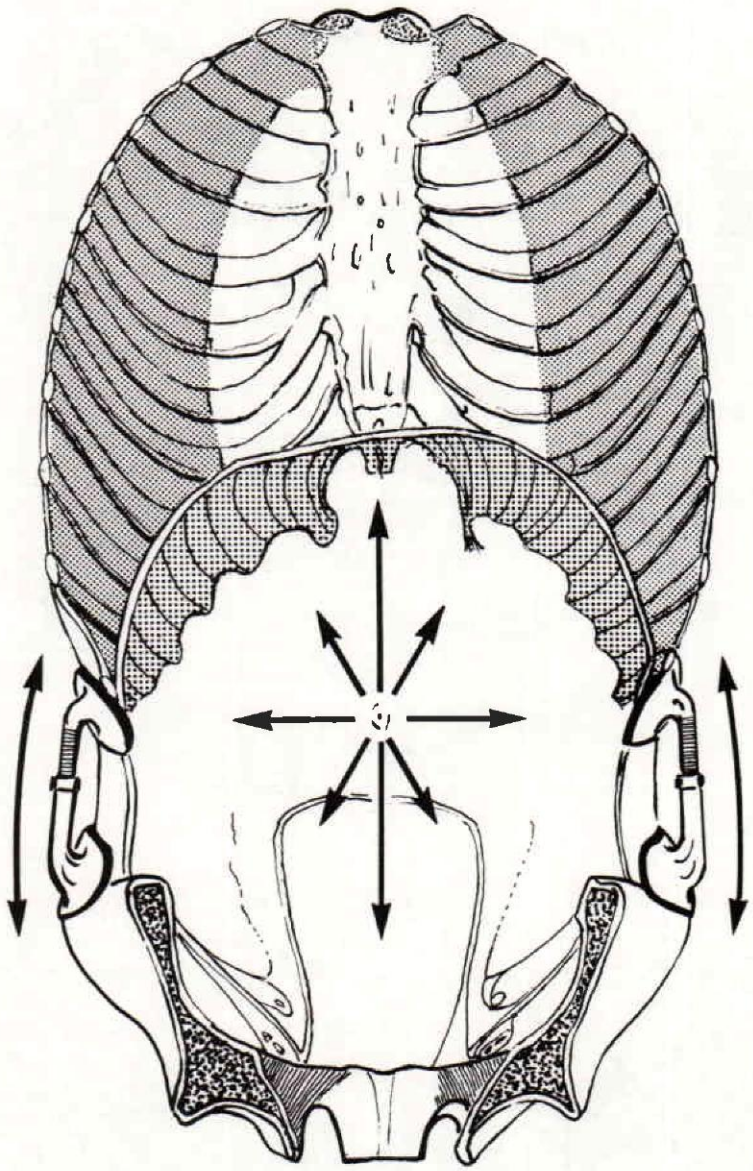
The support of the rib cage in the proximal "socket" of the orthosis is illustrated in the frontal section of the trunk shown below. The arrows demonstrate the distribution of pressure applied to the abdomen and the semifluid abdominal contents. As Morris[5] has shown, this pressure is the most important feature of existing three-point-pressure orthoses in that it functions to provide a degree of unweighting of the lumbar discs. In addition to the paravertebral component of pressure, there is pressure distribution upward against the diaphragm, the diaphragm being a muscle attached peripherally to the rib cage, which, in turn, has ligamentous and muscular attachments to the thoracic vertebrae, and, by crura, to the upper three lumbar vertebrae.

It is the authors' belief that the external support of the rib cage (in slight distraction) and the stimulus to withdrawal complement the effect of the upward pressure on the diaphragm by the abdominal pad in providing an increased element of "uplift" to the thorax and thus unweighting of the lumbar spine.

Prefabricated components of the orthosis are available in kit form. One size has been found to be sufficient for use on most adult patients. Included in the kit are two pelvic bands contoured to fit snugly

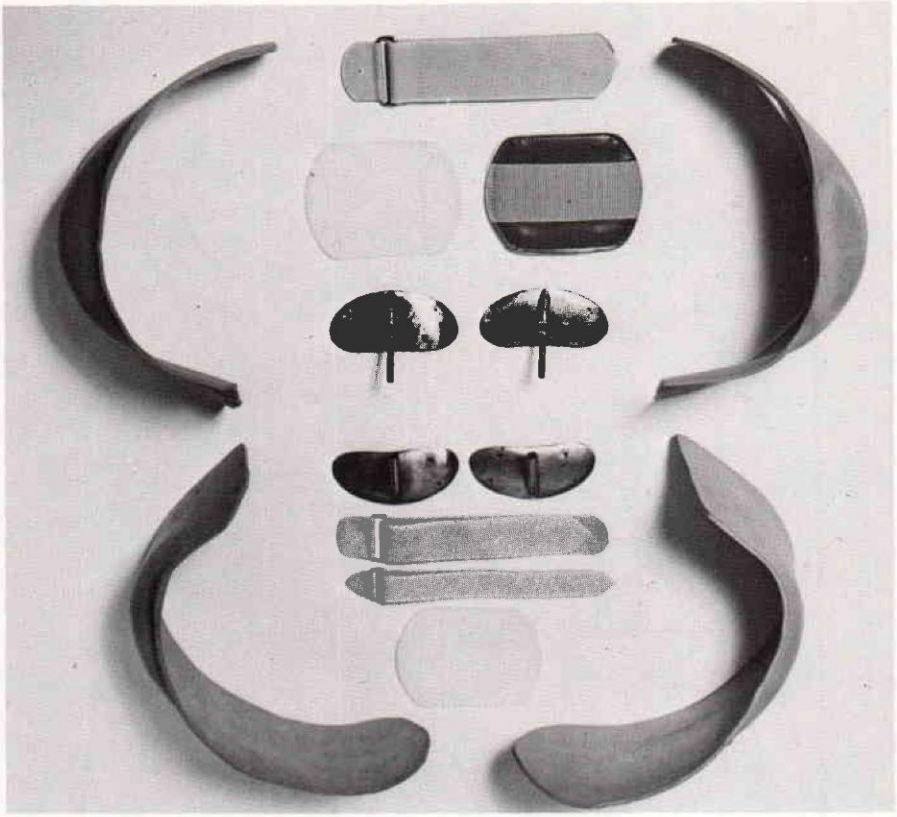
[4]These investigators inserted intradiscal needles into the lumbar area, attached these to manometers, and showed that, by increasing the abdominal pressure, the intradiscal pressure was significantly reduced.

[5]"It would appear that the efficacy of corsets and back supports is due largely to compression of the abdomen with a resulting decreased load on the vertebral column itself."(*3*)

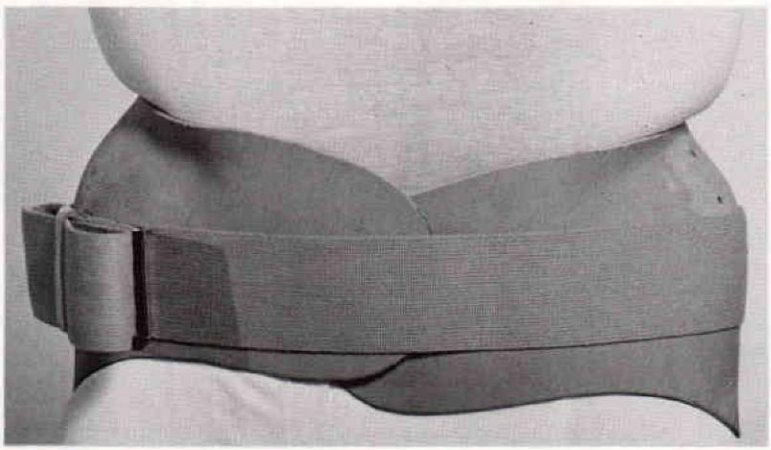


over the iliac crests and two thoracic bands fabricated for fitting beneath and around the lower thorax. These bands are made from 3/16-in.-thick Prenyl^{R}, a semirigid thermoplastic that can be formed at a relatively low temperature.

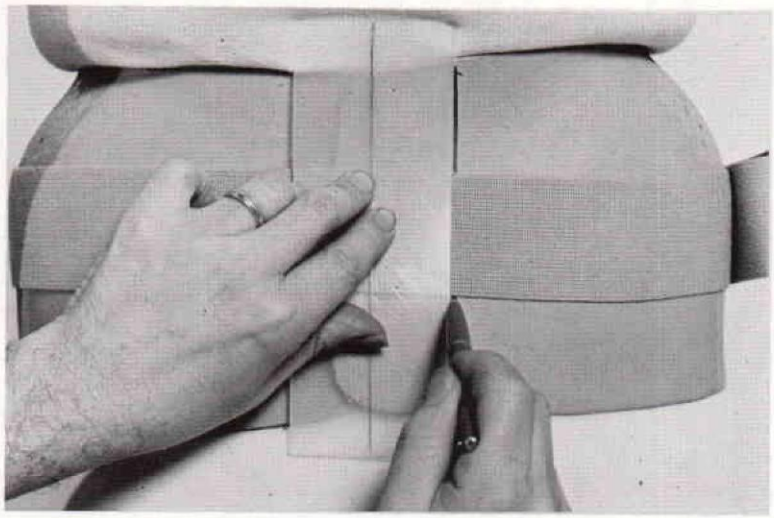
Two threaded metal struts with a ball joint riveted to stainless-steel plates for attachment to the pelvic bands, and two metal tubes riveted to similar stainless-steel plates for attachment to the thoracic bands are provided. Two polypropylene strips for connection of the bands posteriorly, an abdominal pad, and three Velcro straps complete the kit.



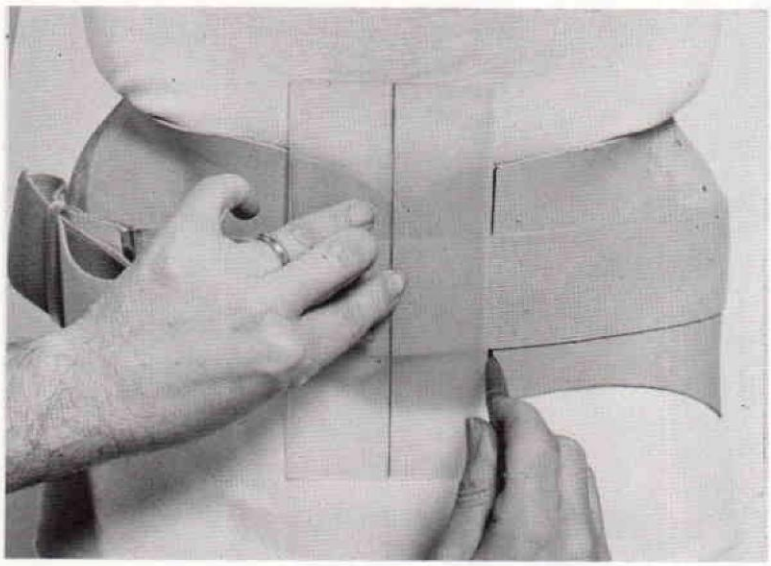
FITTING PROCEDURE



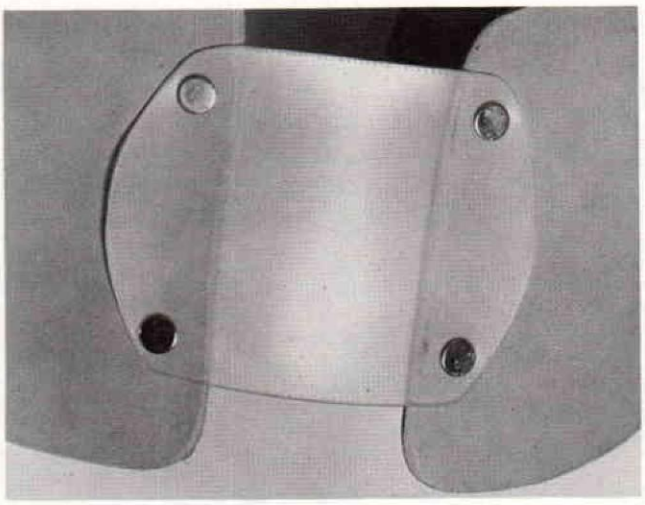
The pelvic bands are placed on the patient and held firmly in place over the illiac crests with a webbing belt.



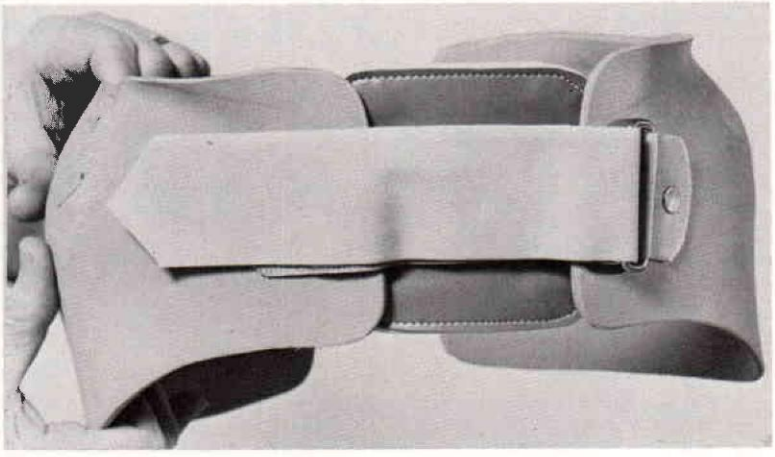
Trimlines are established on the posterior aspect so as to fall 1 1/4 in. on each side of the center line of the spine.



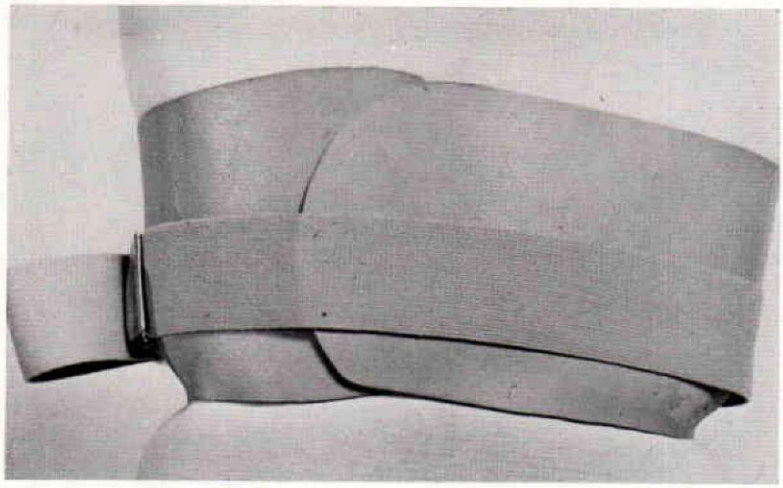
Trimlines are established on the anterior aspect so as to fall 1 3/4 in. on each side of the vertical center line of the body.



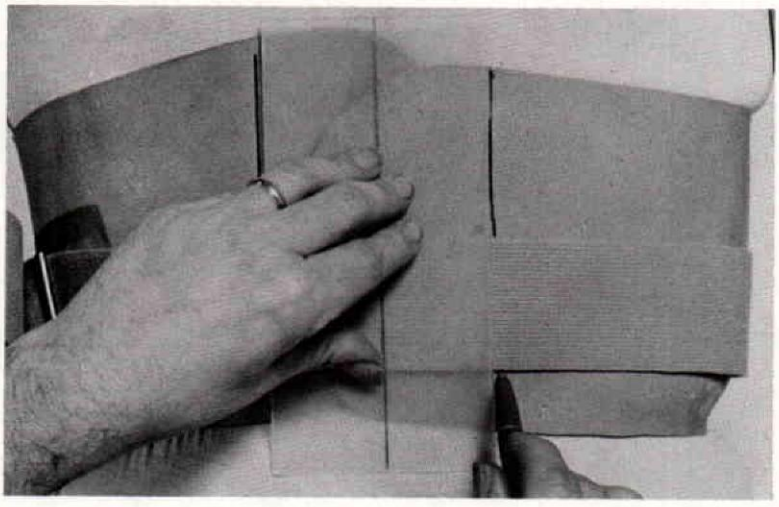
The Prenyl bands are trimmed as marked, the edges are sanded, and the posterior portions are connected using the polypropylene strip.



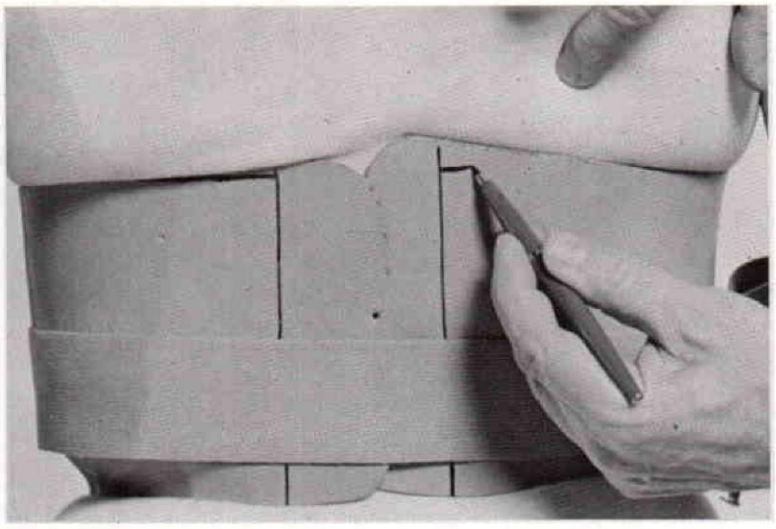
On the anterior aspect, adjustable closure is provided by using 2-in.-wide Velcro strap to which the abdominal pad has been attached.



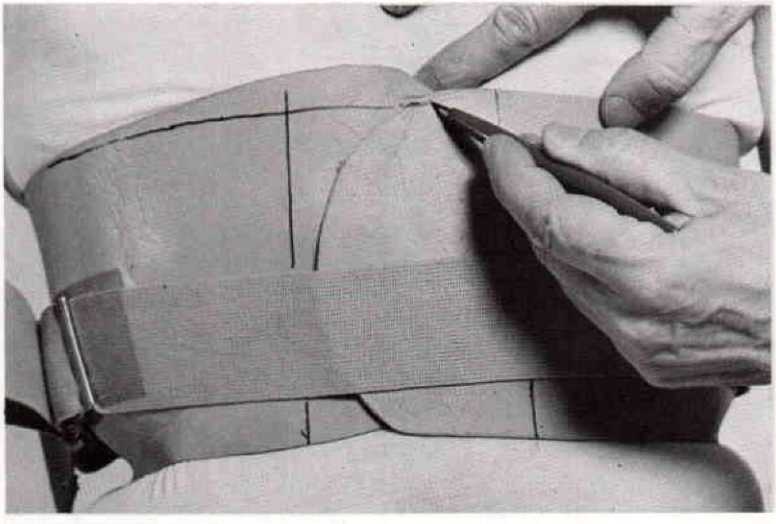
The two thoracic bands are placed on the patient so they fit firmly around and under the lower rib cage, and a strap is used to hold them in place.



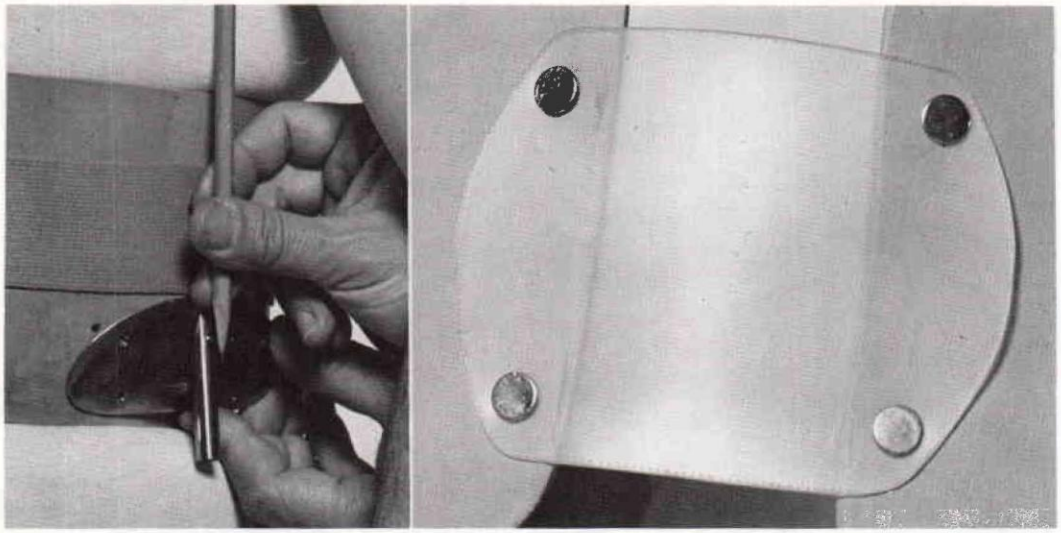
The posterior and anterior trimlines are established, using the same measurements as used on the pelvic sections.



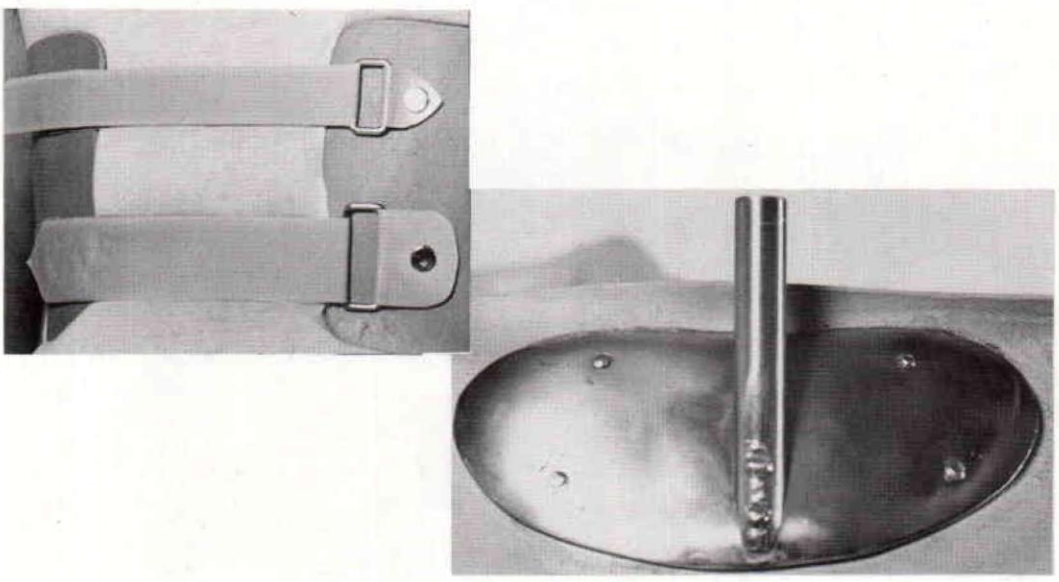
The trimlines on the proximal-posterior aspect of the thoracic bands are located and marked so that the upper edges will come to a level 1 in. below the inferior angle of the scapula.



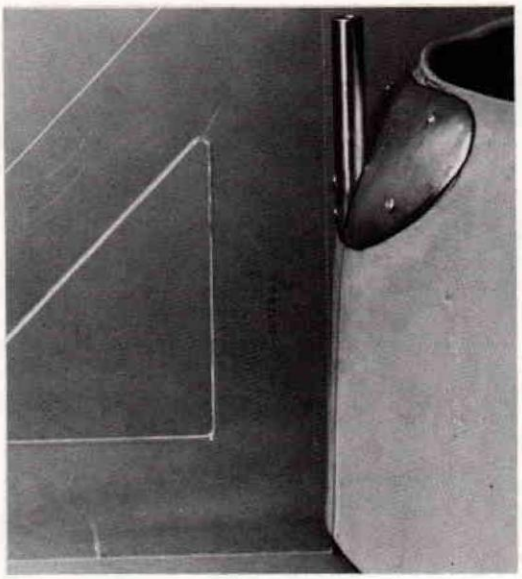
The trimline on the thoracic bands on the proximal-anterior aspects are located and marked so that the upper edges come to the level of the xiphoid-sternal junction.

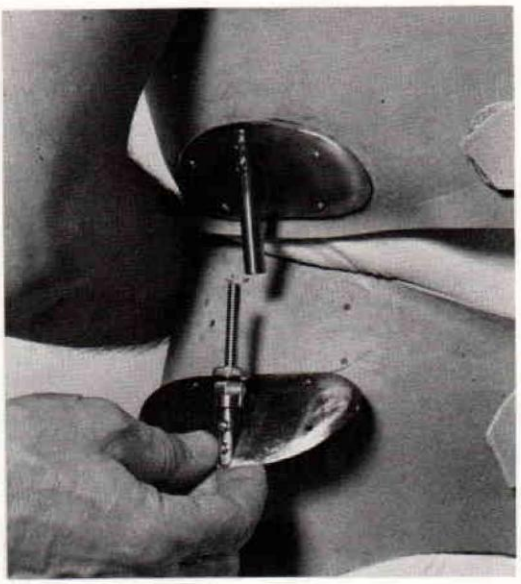


The location of the metal plates that have the tubing attached is established. The plate should be placed as close to the lower edge as possible, and the tube should lay in the frontal plane that bisects the body. The thoracic bands are trimmed as marked, the edges are sanded, and the bands are connected on the posterior aspect with a polypropylene strip.



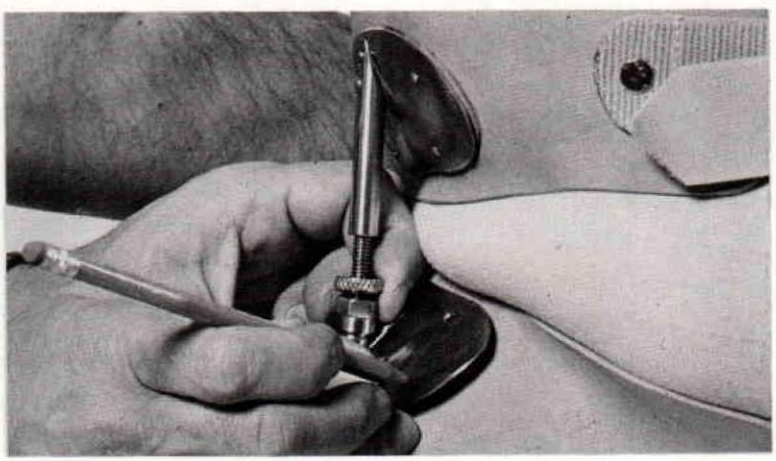
The thoracic bands are connected on the anterior aspect with two Velcro straps. The metal plates are riveted to the thoracic bands as marked.



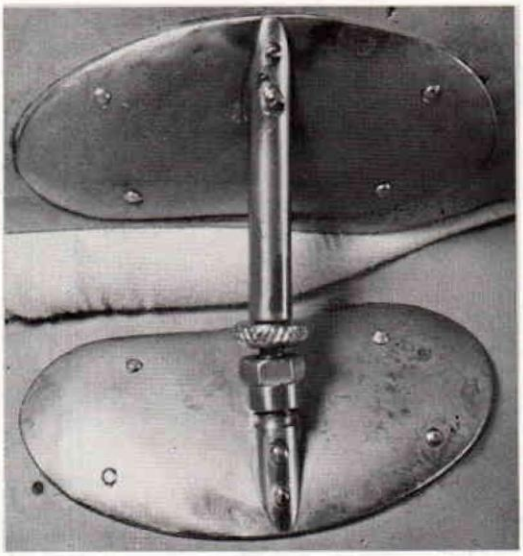


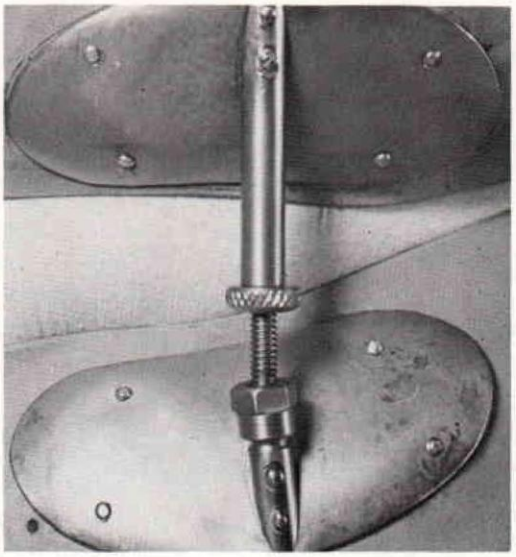
The metal tubes must be parallel to each other in all planes. If necessary, slight changes are made in the location to accomplish this.

Both sets of bands are placed on the patient. The threaded rods of the lower plates, which have not been attached to the lower band as yet, are inserted in the tubing of the upper plates.



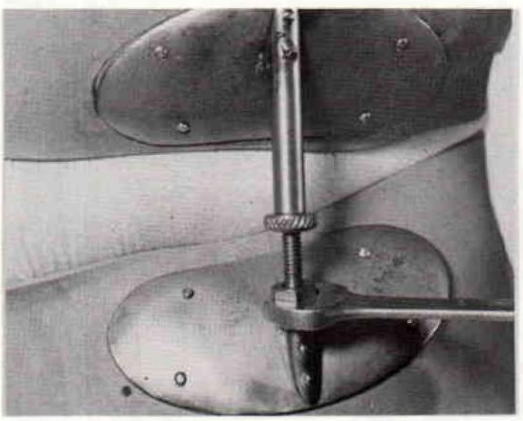
The location of the lower plates are established on the pelvic bands. The ball joints must not be locked at this time.

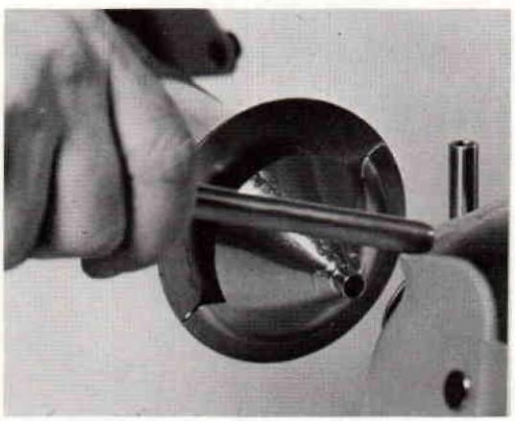




After the plates have been riveted to the pelvic bands, the orthosis is reapplied to the patient, while making sure that the bands are located correctly over the iliac crests and under the rib cage (or, in the case of the short, stocky patient, alongside the flexible lower ribs). The metal plates are placed as close to the midline as possible.

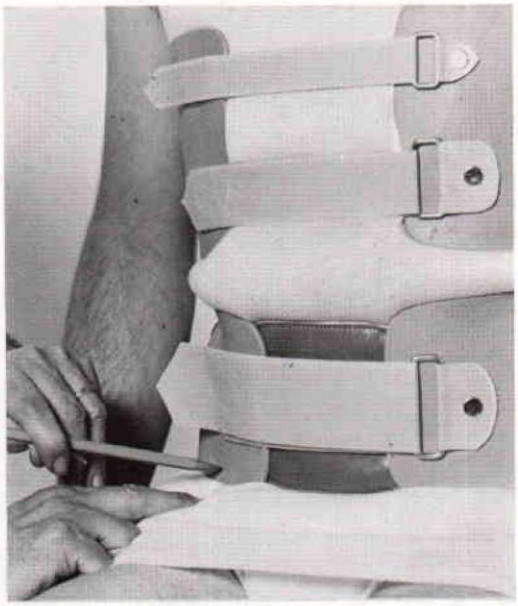
At this time, the patient is asked to take a deep breath and to elevate his lower rib cage away from the thoracic bands. The adjustment devices on the plates are threaded upward until there is about a 1/2-in. separation between the thoracic and pelvic sections.

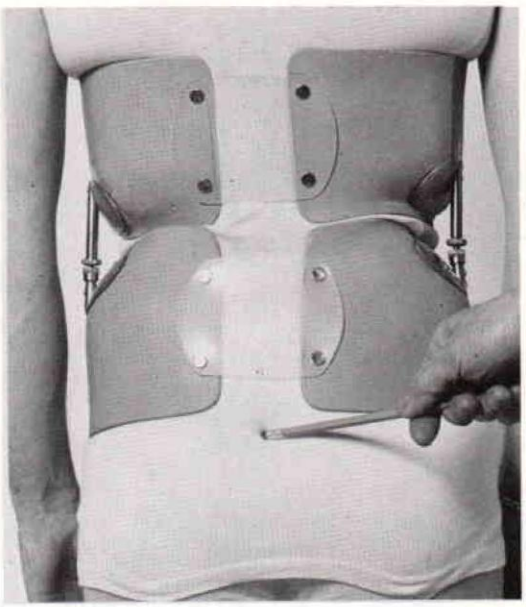




The ball-joint adjustment is locked, and the patient is instructed to relax while the fit of the orthosis is checked for any pressure areas. If the ball joint loosens due to excessive stress, which may occur in the case of overweight patients, it should be "frozen" in place with an epoxy adhesive.

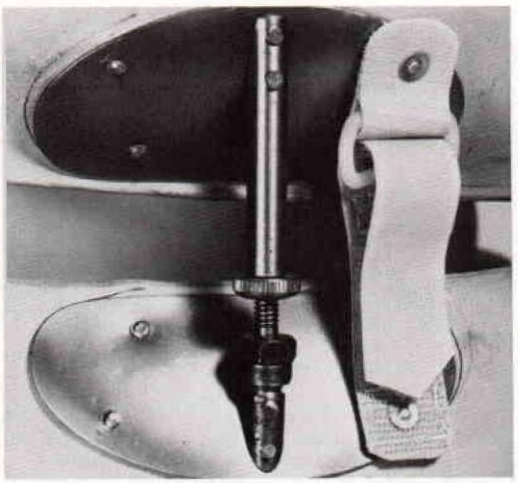
If the edges of the Prenyl bands "dig in," they should be rolled out with a round metal rod and with the help of a heat gun. Other areas of discomfort are provided relief in a similar way.

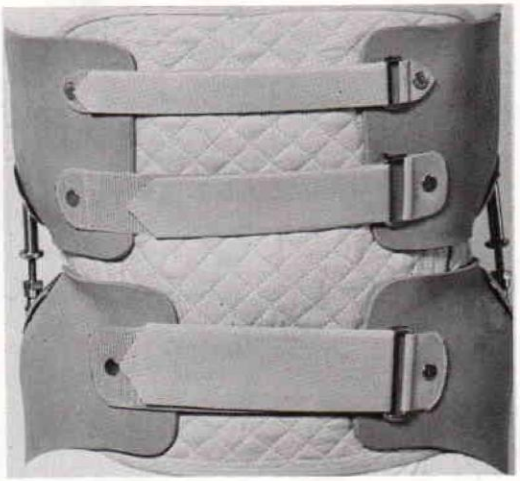




The patient is asked to sit while the fit of the orthosis in the inguinal fold is checked. The pelvic bands are trimmed in this area if necessary.

The lower posterior border of the orthosis should not extend distal to the sacrococcygeal junction.





If the solid metal uprights tend to slip within the tubular components as the patient bends laterally, they may be retained in position by the addition of Velcro straps in parallel, snugged down to maintain pressure on the nut. Of course, a locking nut may be added if necessary.

In the case of an obese patient, the abdominal pad is replaced with a full abdominal coutil apron.

FITTING THE COMPLETED ORTHOSIS

- When applying the brace, the first step is adjustment of the lower Prenyl band so that the curved upper brim fits *over* the iliac crests.
- The thoracic Prenyl band is placed and tightened around the rib cage by the lower of the two straps. The upper strap should be closed with light tension.
- The threaded rods should be adjusted upward 3/8 in. to 1/2 in., or an amount sufficient for the patient to sense mild upward pressure on the rib cage. When the patient takes a moderately deep inspiration, it should be possible for the orthotist to pass his fingers between the rib cage and the upper band. When the patient relaxes from the moderately deep inspiration, his rib cage should rest in the "socket" of Prenyl without *localized* areas of bone discomfort.
- The orthotist, upon sliding his fingers, palms upward, horizontally beneath the lower margin of the upper Prenyl band just anterior to the metal struts, should find that the fingers either contact the lower, flexible border of the rib cage or slide beneath it.
- An undershirt must be worn beneath the orthosis. In those occasional instances when excessive perspiration occurs, perforation of the Prenyl should be considered.
- If the patient is a wearer of snugly fitted trousers, the posterior seam should be opened at the belt line to allow closure over the orthosis.

INDICATIONS FOR USE

This brace should be used for patients who have persistent, severe, low-back pain, with or without sciatic radiation, and who have not obtained significant relief from the use of other rigid back braces, such as the Knight Spinal orthosis. Prior disc surgery is not a contraindication to its use.

CONTRAINDICATIONS TO USE

As a corollary to the above, patients who obtain relief from fabric-type reinforced lumbosacral orthoses, or "chairback braces," should not be issued the VAPC orthosis. It is contraindicated for patients with inguinal or diaphragmatic hernias. The prefabricated components have not been designed to be fitted to patients with waistlines greater than 42 in. or less than 34 in.

COMMON FITTING ERRORS

- The upper of the two thoracic straps has been adjusted too tightly.
- The lower posterior polypropylene strap has been left excessively long, and, therefore, the lower Prenyl band has not been adequately seated *over* the iliac crests. This will allow the pelvic band to slip down alongside the pelvis.
- The metal uprights have been placed too far laterally. This will not only make the metal components appear to be short, but will adversely affect cosmesis.
- Discomfort from pressure on a rib or the iliac crest has not been eliminated. Prenyl is a thermoplastic material, and such areas of discomfort can be eliminated easily.

POST-FITTING INSTRUCTIONS

- The patient should be instructed to return to the orthotist one week from the time of delivery. Problems which were not obvious at the initial fitting will have manifested themselves by that time and they can be eliminated.
- The patient should be given "withdrawal" exercise instructions:
  a. Frequent deep inspirations to lift the thoracic cage away from the upper band.
  b. Frequent tilting of thorax, first to one side and then the other, accompanied by pushing downward on the brim of the upper Prenyl band on the side from which the thorax is tilted.
- Isometric abdominal muscle tightening exercises should also be taught.

CONCLUDING REMARKS

The response of the VAPC patients who have used this orthosis has been uniformly positive and frequently enthusiastic. The design of the orthosis introduces what the authors consider to be maximum modularity for a device of this type. Fabrication is relatively simple.

There are a large number of chronic low-back patients who are permanently disabled even though they have been treated by well-established procedures (*4*), and therefore there is a need for an orthosis of this type.

ACKNOWLEDGMENTS

The authors wish to state their indebtedness to Mr. Michael Danisi, C.O., and Mr. Eugenio Lamberty, Orthotic Technician, for their contributions and enthusiastic cooperation.

REFERENCES

1. Bartelink, D. L., *The role of abdominal pressure in relieving the pressure on the lumbar intervertebral discs.* J. Bone and Joint Surg., **39-B**:4:718-725, November 1957.

2. Beals, R. K., and N. W. Hickman, *Industrial injuries of the back and extremity.* J. Bone and Joint Surg., **54-A**:-8:1593-1611, December 1972.

3. Morris, James M., *Biomechanics of the spine.* In Spinal Orthotics—A Report of a Workshop held at University of California, San Francisco, March 28-29, 1969, National Academy of Sciences, 1970.

4. Nachemson, A., and J. M. Morris, *In vivo measurements of intradiscal pressure, discometry, a method for the determination of pressure in the lower lumbar discs.* J. Bone and Joint Surg., **46-A**:5:1077-1092, July 1964.

Orthotics and Prosthetics, Vol. 28, No. 3, pp. 23-41, September 1974

EVALUATION OF TWO EXPERIMENTAL SPINAL ORTHOSES[1]

Michael J. Quigley, C.P.O.[2]

The first metal spinal orthosis is said to have been designed by Lorenz Heister in the Eighteenth Century (1), and consisted of a flat metal piece extending from the pelvis to the occiput, with a crosspiece just below the shoulders.

The present design of the majority of spinal orthoses dates back to 1863, when Dr. C. F. Taylor (1) published an article in the *Transactions of the New York State Medical Society* entitled, "On the Mechanical Treatment of Pott's Disease of the Spine." Taylor's article described the function, use, and placement of paraspinal uprights, axillary straps, pelvic bands and abdominal aprons (Fig. 1). James Knight described a new design in 1884 claiming that it differed from Taylor's orthosis in that it "gives lateral support, and not extension" (*1*).

During the era of Taylor and Knight, work was being done by Goldthwait and his co-workers on body mechanics and its importance in postural deformities. Goldthwait designed his own spinal orthosis, but the three-point pressure system described by Taylor was still the basic principle behind its function. Goldthwait, however, stressed the fact that spinal orthoses should be used only as an aid or adjunct to the development of muscular strength and body balance by exercises (*1*).

The "Williams Lordosis Orthosis," a lumbosacral posterior and lateral control spinal orthosis, was the only significant development in metal orthotic designs since the late Nineteenth Century. According to Williams, the orthosis is designed "to exert a constant corrective force" on the lumbar spine, lumbosacral joint, and pelvis in order to overcome excessive lordotic curves (*1*).

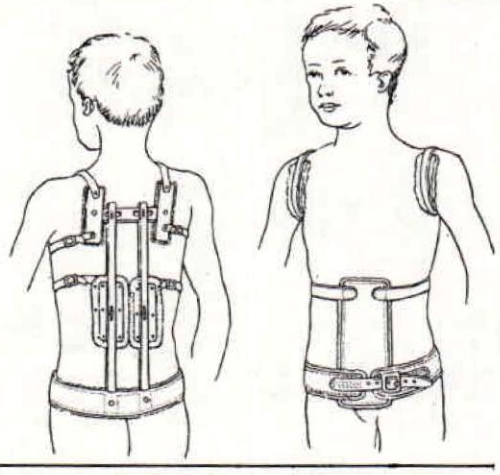


Fig. 1. Redrawn from the original illustrated description by Charles Fayette Taylor in 1863. This Taylor spinal brace was alluded to as "The Spinal Assistant."

"BODY JACKET" ORTHOSES

Paralleling the development of the metal spinal orthotic designs was the development of rigid body jackets. These supports typically extend from the mid-thoracic level to the sacral level and are designed as rigid or semirigid cylinders completely encircling the trunk.

One of the earliest examples of a body jacket was one made of tree bark, and discovered in the pre-Columbian Indians' cliff dwellings in Mesa Verde Park, Colorado (Fig. 2). It is estimated that it dates from about 900 A.D.

It is obvious that man has intuitively applied intra-abdominal pressure to relieve low back pain. Most present-day designs of body jackets can be traced back to the spinal orthotics renaissance in the late nineteenth century. During the 1940's Hauser (*2*) used a flexion body cast to produce flexion of the lumbar spine. The cast technique

[1] Prepared for the Subcommittee on Evaluation, Committee on Prosthetics Research and Development, National Academy of Sciences. The work was performed under the provisions of Contract SRS-72-7 between the Social and Rehabilitation Service and the National Academy of Sciences and Contract V101(134)P-75 between the Veterans Administration and the National Academy of Sciences.

[2] Staff Prosthetist-Orthotist, Committee on Prosthetics Research and Development.

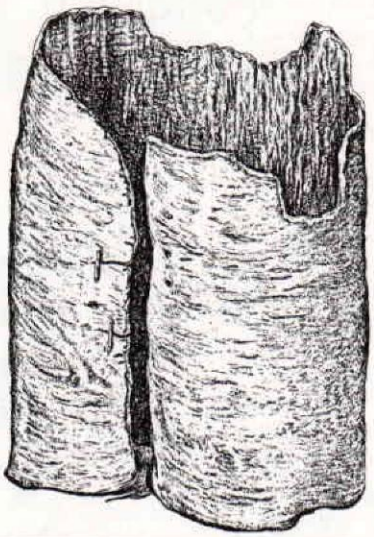


Fig. 2. Drawing of orthopaedic corset of tree bark, from the pre-Columbian Indians' cliff dwellings, circa 900 A.D., found in Mesa Verde Park, Colorado. (From the Colorado State Historical Museum, Denver) (*Orthopaedic Atlas*, Volume 1, 1952).

was modified by Raney who fabricated a thermoplastic (Royalite) orthosis that included an indented front to provide intra-abdominal pressure. Raney stated that the factors "contributing to the back pain predominantly are the increased lordosis, the tight posterior structures (hamstrings), the poor anterior support, and nerve root compressions or irritation" (*8*). This orthosis has been termed the Royalite flexion jacket and is presently being widely used in the United States.

SCOLIOSIS CONTROL ORTHOSES

The classic example of the evolution of present orthotic principles is the development of orthoses to control scoliosis, which is often accompanied by back pain. In 1841, an orthosis designed by Tavernier of Paris consisted of a pelvic band to which a thoracic sling was attached on one side and an axillary crutch-like extension on the other. In 1868, an "oblique and spiral bandage" that extended from the shoulder to the thoracic convexity and then across and down to the opposite thigh was used by Richard Barwell of London (*1*).

Dynamic scoliosis control was attempted in the Barr-Buschenfeldt orthotic design as reported in the *Journal of Bone and Joint Surgery* in 1936 (*1*). This design incorporated an ingenious adjustable lever system that could apply the various pressures needed in the three-point pressure system. Dynamic correction was also attempted by Steindler in his design, which included elastic straps to provide corrective forces over the thoracic convexity and a thigh extension for additional stability when treating low thoracic and lumbar curves.

All of these former designs are rarely used at this time owing to the development by Drs. Blount and Schmidt of the "Milwaukee" design of scoliosis control orthoses (*2*). Although this orthosis originally was intended and considered to use dynamic forces to provide traction, it has been shown to act by stimulating the patient to do this by providing pressure points at selected areas. When the patient assumes poor postural alignment, he hits a pressure point which stimulates him to withdraw his body from the pressure thereby correcting his posture. This principle has proven effective and is widely accepted by authorities on scoliosis. This orthosis therefore provides a static stop against increasing deformity and a dynamic force using the musculature to correct the deformity.

POPULATION OF PERSONS WITH IMPAIRMENT OF THE BACK AND SPINE

In 1966, the Social Security Administration conducted a survey among the civilian, noninstitutional population, 18-64 years of age, to determine the extent of work-limiting disability in this group (*6*). As part of the study each disabled person was asked to select from a list of 39 chronic disabling conditions the major one causing his limitation to work. Back or spine impairment (except paralysis) was the third leading chronic major disability in this group being responsible for 11.4 percent of all major disabilities. In the age group between 17 and 44 years, back and spine impairments ranked as the leading cause of chronic major disability.

In 1967, chronic disabling back and spine impairment affected an estimated 1,756,000 people 17 years of age and over (*6*). Forty-one percent (720,000) of this population were unemployed because of their impairment.

During 1971 there were in the United States an estimated 12.5 million impairments due to injury (*7*), the most frequently reported type being im-

pairment of the back or spine (except paralysis) with an estimated prevalence of 3.1 million cases.

THE PRESENT USE OF SPINAL ORTHOSES

Many types of spinal orthoses are presently used to treat low back pain. The factors influencing the type prescribed by the physician include geographical location, treatment philosophy, duration of pathology, type of pathology, availability, and effectiveness of the orthosis.

In a survey (*8*) of over 5,000 orthopedic surgeons, conducted by the Committee on Prosthetic-Orthotic Education (CPOE) of the National Research Council (NRC) in 1970, over 99 percent of responding orthopedic surgeons used external support for low back problems and over 90 percent of these indicated they used two or three different types of supports, the most common being the corset (Table 1).

Table 2 points out some interesting facts about orthotic usage in clinical situations. At the top of the "Frequency of Use" column, external support is usually used by 84 percent of physicians, by 51 percent of physicians in the middle of the column, and by only 17 percent at the bottom. The "Support Preference" column shows a similar situation. This reversal of the usage figures relates directly to the clinical situation (etiology).

It can generally be stated that external support is rarely used for low back problems of short duration (6-8 weeks) and usually used for problems of long duration (over 6-8 weeks). This is due to the variable effectiveness of spinal orthoses for short-term problems and the usual lack of prompt availability of the orthoses. Spinal orthoses have proven to be effective in many long-term cases where prompt availability is not such a deciding factor. However, one clinical situation, listed as "Chronic" in Table 2, did not follow this pattern.

CHRONIC LOW BACK PAIN

Chronic low back problems can be caused by a number of pathologies and either are of long duration or recur often. Problems in this category include herniated discs, arthritis, and spondylolistheses. It is apparent in the practices of orthopedics, physical therapy, and orthotics that there are many thousands of patients with chronic low back pain that obtain only minimal relief from pain by using medication, exercises, and spinal orthoses. Surgical stabilization of the spine is of-

TABLE 1. SUPPORT PREFERENCE [FROM (8)]

Support	By Individual Physicians (percent response)	For All Clinical Indications (percent)
Lumbosacral (LS) Corset	28.5	44.2
LS Orthosis/A-P Control (Knight)	21.11	22.4
LS Orthosis/P-L Control (Williams)	9.9	8.3
Body Cast	9.2	6.3
Flexion Cast	8.4	5.0
Body Cast and One Leg	6.0	2.6
Other Orthoses	11.6	8.3
Other Corsets	3.9	2.5
Other Casts	1.2	0.5
TOTAL	99.81	100.1

TABLE 2. EXTERNAL SUPPORT PREFERENCE BY CLINICAL ENTITY [FROM (8)]

Clinical Situation	Total Listing (Percent)	Frequency of Use		Support Preference		
		Rarely (Percent)	Usually (Percent)	Brace (Percent)	Corset (Percent)	Cast (Percent)
Postop. Fusion	100	16	84	51	20	29
Spondylolisthesis	100	30	70	59	33	28 [sic]
Pseudarthrosis	100	34	66	57	28	15
Preop. Trial	100	46	54	37	25	38
Disc Syndrome	100	49	51	34	51	15
Chronic	100	52	48	29	67	4 [sic]
Postop. Disc	100	72	28	31	65	4
Obesity and Pain	100	81	19	13	84	2 [sic]
Acute Strain	100	83	17	14	77	9

ten necessary, but it does not always guarantee freedom from pain.

Patients with chronic low back pain rely on corsets for external support the majority of the time, mainly because corsets seem to provide the same amount of pain relief as rigid orthoses, but are less restrictive, less expensive, and more readily available.

The need for an orthosis that will provide more pain relief than corsets and conventional rigid spinal orthoses, to the patient, is apparent.

DESCRIPTION AND USE OF THE EXPERIMENTAL ORTHOSES

THE LUMBOSACRAL A-P AND L CONTROL ORTHOSIS WITH INFLATABLE PADS (LSO/INFLATABLE PADS)

The LSO/Inflatable Pads, developed at the University of California Biomechanics Laboratory under the direction of James Morris, M.D., is a plastic trunk and spine support. The inflatable pads are used optionally to provide additional intra-abdominal pressure. The orthosis encompasses the trunk posteriorly from about the T9-10 vertebral level to the sacral and gluteal area and anteriorly from just inferior to the xiphoid process to the symphysis pubis (Fig. 3). One opening provided at the anterolateral aspect of the orthosis is fastened by Velcro closures. The anterior aspect of the orthosis contains an oval inflatable pad (football or ptosis bladder) on the anterior aspect and a tubular inflatable pad (24-in. above-knee tourniquet) attached to the posterior inferior wall of the orthosis. An inflation valve protrudes through the plastic wall of the orthosis where the pads are placed. The bladders are attached to the plastic wall by Velcro, thereby allowing easy adjustment and removal.

Fabrication and Fitting

A plaster mold of the patient is taken in a standing position with the patient's knees flexed and the trunk inclined forward to decrease or eliminate lumbar lordosis. The mold extends from the mid-thoracic level to the gluteal fold. Before the plaster sets, an oval convex plate is pressed very firmly against the abdomen to form the indentation needed to increase intra-abdominal pressure in the area. Superior to the iliac crests, the cast is also indented to identify the iliac crests.

The negative mold is filled with plaster and the positive mold modified to relieve bony prominences and provide pressure over the abdomen. Plastic is then applied to the mold by either laminating or thermoplastic forming techniques. The plastic is trimmed and the closures and pads are attached when they are to be used.

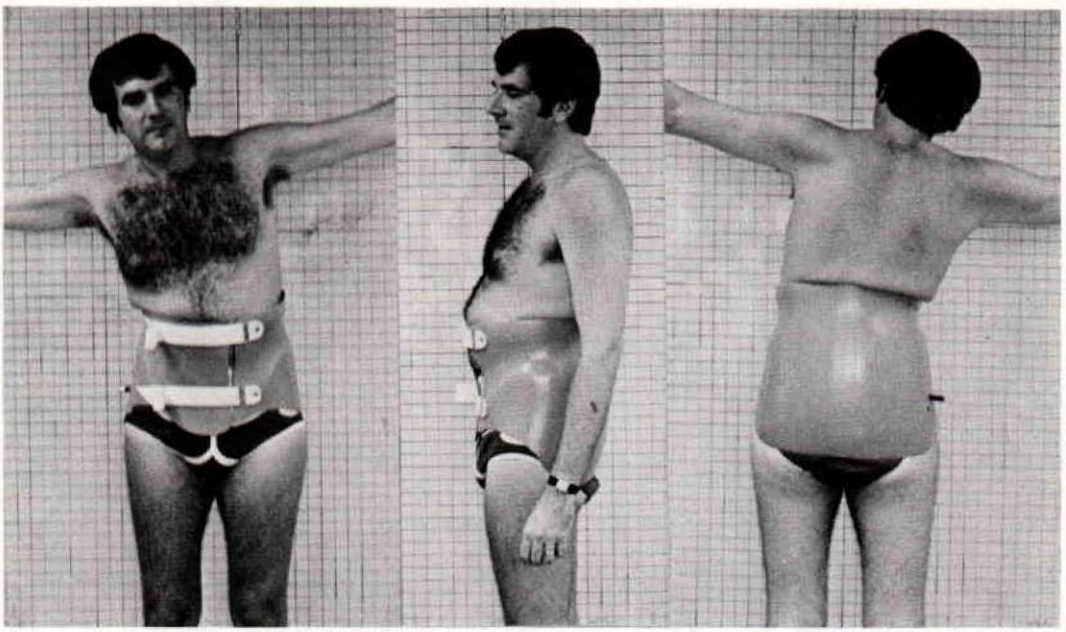


Fig. 3. The Lumbosacral Orthosis with Inflatable Pads.

To don the LSO/Inflatable Pads, the patient tightens the closures and then inflates the bladders (using an inflation bulb) to provide intra-abdominal pressure until he feels he has adequate support. The patient may not need the additional pressure supplied by the inflatable pads for relief of pain, so the pads are used as an option.

THE LUMBOSACRAL A-P AND L CONTROL ORTHOSIS INCORPORATING A STIMULUS TO WITHDRAWAL (LSO/STIMULUS TO WITHDRAWAL)

The LSO/Stimulus to Withdrawal, developed by Gustav Rubin, M.D., and Werner Greenbaum, C.P.O., Veterans Administration Prosthetics Center, consists of a molded thermoplastic pelvic section and a molded thermoplastic thoracic section that are separated by two threaded rods, one on the right lateral side and one on the left lateral side. Each rod is attached to the pelvic section by means of a ball joint riveted to a metal attachment plate. A nut on the threaded rod makes it possible to easily adjust the distance between the pelvic and thoracic sections (Fig. 4).

The pelvic and thoracic sections both consist of separate right and left halves that are attached posteriorly, with an anterior opening that is fastened by adjustable Velcro straps. The thermoplastic sections are prefabricated and premolded to fit superior to the iliac crests and inferior to the inferior costal margin.

Fabrication and Fitting

The orthosis is fitted by placing the right and left pelvic sections firmly on the patient, or on a plaster mold of the patient, and trimming away the excess material. Modifications of flares and reliefs may be made in the thermoplastic by heating and recontouring. The two halves are riveted together posteriorly and a Velcro closure is placed anteriorly. The thoracic section is then fitted in approximately the same manner. The metal attachment plates and the tubing in which the threaded rods will be held are then aligned vertically and parallel to each other, and riveted to the right and left lateral aspects of the thoracic section. The threaded rods are aligned to match the tubing placement and riveted to the pelvic section. Final rod adjustments and trimming complete the fitting.

The patient can adjust the pressure against his costal margin by increasing or decreasing the

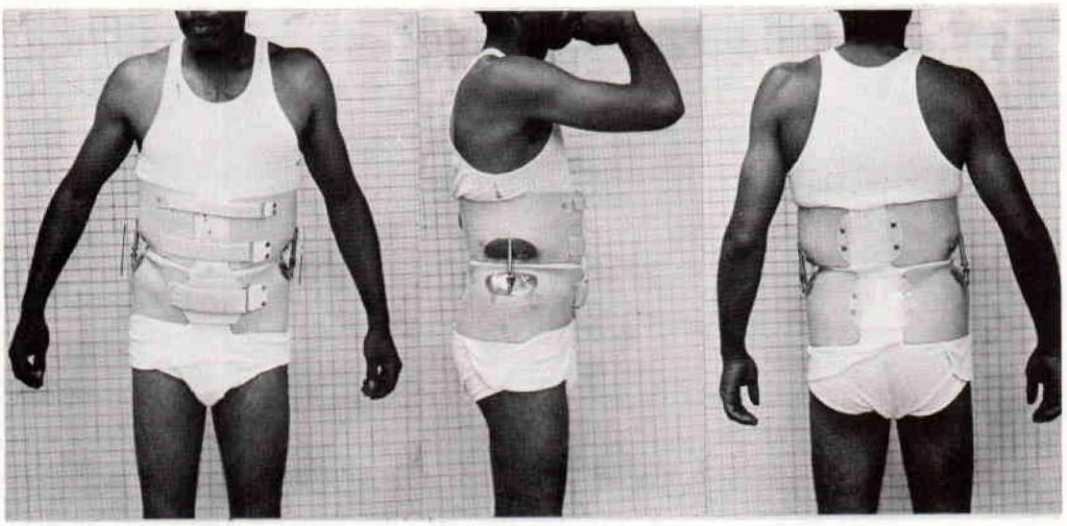


Fig. 4. The Lumbosacral Orthosis Incorporating a Stimulus to Withdrawal.

distance between the pelvic and thoracic sections. This is accomplished by raising or lowering the adjustment nut on the threaded rods. The amount of intra-abdominal pressure can be adjusted by varying the tension of the Velcro closures.

BIOMECHANICAL PRINCIPLES

The three-point pressure-system principle is inherent in both orthoses. Intra-abdominal pressure is also inherent in both orthoses, but to a greater degree in the LSO/Inflatable Pads. The "stimulus to withdrawal" principle is utilized in the VAPC design.

Because these biomechanical principles are the foundation of the orthoses that were evaluated, a review of these principles is presented in this section.

THE THREE-POINT PRESSURE SYSTEM

This well-known biomechanical force system has been the basic principle of orthotics for over a century.

In Figure 5, the patient is attempting right lateral flexion of the spine while wearing the LSO/Inflatable Pads. This motion is resisted by a counterforce of the orthosis at points A, B, and C. The force at point A causes the tissue bulge superior to the orthosis, and the force at point C causes the tissue bulge inferior to the orthosis. It is then evident that these two forces are directed towards the patient because they resist the patient's lateral motion. Forces A and B must be equalled by a force in the opposite direction or the force system would not be in equilibrium. Force C provides this equal and opposite force. Thus when the patient attempts right lateral flexion he is also resisted by force C, which is located at and superior to the iliac crests.

Figure 6 demonstrates the same force system on a patient attempting right lateral flexion while wearing the LSO/Stimulus to Withdrawal. The system may be in effect to resist flexion and extension of the spine as long as there is a mechanical force resisting these motions.

INTRA-ABDOMINAL PRESSURE

The biomechanical principle of intra-abdominal pressure cannot be observed on the patient as in the previous case and, therefore, will be presented graphically. The explanation and diagrams of the biomechanics of intra-abdominal pressure presented here are based entirely upon the work of Morris, Lucas, and Bressler (*5*).

When a 170-lb. man lifts a 200-lb. barbell, forces acting upon the spine may be computed (Fig. 7) by multiplying the weights of the body parts, and the weight of the barbell times the perpendicular distance to the fulcrum. When the disc between the fifth lumbar vertebra and the

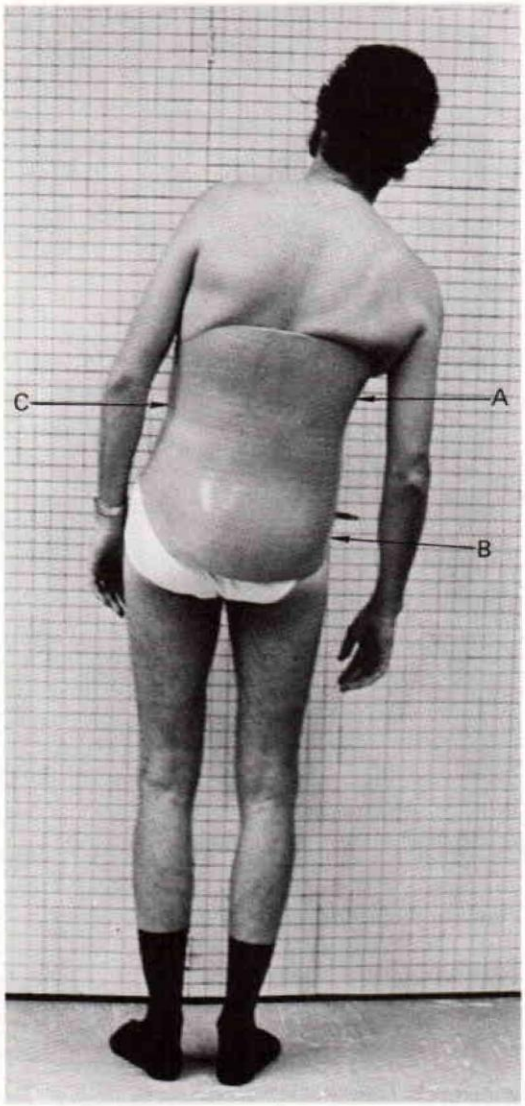


Fig. 5. The three pressure points preventing right lateral flexion of the spine on the LSO/Inflatable Pads.

first sacral vertebra (lumbosacral disc) is considered to be the fulcrum, the force on the lumbosacral disc will be 2,071 lb. However, experimental studies of the isolated ligamentous spine have demonstrated structural failure (fracturing) of the vertebrae under compressive loads ranging from 1,000 to 1,710 lb. and as little as 300 lb. in older people. The question arises as to how the lumbar vertebrae and discs are able to withstand the amount of force that can be imposed in this example.

One possible explanation is to consider the spinal column as a segmented elastic column supported by the paraspinal muscles and attached to the thoracic and abdominal cavities. These cavities are filled, respectively, with air and a semifluid mass. The action of the trunk muscles converts these chambers into nearly rigid-walled cylinders which can resist a part of the force generated in loading the trunk and thereby relieve the load on the spine itself.

When large forces are applied to the spine—for example, lifting weights of 100 to 200 lb.—there is generalized contraction of the trunk muscles, including the intercostals, the muscles of the abdominal wall, and the diaphragm. The muscles about the shoulder girdle and those of the back are, of course, also active during lifting, just as the muscles of the thighs help maintain body balance and the erect position.

The action of the intercostals and of the muscles

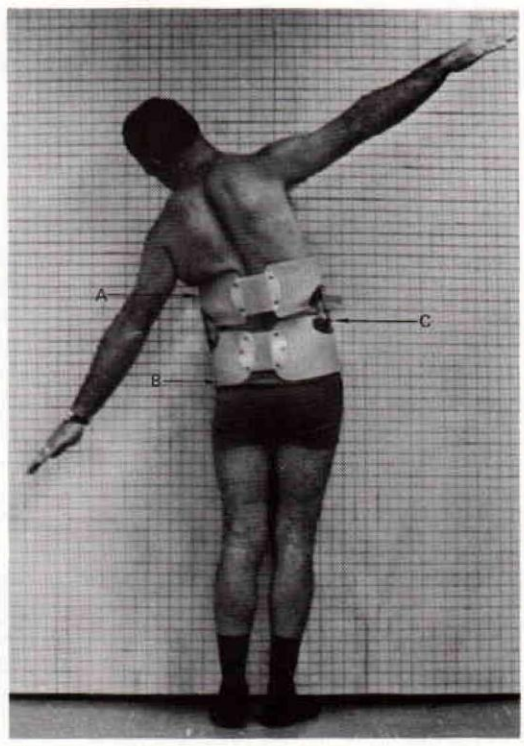


Fig. 6. The three pressure points preventing left lateral flexion of the spine on the LSO/Stimulus to Withdrawal.

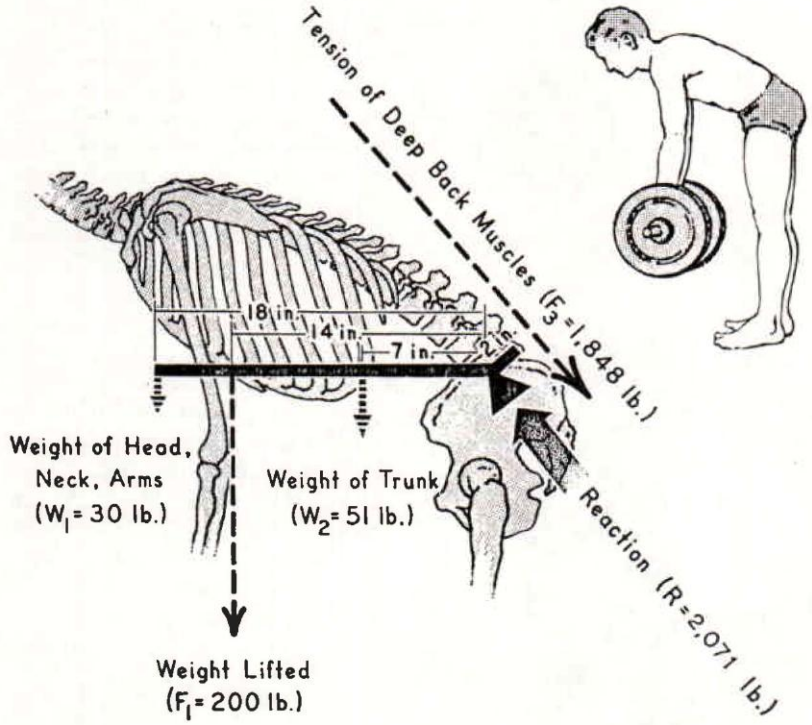


Fig. 7. Forces applied to the spine of a 170-lb. man lifting a 200-lb. weight, the tension of the deep back muscles, and the lever arms that transfer 2,071 lb. of force to the lumbosacral disc. (*Journal of Bone and Joint Surgery*)

of the shoulder girdle renders the thoracic cage a quite rigid structure firmly bound to the thoracic part of the spine. When inspiration and the action of the intercostal muscles which stabilize the rib cage increase intrathoracic pressure, the thoracic cage and spine become a solid, sturdy unit capable of transmitting large forces. By the contraction of the diaphragm, attached at the lower margin of the thorax and overlying the abdominal viscera, and of the muscles of the abdominal wall, especially the transversus abdominis, the abdominal contents are compressed into a semirigid cylinder.

The force of weights lifted by the arms is thus transmitted to the spinal column by the shoulder-girdle muscles, principally the trapezius, and then to the abdominal cylinder and to the pelvis, partly through the spinal column but also through the rigid rib cage.

When larger forces are involved, there is need for increased rigidity of the rib cage and compression of the abdominal contents. This accounts for the increased activity of the trunk muscles and the increase in intra-abdominal pressure due to the contraction of the abdominal muscles and to the compression of the abdomen by the force which is transmitted through the trunk (Fig. 8).

This view is well substantiated by the fact that when an air-pressure corset is worn, although the resting abdominal pressure is considerably elevated (by approximately twenty millimeters of mercury), the pressures recorded during loading of the spine are similar to those recorded without the corset (Figs. 9 and 10). However, the activity of the abdominal muscles is markedly decreased when the inflatable corset is worn. It appears, therefore, that the contracted muscles of the abdominal wall or the rigid external-pressure apparatus act to contain the abdominal contents in a compressed state capable of transmitting force. When the compression or restraint is accomplished by an external apparatus, there is little

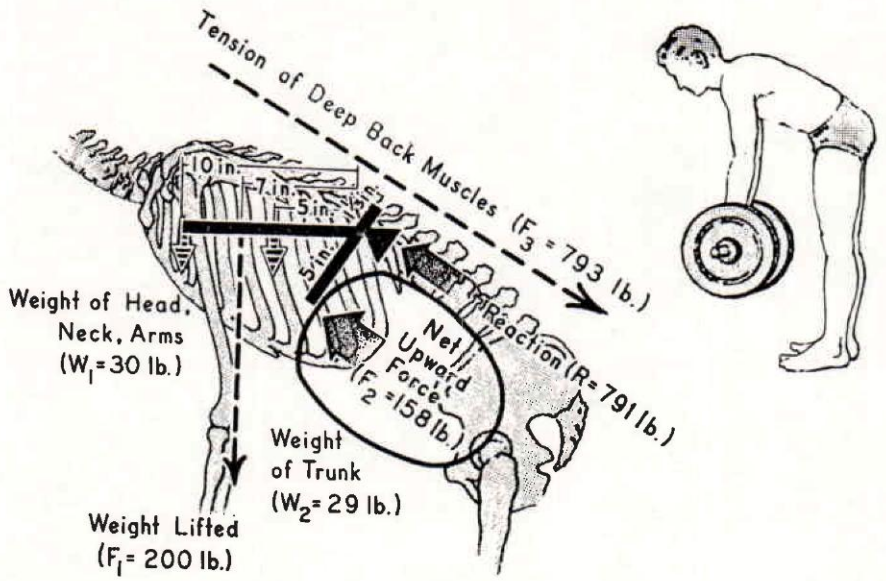


Fig. 8. Effect of intra-abdominal pressure. The force on the lower thoracic and upper lumbar vertebrae is reduced to 791 lb.

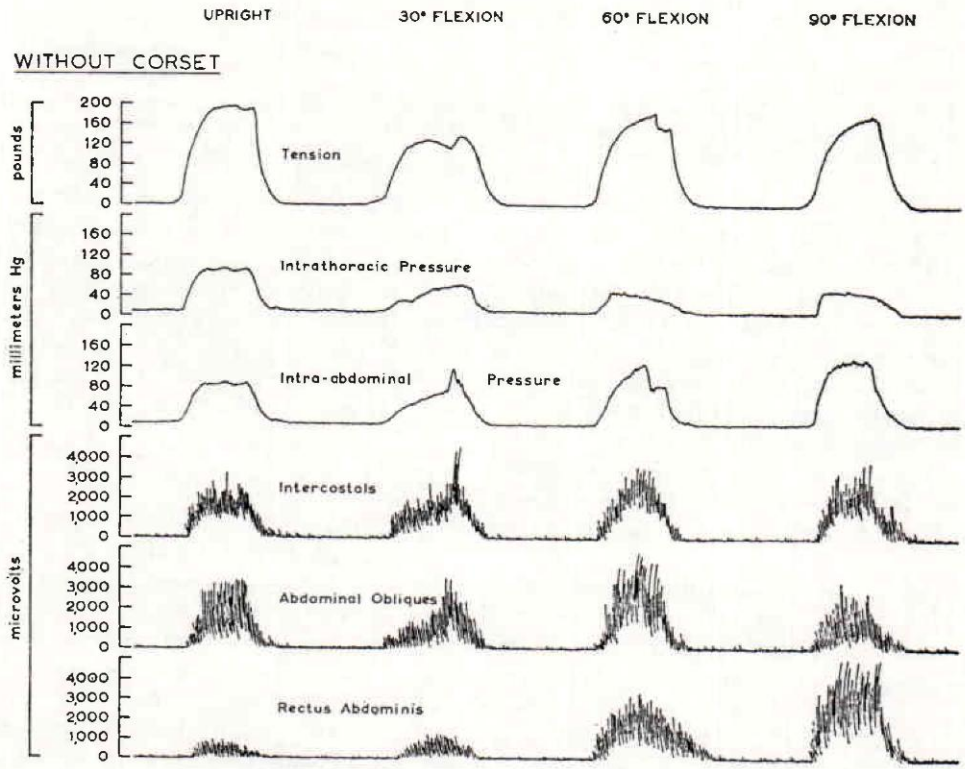


Fig. 9. Without corset, during static loading of the spine, intra-abdominal and intrathoracic pressure increase as abdominal muscle contraction increases. (*Journal of Bone and Joint Surgery*)

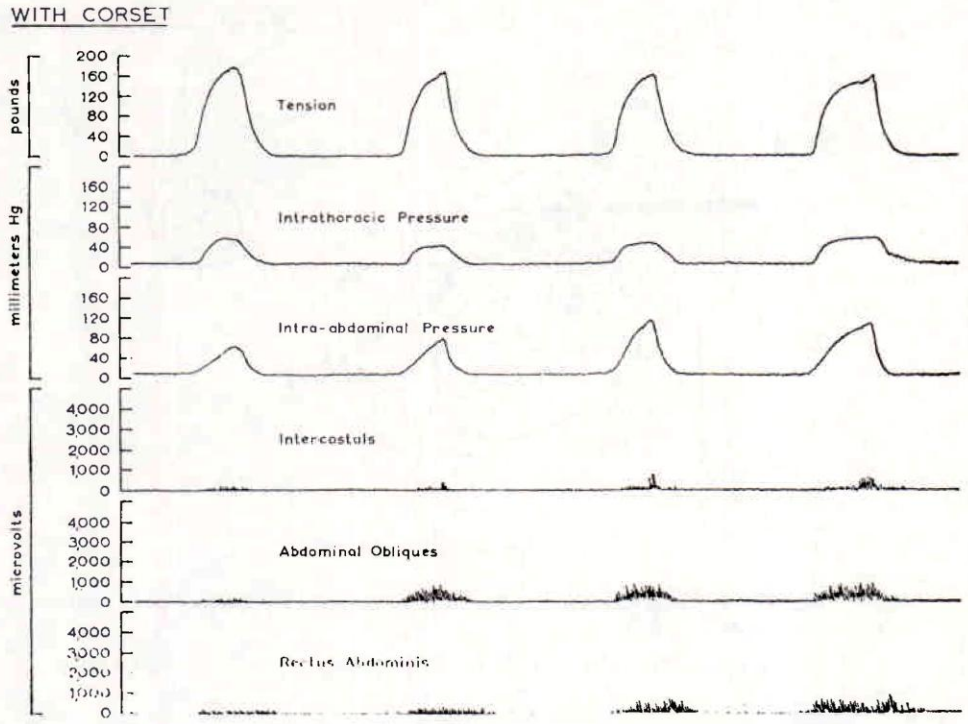


Fig. 10. While wearing a corset, during static loading of the spine, intrathoracic and intra-abdominal pressures increase, but less contraction of the abdominal muscles is necessary due to the supportive effect of the corset. (*Journal of Bone and Joint Surgery*)

need for contraction of the abdominal muscles. However, a small amount of activity is noted in the abdominal muscles even when the corset is worn, especially when greater forces or heavier loads are applied. The amount of compression of the viscera necessary to transmit these great forces can be tolerated briefly but not for prolonged periods. Since, in this study, the apparatus was inflated to the limit of comfort for extended periods, the abdomen was not compressed enough to obviate entirely the need for muscle activity with the larger forces.

It should be emphasized that the mechanism discussed here is a reflex mechanism. When a load is placed on the spine, the trunk muscles are involuntarily called into action to fix the rib cage and to restrain or compress the abdominal contents. The intracavity pressures are thereby increased, aiding in the support of the spine.

It may be concluded, from this calculation of the contribution of the trunk compartments to the support of the spine, that the actual force on the spine is much less than that considered to be present when support by the trunk, or the effect of the intracavitary pressures, is omitted. The calculated force on the lumbosacral disc is about 30 percent less, and that on the lower thoracic portion of the spine is about 50 percent less than would be present without support by the trunk.

STIMULUS TO WITHDRAWAL

The effect of the stimulus to withdrawal has also been called "inductive pressure" or the stimulus to "voluntary distraction." Jordan used the term "active correcting" to describe stimulus to withdrawal and defined it for spinal orthoses by stating, "the corrective forces of this appliance (CTLS "Milwaukee" orthosis) bring the trunk and the spine into such a position that the patient has to use his active muscle power for the correction of the deformity" (*4*).

The stimulus to withdrawal is caused by small pressures over prominent body areas. The pres-

sure is *not* continuous, and the patient can at any time withdraw himself from the pressure (*10*). An example of this is found in the throat mold on the anterior neck ring of the CTLS "Milwaukee" orthosis. When the patient slumps forward, his neck presses against the throat mold, and he withdraws his neck from this pressure by extending his spine.

The pressures causing the stimulus in the LSO/ Stimulus to Withdrawal are caused by the undercut contour of the pelvic and thoracic bands. When the patient slumps in the orthosis, the weight of the thorax rests on the inferior costal margin and the iliac crests. The pressure stimulates the patient to withdraw his weight by extending the spine and inspiring. This system, in effect, reminds the patient to maintain correct spinal alignment (Figs. 11 and 12).

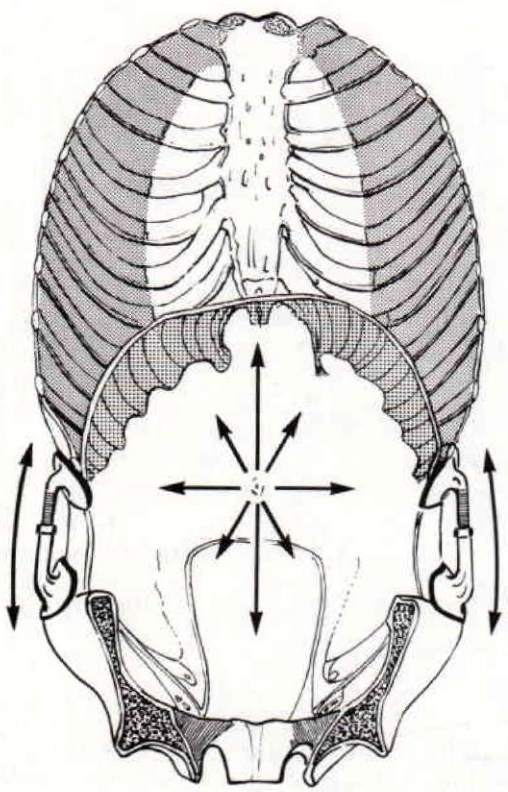


Fig. 11. View of trunk sectioned in frontal plane. The posterior section has been removed and viewer is looking toward the sternum. Note the curve of the diaphragm, the upper distribution of pressure, and the lateral supporting struts.

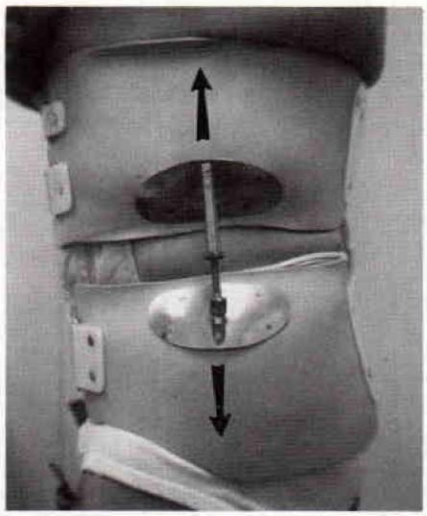


Fig. 12. Sagittal view of patient wearing the Lumbosacral Orthosis Incorporating a Stimulus to Withdrawal. Arrows depict the direction of forces applied by the pelvic and thoracic sections.

THE PURPOSE AND ORGANIZATION OF THE EVALUATION

The primary purpose of the clinical evaluation was to determine whether or not these orthoses could benefit patients with low back pain by providing relief from this pain. Also of importance was an attempt to determine if the orthoses utilized the principles stated by the developers, and to detect characteristics of design and materials. The results of the study are to be used by the Veterans Administration and by the Department of Health, Education, and Welfare to determine policy, by educational institutions as instructional material, and by medical and paramedical personnel as a guide for patient management. A schematic presentation of the major steps in the program is made in Figure 13.

The evaluation was initiated as a result of a request by the Veterans Administration.

At the fifteenth meeting of the Subcommittee on Evaluation the assignment was accepted, the members and staff were made familiar with the orthoses, and guidelines for the study were developed.

A steering committee was formed which met later in New York at which time the evaluation centers were chosen, the protocol was formed, and the timetable was set.

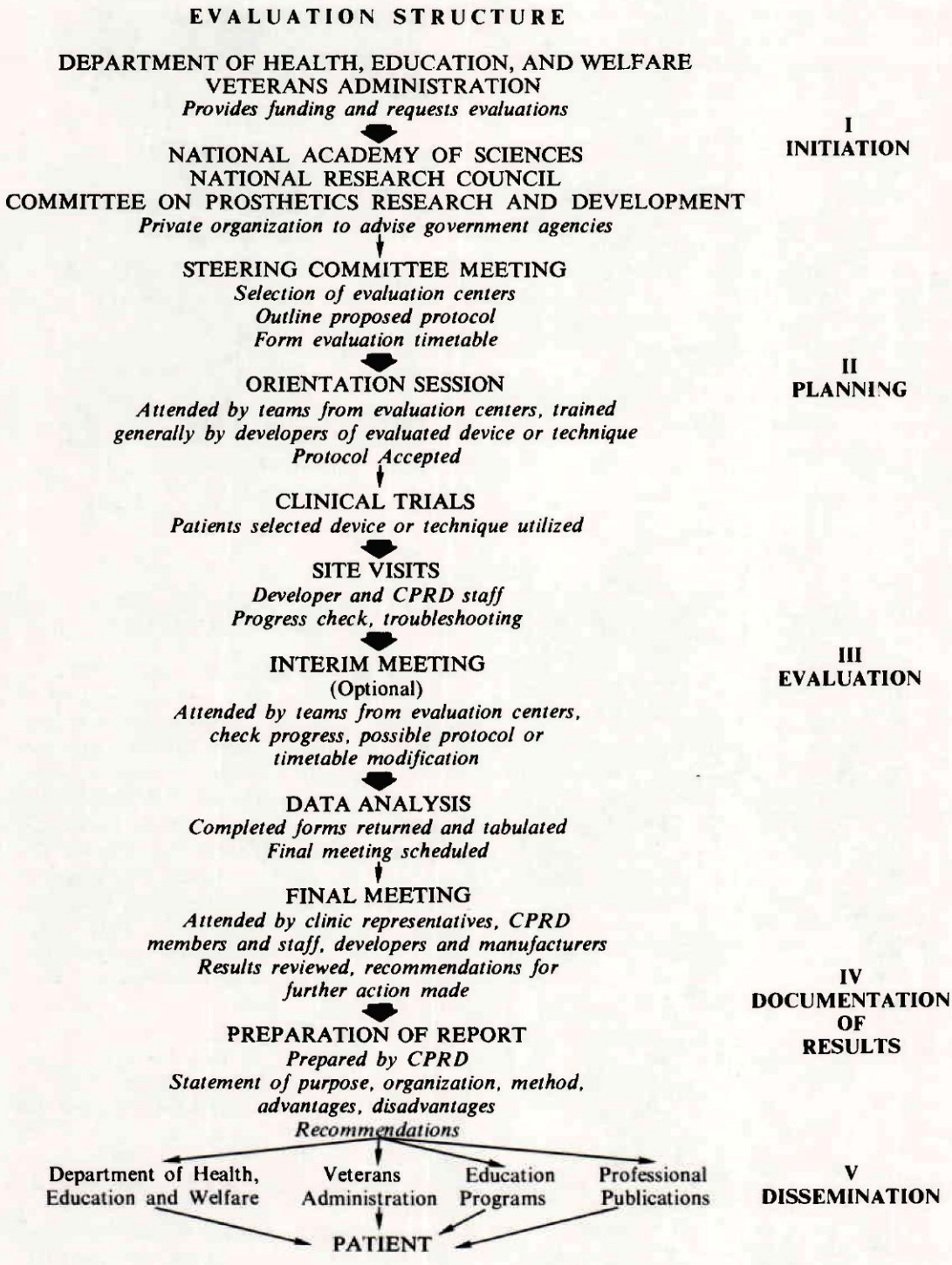


Fig. 13. Schematic presentation of major steps of a typical clinical evaluation program carried out by CPRD.

EVALUATION CENTERS

The evaluation centers and members of the respective clinic teams were:

New York University
George Hartman, C.P.O.
Susan Bergholtz, R.P.T.
Ralph Lusskin, M.D.

Columbus Orthopedic Appliance Company
Herman B. Ording, C.O.
Edward Weis, M.D.

Northwestern University
James Russ, C.O.
Robert Keagy, M.D.

Rancho Los Amigos Hospital
Roy Snelson, C.P.O.
Vert Mooney, M.D.

PROTOCOL

The patient protocol was determined as follows:

1. *The patient must have a six-month history of low back pain.* This would eliminate the many patients who recover from back pains naturally within this period of time.

2. *There must have been history of previous use of conventional spinal orthoses.* Both orthoses are intended only for patients who cannot obtain relief using a less restrictive type of support.

3. *Appropriate trunk sensation and musculature must be present.* Both orthoses depend upon patient sensory feedback as both of them have pressure adjustment mechanisms. Muscle control is needed to withdraw from pressure areas when necessary. Sensation is also necessary if the patient is to provide valid opinions of the fit of the orthoses.

4. *There was to be no history of recent postoperative spinal fusion or other complicating problems.* This restriction was made in order to limit variables which might arise from postsurgical complications or additional pathologies.

5. *Patients were to be male adults.* The LSO/Stimulus to Withdrawal was developed by VA and had only been fitted on male patients. This rule was also applied to the LSO/Inflatable Pads to eliminate variables.

6. *There should be no underlying financial or emotional factors present which might unduly influence the patient's assessment of the orthoses.* Low back pain often originates from accidents involving lawsuits, or is the primary reason a patient receives disability compensation, and therefore a financial factor enters the picture. Emotional problems, often family-related, often accompany recurrence of back pain, and may cause a further bias in the patient's opinions.

NUMBER OF CLINICAL TRIALS

It was planned that each evaluation center would fit eight patients with each type of spinal orthosis, for a total of 16 fittings. In addition, each center would fit one of each type of orthosis as a practice fitting, not to be included in the results. A total of 64 patients, 32 with each type of orthosis, would be fitted by the end of the evaluation. A trial wear period of three months would be necessary to determine the success of each orthosis. It was estimated that all patients could be fitted during the first three months of the evaluation, and wear the orthoses the final three months.

TIMETABLE

The evaluation timetable was set as follows:

June 1973	Orientation session
July	Site visits after practice session
August	
September	Completion of all fittings
October	
November	Conclusion of study and submission of
December	evaluation forms to the Committee on
January 1974	Prosthetics Research and Development

ORIENTATION SESSION

Clinic teams from the four centers met at the VA Prosthetics Center in New York June 4-7, 1973. An explanation of the orthoses was given by the developers, Drs. Rubin and Morris, on the first day. The evaluation protocol was explained, as well as instructions on filling out the seven evaluation forms.

Two additional forms were included in the evaluation to record supplementary information. These were the "Technical Analysis Form for the Spine," and the "Subjective Pain Picture" form used at Rancho Los Amigos Hospital to record the location and type of pain a patient experiences.

The second and third days of the orientation

session were laboratory sessions for the orthotists. Measurements, casting, modifications, and fitting were demonstrated for the LSO/Inflatable Pads, and each orthotist fitted the LSO/Stimulus to Withdrawal.

RELATED STUDY

A related study of the orthoses was to be undertaken as part of a larger study by Robert Tooms, M.D., and Ralph Snell, C.P.O. The purpose of the study was to determine roentgenographically the amount of spinal immobilization that spinal orthoses provide.

EVALUATION

Each of the evaluation centers received the components needed for the casting and fabrication of the orthoses. They also received a folder of instructions and evaluation forms for each patient. All problems concerning the materials were reported to CPRD directly, and then the developers were notified. This system allowed CPRD to record any complications that would arise.

Site Visits

Clinical trials began in late June and July and site visits to the four clinics were made in August. By August, three of the centers fitted one LSO/Stimulus to Withdrawal, each with no apparent problems. The fourth center, Rancho Los Amigos Hospital, had fitted ten of the same orthoses by this time, including two additional fittings on females.

At this point in the evaluation it was obvious that all centers preferred fitting the LSO/Stimulus to Withdrawal because of the ease of fabrication. The fittings began slowly due to vacation schedules.

Another site visit was made in October by a CPRD staff member and Werner Greenbaum. The status of the evaluation at this time was:

New York University—Not visited. One patient had been fitted. Local treatment philosophy and a lack of physician cooperation apparently restricted patient recruitment.

Columbus Orthopedic Appliance Company—Six patients wearing the LSO/Stimulus to Withdrawal were reviewed. Four of the six patients obtained more relief in the orthosis. One patient wearing the LSO/Inflatable Pads was reviewed, and he also stated he had additional relief.

Northwestern University—Two patients using the LSO/Stimulus to Withdrawal had favorable results.

Rancho Los Amigos Hospital—Of the ten patients fitted, three using the LSO/Stimulus to Withdrawal were seen. Two had good results. One patient fitted with the LSO/Inflatable Pads rejected it due to an unsatisfactory fit.

Of the 64 orthoses to be fitted in the evaluation, 23 were on patients at this time. However, 21 of these were the LSO/Stimulus to Withdrawal. At this point, the major thrust of the evaluation was placed on fitting the vast majority of future patients with the LSO/Inflatable Pads. It was also apparent at this time that physician cooperation was lacking at three of the four centers.

DATA ANALYSIS

In December 1973, all centers were requested to complete the evaluation forms, take photographs of their patients, and forward this information to the Committee on Prosthetics Research and Development for tabulation by January.

The data were tabulated by the CPRD staff and by a member of the Subcommittee on Evaluation, Dr. G. E. Sharples. Dr. Sharples helped design the forms in a manner that made it easy for the clinics to record information, and simplified the task of tabulation and data comparison.

Lumbosacral Orthosis Incorporating a Stimulus to Withdrawal

The following section presents the results obtained from evaluation forms.

Clinical Trials

Total patient fittings	21
*Patients meeting protocol	14
Average age (years)	49
Age range (years)	30-69

*The most common breach of protocol concerned recent surgery and complicating conditions; four patients did not meet this standard. Two patients were female.

Pathologies

Herniated disc	5
Chronic low back pain	4
Facet arthropathy	3
Spondylolisthesis	2
Degenerative disc	2
Osteoporosis and scoliosis	1
Unstable fusion	1
Marfan's syndrome	1
	19
Not given	2
	21

Pain Levels

Prior to fitting of their previous orthoses (not evaluated orthoses), pain level ranged from moderate to severe for all 21 patients.

Pain Relief from Previous Orthoses

Some relief	13 patients
No change	5 patients
No response	3 patients

Previous Orthotics Experience

Previous orthoses were utilized by 18 of the patients. The orthoses in order of frequency were:

Lumbosacral corsets	9
Lumbosacral A-P control	5
Thoracolumbosacral A control (hyperextension)	1
Sacroiliac belt	1
Lumbosacral P-ML control (flexion)	1
Flexion body jacket	1
No previous orthosis	2
No response	1
	21

The length of time the patients had used their previous orthoses ranged from two weeks to five years. *The average time was 16 months, the mean time was 12 months.*

Experience with the LSO/Stimulus to Withdrawal

Patients provided information after a 3-month trial-wear period by comparing the new orthosis to previous orthoses.

Increased relief of pain	7 patients
Decreased relief of pain	3 patients
No change	9 patients
No response	2 patients
Rejected	0

Amount of Pain Relief with Medication

The change in amount of medication used for pain relief was noted in order to further evaluate the effectiveness of the orthoses.

Increase in medication	1 patient
Decrease in medication	5 patients
Does not use medication	2 patients
No change	9 patients
No response	4 patients

Activity Levels

Increase in activity	5 patients
Decrease in activity	3 patients
No change	13 patients

Physicians' Comments

In 15 instances the physicians thought the orthoses performed as stated by the developer, but in five they did not think so. However, 19 of the 20 physician responses indicated that they planned to prescribe the LSO/Stimulus to Withdrawal for other patients when it became available.

An average physician response was that 30 percent of chronic low-back-pain patients might benefit from the orthosis.

Orthotist Time Requirements

Average evaluation and measurement time	1 hour 20 min.
Average fabrication time	1 hour 15 min.
Average fitting time	2 hours 20 min.
Average total time	4 hours 55 min.

Lumbosacral Orthosis with Inflatable Pads

Clinical Trials

Total patient fittings	13
*Patients meeting protocol	10
Average age (years)	44
Age range (years)	22-70

*Three patients were female.

Pathologies

Herniated disc	3
Chronic low back pain	2
Arthritis	2
Laminectomy $L_{345}S_1$	1
Low back strain	1
Trauma	1
	10
Not given	3
	13

Pain Levels

Ten patients reported having severe pain prior to their previous orthotic fitting (not the evaluated orthosis); two reported moderate pain.

Pain Relief from Previous Orthoses	
Much relief	3 patients
Some relief	7 patients
No change	2 patients
Worse	1 patient

Previous Orthotics Experience	
Lumbosacral A-P control	7
Lumbosacral corsets	4
Lumbosacral P-ML control (flexion)	1
	12
Not given	1
	13

These orthoses were used from 3 months to 40 years. One patient wore a lumbosacral A-P control 40 years, one wore one 15 years, and one for 5 years. Another patient had worn a corset for 6 years. The average length of time that previous orthoses were worn was 6 years 5 months, although the mean time was only 2 years.

Experience with the LSO/Inflatable Pads

Patients provided information after a 3-month trial-wear period by comparing the new orthosis to their previous orthoses.

Increased relief of pain	6 patients
No change	3 patients
Orthosis rejected	4 patients

Amount of Pain Relief with Medication	
Decrease in medication	1 patient
No change	8 patients
No response	4 patients

Activity Levels	
Increase in activity	4 patients
Decrease in activity	2 patients
No change	3 patients
No response	4 patients

Physicians' Comments

Eight of the patients' physicians thought the orthosis was a suitable prescription, one did not. Seven patients' physicians thought the orthosis performed as indicated by the developer, four did not respond to the questions.

Four physicians thought the LSO/Inflatable Pads would benefit 10 percent of chronic low-back-pain patients, one stated 20 percent, and seven did not respond. Seven patients' physicians stated they would prescribe the orthosis again; three were unsure.

Orthotist Time Requirements	
Average evaluation and measurement time	1 hour 15 min.
Average fabrication time	6 hours
Average fitting time	1 hour 20 min.
Average total time	8 hours 35 min.

FINAL MEETING

A final meeting was held on March 6 to interpret the results and to make recommendations for further use. The orthotist from each clinic, the developers, members of the CPRD Subcommittee on Evaluation and staff, and representatives from the Veterans Administration and the Department of Health, Education, and Welfare attended.

Each clinic reviewed their results, and the developers reported their experiences with the orthoses.

RECOMMENDATIONS

GENERAL

Due to the increased activity levels of the patients, the 10 to 1 preference by patients to keep the orthoses, and the additional pain relief obtained by approximately 50 percent of the patients, it was recommended that both the LSO/Stimulus to Withdrawal and the LSO/Inflatable Pads be included among those utilized by the Veterans Administration physicians and all other physicians when patients meet the indications.

THE LSO/STIMULUS TO WITHDRAWAL

Prescription Considerations

The following prescription considerations were recommended:

1. Patients with low back pain should use conservative measures such as bed rest, analgesics, lumbosacral corsets and orthoses, etc., before utilizing this orthosis, which should be used mainly for chronic persistence of pain.

2. Contraindications include front herniated disc with sciatica and neurological deficit, throm-

bophlebitis, cardiac problems, emphysema, severe varicose veins, obesity, etc.

3. Patients should have adequate trunk sensation and musculature in order to effectively adjust the distraction rods.

Orthotic Recommendations

1. Different types of plastics, such as polyethylene and polypropylene, should be tried to replace the present material (Prenyl).

2. The prefabricated pelvic and thoracic sections should be more symmetrical and possibly flared over pressure areas.

3. The draft instruction manual should be updated to include the indications for the orthosis, the principles employed, and contemporary terminology.

The developers and manufacturer indicated that they would comply with the recommendations.

THE LSO/INFLATABLE PADS

Prescription Considerations

The following prescription considerations were recommended:

1. Patients with low back pain should use conservative measures such as bed rest, analgesics, lumbosacral corsets and orthoses, etc., before utilizing this orthosis, which should be used mainly for chronic persistence of pain.

2. Contraindications include front herniated disc with sciatica and neurological deficit, thrombophlebitis, cardiac problems, emphysema, severe varicose veins, obesity, etc.

3. Patients should have adequate trunk sensation and musculature in order to adjust the inflatable pads effectively when they are used.

4. Prospective patients should wear a plaster flexion body cast (Hauser type) for three days, as the effectiveness of this cast for pain relief will generally indicate the effectiveness of the orthosis.

5. When using the orthosis for postsurgical stabilization, apply it after the sutures are removed (7-8 days postoperative) and request the patient to wear it all day for 6 months, preferably being removed only for bathing.

Orthotic Recommendations

1. The inflatable pads should be used *optionally*, and are not needed in many cases. The pads can be placed in the orthosis at a later date, although they will fit in the orthosis better if allowed for during fabrication.

2. Although a thermoset (polyester resin) was used throughout the evaluation for fabrication, it is recommended that a thermoplastic material be used to decrease fabrication time.

3. The draft instruction manual used throughout the evaluation needs rewriting, specifically to clarify and augment the design principles, casting and cast modification procedures, to state fitting procedures, and to explain the proper use of the orthosis.

4. The inflation system of the air bags and the valves need improvement.

The developer agreed with the recommendations and indicated that future work would follow along these lines.

EVALUATION ASSESSMENT

The evaluation provided results that can be applied to redesign and use of the two orthoses. However, a number of problems occurred during the evaluation that might have been avoided. Each of the evaluation steps will be reviewed briefly in this section in order to assess where problems arose.

INITIATION

The LSO/Stimulus to Withdrawal had been used successfully by the developers on over 20 patients before it was evaluated. Prefabricated components had been made and the limitations of the orthosis were well defined.

The LSO/Inflatable Pads was still in the development stage when it was evaluated, and the measurement, casting, fabrication and fitting procedures had not been well defined.

Thus, at the initiation of the evaluation both orthoses were designed to relieve chronic low back pain, but were at different stages of development. This fact partially accounts for the greater patient acceptance the LSO/Stimulus to Withdrawal received in the evaluation.

PLANNING

Three of the evaluation centers did not fit their quota of patients. One of the centers only reported two fittings prior to the final meeting. This problem could probably have been avoided had the centers been screened more thoroughly before their participation was requested. Two physicians in each area could have given estimates of the probability of recruiting 16 chronic low-back-pain patients within a three-month period who fitted the protocol. However, a patient-recruitment problem was not foreseen because of the large population of chronic low-back-pain patients. Had a screening taken place, possibly two of the four evaluation centers would have been changed.

The protocol was very practical. Despite the fact that 30 percent of the patients did not fit all six protocol requirements, the results were successful. A protocol should be used to define the type of patient, but should allow a small amount of flexibility during the evaluation if it is to be realistic.

The seven evaluation forms were designed as checklists, with each of the seven forms covering slightly different areas. Some areas overlapped in order to cross-check and compare information. The small amount of time required to complete these forms accounted for the large amount of feedback received from such a small number of patients. Long, complicated forms that require written answers often are left incomplete.

The "Technical Analysis Form for the Spine" was generally found to be confusing to use, and of little clinical use to the participants of the evaluation. It was recommended that this form be utilized as a teaching aid rather than a clinical tool.

The "Subjective Pain Picture" was found to be a useful method of recording the patterns and types of pain experienced by chronic low-back-pain patients.

The orientation session went well for the major part of the presentations, but the lack of a defined system of casting, measurement, fabrication and fitting of the LSO/Inflatable Pads resulted in a disorganized laboratory session with the orthotists. This lack of organization and understanding followed the LSO/Inflatable Pads throughout the entire evaluation. The orthotists were also disenchanted with the great amount of time needed to fabricate this orthosis, and it was apparent in the evaluation results that they did not have the time.

EVALUATION

The lack of available patients, mentioned earlier, was the only complication throughout the evaluation.

The related study of the limitation of motion provided by spinal orthoses (Tooms, Snell) did not produce well-defined results for these orthoses, and therefore the results have not been included in this report.

COMMENTS

The amount of feedback from evaluation centers and the acceptance of the evaluation by the centers directly relate to the planning of the evaluation. Uncomplicated and brief evaluation forms, advance screening of the centers, and open lines of communication will undoubtedly result in a successful evaluation.

LITERATURE CITED

1. American Academy of Orthopaedic Surgeons, *Orthopaedic Appliances Atlas, Vol. 1*, J. W. Edwards, Ann Arbor, Mich., 1960, Chapt. 1.

2. Blount, W. P., and J. H. Moe, *The Milwaukee Brace*, Williams & Wilkins, Baltimore, 1973.

3. Hauser, E. D. W., Corrective cast for treatment of low back pain. *J.A.M.A.*, **128**:92, May 1945.

4. Jordan Henry H., *Orthopedic Appliances: The Principles and Practice of Brace Construction*. 2nd ed., Charles C Thomas, Springfield, Ill., 1963.

5. Morris, J. M., D. B. Lucas, and B. Bressler, Role of the trunk in stability of the spine. *J. Bone and Joint Surg.*, **43-A**:3:327-351, April 1961.

6. National Center for Health Statistics, *Chronic Conditions and Limitations of Activity and Mobility: United States, July 1965—June 1967*. PHS Publ. No. 1000, Series 10, No. 61, January 1971.

7. National Center for Health Statistics, *Impairments Due to Injury: United States, 1971*. DHEW Publ. No. (HRA)74-1514, Series 10-87, December 1973.

8. Perry, J., The use of external support in the treatment of low back pain. *J. Bone and Joint Surg.*, **52-A**:7: 1440-1442, October 1970.

9. Raney, Frank L., Jr., *The royalite flexion jacket*, in *Spinal Orthotics*, [report of a workshop sponsored by the Committee on Prosthetics Research and Development], National Academy of Sciences, March 1969.

10. Rubin, G., W. Greenbaum, and D. Molack, *A Lumbosacral A-P and M-L Control Orthosis Incorporating a Stimulus to Withdrawal*. Veterans Administration Prosthetics Center, New York, N.Y., 1974.

Orthotics and Prosthetics, Vol. 28, No. 3, pp. 43-48, September 1974

POLYPROPYLENE IN SPINAL ORTHOTICS

Mark Schultz, C.P.[1], and
Newton C. McCollough, III, M.D.[2]

For several years the thermoplastic material, Orthoplast[3], has been in use for the fabrication of certain spinal orthoses, particularly for the pelvic girdle of the Milwaukee Brace. However, Orthoplast, a synthetic balata, has limitations with respect to durability. We have found it to be quite acceptable for about a year and, in some cases, it has served adequately for as long as two years as the pelvic girdle for a Milwaukee Brace. However, body chemicals and time usually join forces soon after the first year to accelerate the deterioration of Orthoplast, causing the patient to face a rather expensive and time-consuming replacement process.

This problem led us to search for a more durable material, while recognizing the advantages of Orthoplast and similar thermoplastic materials —cosmesis, light weight, and better "total-contact" fit than has been possible with more conventional materials. Thermoplastics such as Kydex[4] and Vitrathene[5] have been tried as a substitute for Orthoplast with varying degrees of success. Both Kydex and Vitrathene are difficult materials to work compared with polypropylene.

The following is a summary of our experience with polypropylene, including the techniques for casting and molding it in the fabrication of pelvic girdles for the Milwaukee Brace and scoliosis jackets. A new application using polypropylene in the construction of a spinal flexion orthosis is also described.

Our initial experience with polypropylene was in the construction of ankle-foot orthoses (AFO) for drop-foot, where it proved to be resistant to repeated stress, easy to work, and remarkably durable. We have used polypropylene for AFOs for about a year and a half with no replacements required due to breakage or deterioration. We, therefore, naturally turned to polypropylene for trials in the construction of spinal orthoses. At this point, polypropylene has been used in the construction of over 30 spinal orthotic devices with equally rewarding results.

CASTING CONSIDERATIONS

Casting for the pelvic girdle portion of the Milwaukee Brace is carried out in the currently accepted way.

Casting for the postoperative scoliosis jacket is done in the same manner as for the Milwaukee Brace but with the patient standing in cervical traction straps to give stability during casting.

Casting for the scoliosis jacket for nonambulatory patients is done by lifting the patient into a sitting position until as much of the curve is corrected by gravity as is possible. A second person or a sling suspension must be used. An alternate technique for the wheelchair patient is to apply the cast in two sections, the anterior portion taken with the patient supine and the posterior portion with the patient prone. Plaster splints are used, and the two halves are joined together to form a negative mold.

Casting for the flexion jacket is performed by positioning the patient to eliminate as much lumbar lordosis as possible. Generally, this is best accomplished with the patient sitting partially on the mid portion of the thighs with the hips in about 20-25 deg. of flexion, and the patient's trunk erect with the arms resting on a support.

FABRICATION CONSIDERATIONS

Polypropylene is relatively easy to work. Once a cast has been taken of the patient, filled, modified and smoothed, a sleeve of cotton stockinette is pulled over it. A piece of polypropylene is cut to the circumference and length of the cast and both

[1]Prosthetics and Orthotics, Jackson Memorial Hospital, Miami, Florida 33136.

[2]Associate Professor, Department of Orthopaedics and Rehabilitation, University of Miami School of Medicine, Miami, Florida 33152.

[3]Johnson & Johnson, 501 George St., New Brunswick, N.J. 08901.

[4]Rohm & Haas Co., Independence Mall W., Philadelphia, Pa. 19105.

[5]Stanley Smith & Co., Wortle Road, Isleworth, Middlesex, England.

sides are sprayed with a silicone parting agent to prevent sticking. The material is then placed on an aluminum or stainless-steel tray for approximately 10-15 min. in an oven at a temperature of 400 deg. F. Oven time will vary with its thickness. When the material becomes clear, it is ready to be removed from the oven. It is imperative that polypropylene not be left in the oven too long.

Generally the molding process requires two people. The heated material is lifted slowly from the metal tray (Fig. 1) and placed on top of the prepared cast. When the seam is to be on the anterior aspect, the cast should be facing down. When a seam on the posterior aspect is required, the anterior part of the cast should be facing up. One person molds the top of the cast for total contact between the polypropylene and the cast, paying particular attention to modified areas. At the same time, another person molds the seam, working underneath the cast to insure total contact (Fig. 2). Excess polypropylene is trimmed off to prevent its weight from causing the material to sag and thus interfere with total contact (Fig. 3).

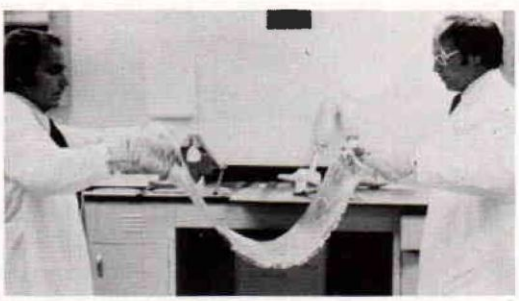


Fig. 1. The heated polypropylene sheet is lifted slowly from the oven.

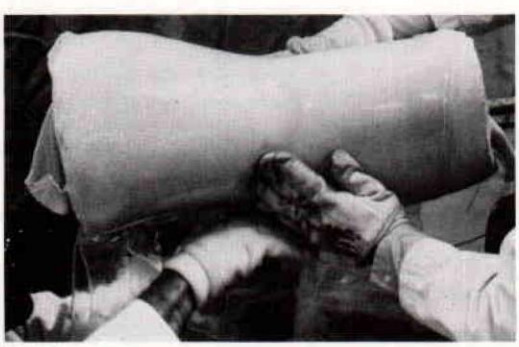


Fig. 2. One person molds the sheet over the upper surface while the other molds the sheet over the lower surface.

Fig. 3. Excess polypropylene is trimmed off to prevent it from pulling the heated sheet away from the cast.

Polypropylene shrinks as it hardens and, unless molded constantly, it will pull away from the mold, particularly in modified areas. It is necessary for one person to continually mold the material lightly, by hand, against the cast until completely hard. The working time varies with the thickness; material 1/16 in. thick has approximately 45 seconds of working time, and 3/32 in., about two minutes.

CASE ILLUSTRATIONS

Case No. 1: C.J. is a 14-year-old girl with a 35-deg. right thoracolumbar scoliosis. She is shown in Figure 4, fitted with a Milwaukee Brace that has a polypropylene pelvic girdle. The thoracolumbar pad is made of Plastazote (expanded polyethylene) which provides comfort comparable to standard pads with much greater durability. These pads are backed with aluminum sheet as in the standard pads (Fig. 5).

Case No. 2: M.S. is a 13-year-old boy postoperative to a Harrington fusion procedure for a right thoracic scoliosis. Figure 6 shows him in his postoperative polypropylene scoliosis jacket which was fabricated from a positive mold six months after insertion of the Harrington instrumentation.

Case No. 3: P.M. is a 20-year-old girl with severe scoliosis, measuring 120 deg. as a result of arthrogryposis (Fig. 7). She was nonambulatory and confined to a wheelchair, but her activities were limited because of trunk instability and the necessity to use her upper limbs for support while sitting. She was unable to transfer. Figure 8 shows her fitted with a polypropylene scoliosis jacket which served to enhance her trunk support and

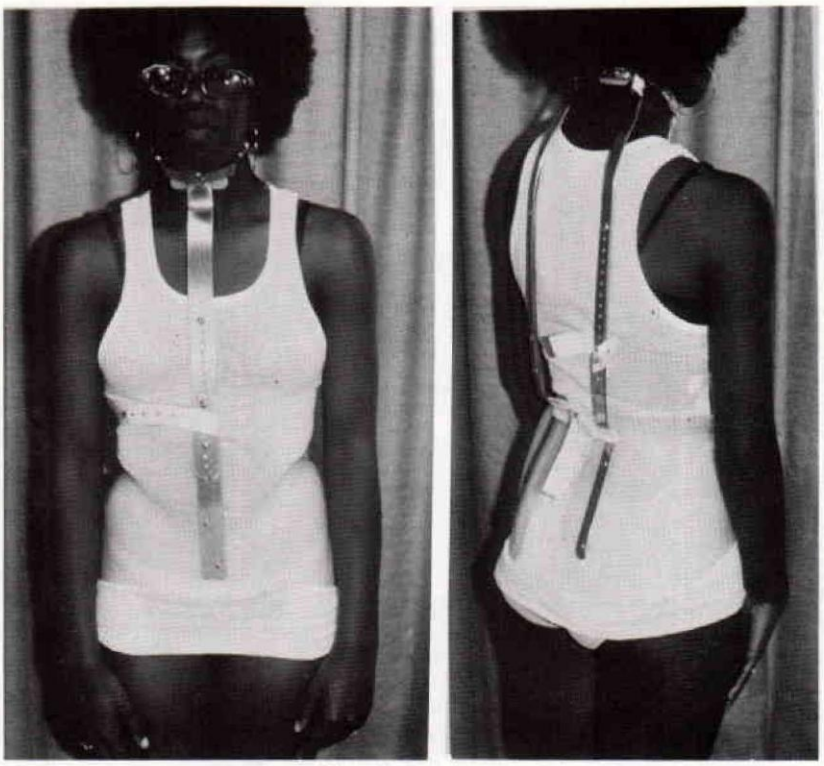


Fig. 4. Case No. 1.

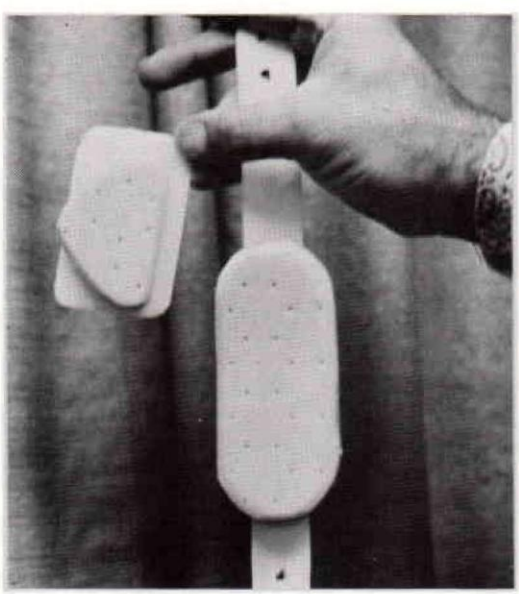


Fig. 5. Close-up view of thoracolumbar pads made of Plastazone backed with aluminum sheet.

made transfer activities possible. Correction of 20 deg. of the scoliosis was obtained.

Case No. 4: N.S. is a 12-year-old girl with Grade I spondylolisthesis and right sciatic pain. Figure 9 shows the rather marked degree of lordosis present in the standing position. Figure 10 shows the patient fitted with polypropylene flexion orthosis which decreases her lumbar lordosis considerably and serves to eliminate her sciatic-nerve root pain completely. This patient later came to spine fusion, and the same orthosis was used for her ambulatory postoperative management.

Case No. 5: N.H. is a 16-year-old girl with muscular dystrophy, who experienced low-back pain as a result of excessive lumbar lordosis. Figure 11 shows the degree of lordosis in the standing position. Figure 12 shows the patient fitted with a polypropylene flexion jacket which eliminated her low-back discomfort. In this particular case, the lordosis had to be controlled rather than eliminated because it was essential to her standing balance and ambulation.

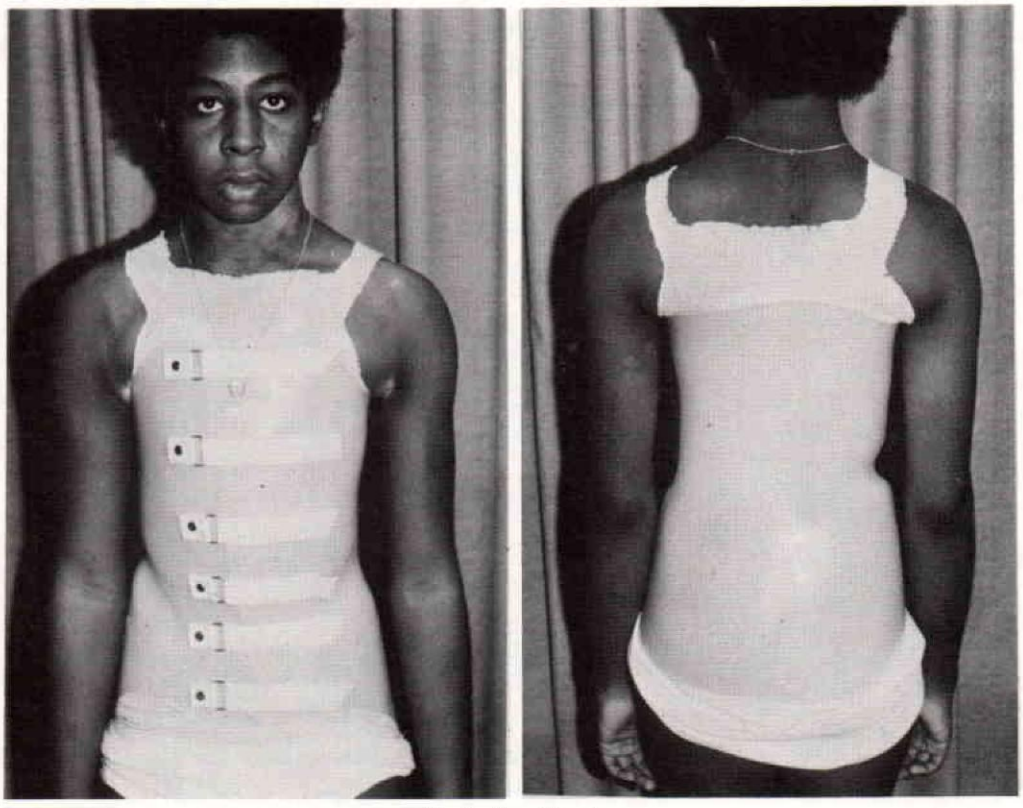


Fig. 6. Case No. 2.

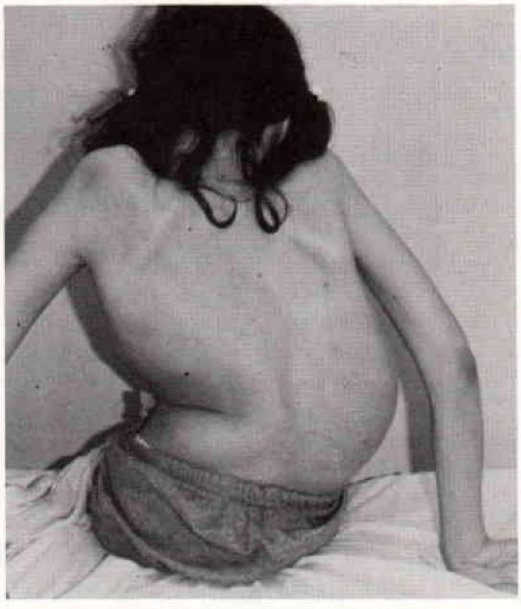


Fig. 7. Case No. 3 without scoliosis jacket.

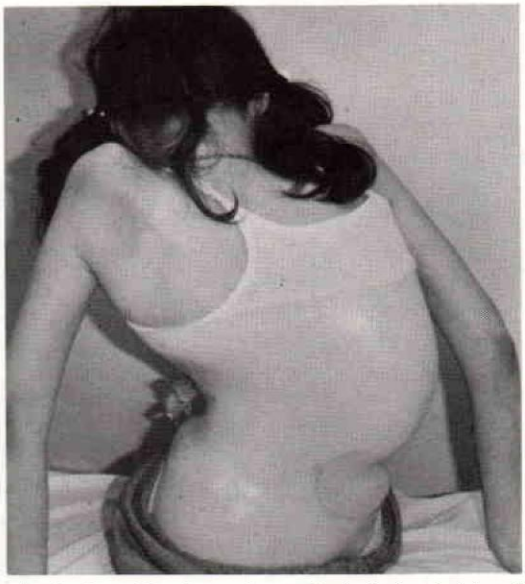


Fig. 8. Case No. 3 wearing scoliosis jacket fashioned from polypropylene.

Fig. 9. Case No. 4 without correction.

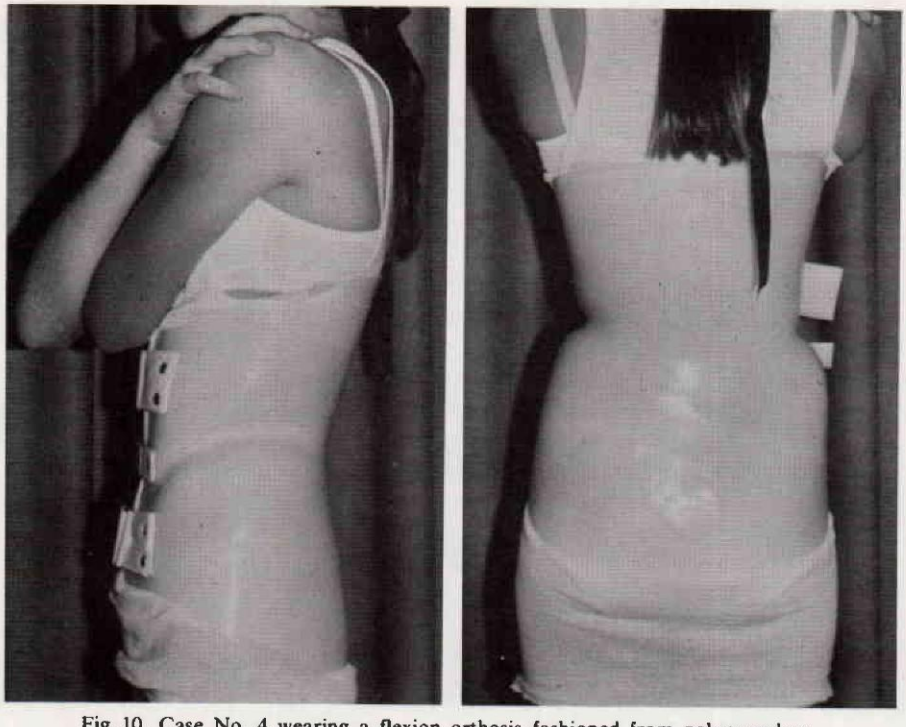


Fig. 10. Case No. 4 wearing a flexion orthosis fashioned from polypropylene.

Fig. 11. Case No. 5 without correction

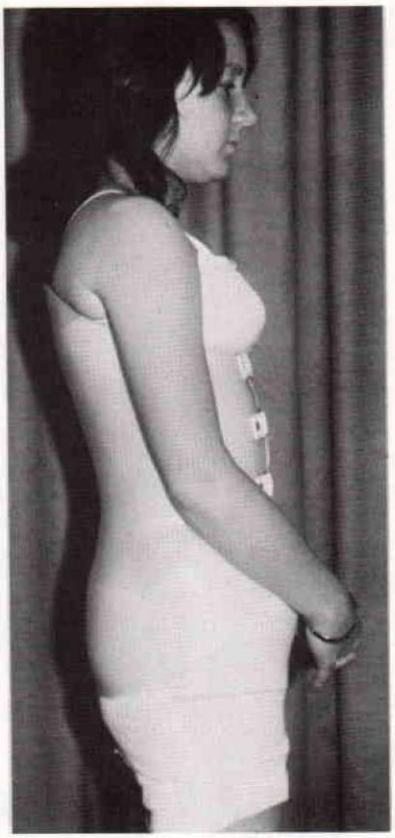


Fig. 12. Case No. 5 wearing a flexion orthosis fashioned from polypropylene.

SUMMARY

Polypropylene has proven to be an excellent material for use in certain spinal orthotic designs. To date, it has been used for the pelvic girdle of the Milwaukee Brace, for scoliosis jackets, and for flexion jackets. It is useful for the nonoperative management of spinal deformity as well as for postoperative care. Light weight, comfort, superior durability, and relative ease of fabrication are all highly desirable features of this material.

REFERENCE

1. Blount, Walter P., and John H. Moe, *The Milwaukee Brace*. Williams and Wilkins, Baltimore, 1973.

Orthotics and Prosthetics, Vol. 28, No. 3, pp. 49-55, September 1974

A HIP-ABDUCTION ORTHOSIS FOR LEGG-PERTHES DISEASE

I. W. Birkeland, Jr., M.D.[1], and
J. H. Zettl, C.P.[1]

There is general agreement that the soft femoral head should be contained within the acetabulum during the fragmentation and reparative stages of Legg-Perthes disease. Deformation of the femoral head occurs because of lateral subluxation and the effects of the resultant abnormal compressive forces upon the biologically soft capital femoral epiphysis. Many attempts have been made to reduce the weight-bearing stresses across the affected hip joint. Strict bedrest is one of the procedures tried but this is detrimental to the psychological well-being of the child since it removes him from his natural surroundings. Moreover, it does not prevent lateral subluxation and resultant head deformity. Bedrest in abduction splints gives better results, but still has the inherent problems just mentioned. It has been felt by some that the child should be allowed to ambulate so that he could participate in school and other social activities. During this ambulation, however, the resultant deforming pressures on the femoral head should be relieved. Various methods and devices have been promoted to achieve this goal.

EARLIER WORK

The paten-bottom ischial weight-bearing orthosis was used for years in the Legg-Perthes Clinic at the Children's Orthopedic Hospital in Seattle. However, Salter (*13*) showed with cineradiography that, in a paten-bottom orthosis with an extension which included the chest, the affected hip subluxed laterally in the stance phase of gait. Petrie (*10*) reported excellent results with the use of bilateral abduction weight-bearing long-leg casts. From his work evolved the Toronto (*4*) Legg-Perthes Orthosis, which was much easier to use and more acceptable to the patient and parents. The Newington (*5*) Orthosis is similar to the Toronto Orthosis but without knee motion. Tachdjian (*15*) designed an ischial weight-bearing, abduction orthosis which is worn only on the involved side. Glimcher (*6*) described a pogo-stick ischial weight-bearing orthosis with a different principle. A quadrilateral socket is used, which supports the pelvis, and as a result the abductors become inactive, because they are no longer necessary to keep the pelvis level. This factor decreases the forces acting on the femoral head.

We have felt that the most important aspect of all these devices is the provision for abduction and internal rotation in order to obtain complete containment of the soft femoral head within the acetabulum. Because of this belief we have modified some of the orthoses previously mentioned, and, over the past six years, have used a quadrilateral ischial weight-bearing hip-abduction orthosis which allows adequate abduction, excellent femoral head coverage (Fig. 1), and easy mobility without crutches, while causing the child very little hindrance. The foot is held in internal rotation to increase the coverage of the femoral head. The tubular support portion of the orthosis must

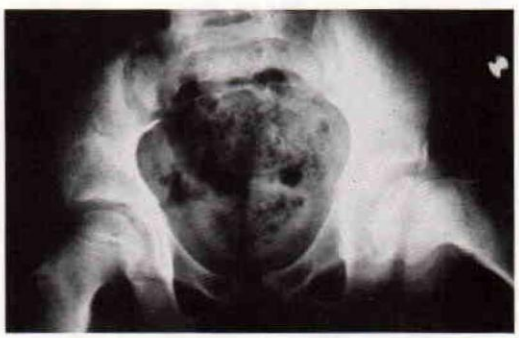


Fig. 1. X-ray of patient standing in orthosis, showing amount of coverage of the femoral head.

[1]Children's Orthopedic Hospital and Medical Center, Seattle, Washington 98105.

be lengthened as the child grows, because the amount of abduction is decreased as the legs lengthen. For bilateral Legg-Perthes disease, the Toronto or Newington orthosis is still used in our clinic. It must be stressed that, prior to prescribing the orthosis, there has to be a normal range of motion in the involved hip, and to obtain this range, hospitalization, traction and an adductor tenotomy with or without an arthrogram may be required.

FABRICATING AND FITTING THE ORTHOSIS

GENERAL CONSIDERATIONS

The orthosis should be fitted and aligned to completely eliminate weight-bearing through the affected hip joint by providing ischial weight-bearing. Hip abduction of 35-40 deg., internal rotation of 20 deg., and knee flexion of 10 deg., are considered to be optimum. Socket suspension is provided by a shoulder strap and occasionally a Silesian bandage to minimize pistoning of the orthosis on the leg and to provide rotational stability (Fig. 2). An appropriate shoe buildup of 2 1/2 to 3 1/2 in. is provided on the sound side (Fig. 3). The orthosis must be rugged enough to withstand the activities of children's play and its fabrication cost must be reasonable. By minimizing moving parts in the orthotic design, service requirements are reduced. Design characteristics should also accommodate growth of the child without having to provide a new orthosis periodically.

MEASUREMENTS AND TRACINGS

- With the patient in a supine position, a tracing of the extremity in the desired degree of abduction, internal rotation, and knee flexion, is obtained.

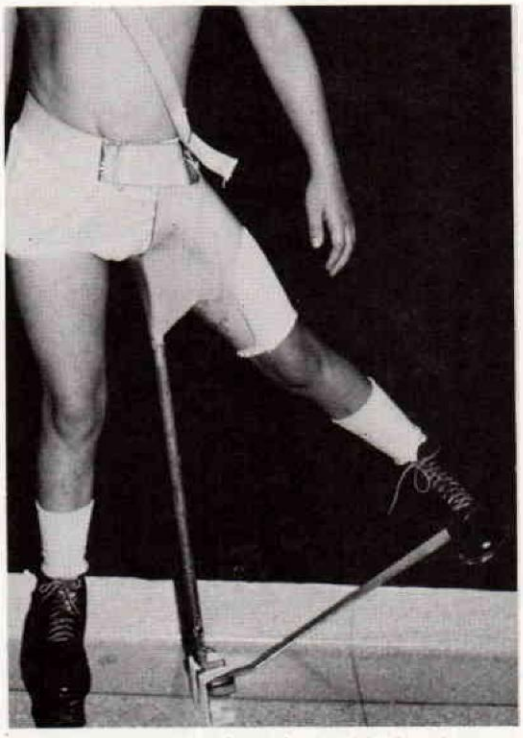


Fig. 2. Front view of the orthosis with shoulder strap and Silesian-bandage waist strap. Note the blocks under the vertical support bar made necessary because of growth.

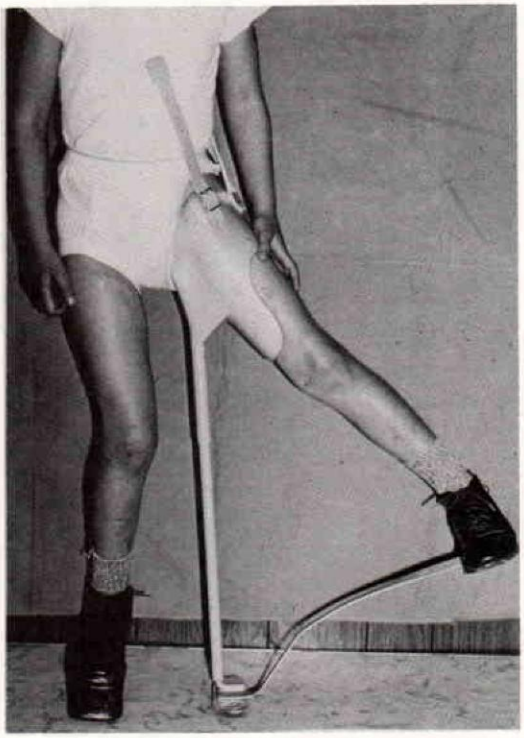


Fig. 3. Front view showing the built-up shoe on the uninvolved side to prevent weight-bearing on the affected side.

• Precise circumferential measurements from ischial tuberosity distally to the proximal border of the patella are secured at two-in. intervals.

• A-P and M-L dimensions at ischial level, including the measurement between the iliac crest and greater trochanter, are obtained.

• The length of the vertical support bar extending from the ischial tuberosity to the rocker base plus the height of the shoe extension, (2 1/2 in.-3 1/2 in.) is determined.

• The measurement for the shoulder-strap suspension is taken from the apex of Scarpa's triangle over the opposite shoulder to the greater trochanter.

• The measurement for the Silesian bandage is taken from the greater trochanter, over the opposite iliac crest, to the midline anteriorly.

• A pair of good quality high-top laced shoes, preferably with leather soles and an internal reinforcement steel shank, are obtained.

CASTING

The thigh shell is cast with the limb in 10 deg. of hip flexion and 35-40 deg. of hip abduction, the precise degree being determined by the prescribing physician. Either hand molding or a prefabricated cast molding brim can be utilized to achieve a quadrilateral-shaped ischial-weight-bearing thigh shell. The proximal trimline of the thigh shelf must be horizontal medially and posteriorly when the extremity is abducted. The anterior trimline of the shell extends 1 1/2-2 in. proximal to the posterior and medial borders; and laterally includes the iliac crest.

• Cotton stockinette or a casting sock is applied over the thigh, buttock, and hip of the limb to be cast and is secured with a 1-in. elastic-webbing strap over the opposite shoulder.

• The use of elastic plaster-of-Paris bandage is recommended for a smooth and accurate replica of the limb. The initial plaster wrap is reinforced with two layers of conventional plaster bandage.

• The wet plaster wrap is molded into a quadrilateral shape as described previously.

• For removal the cast is split laterally with a cast cutter or equivalent after it has dried sufficiently.

• The negative cast is sealed and filled in the usual manner, and a holding pipe inserted, to provide a positive model.

CAST MODIFICATIONS

The positive cast or model is modified in the usual manner to establish relative tension of the resulting laminated thigh shell on the extremity and to assure proper fit, stability, and rotational control. This requires, usually, removal of small amounts of plaster from the plaster mold, similar to the procedures advocated for a quadrilateral above-knee socket (*1*).

To prolong the active use of the orthosis, especially in a growing child, it is permissible to fit the thigh shell initially over the trousers. Obviously this must be calculated and taken into consideration during cast modification, similar to fabrication of a quadrilateral socket fitted with a stump sock.

As the child grows and the thigh shell subsequently becomes tighter, the medial seam of the trousers can be split proximally and a zipper or Velcro closure installed to allow the trousers to be worn over the orthosis, thus providing additional room in the thigh shell itself to accommodate for the growth that has taken place.

• A-P, M-L and circumferential dimensions are established on the positive cast according to accepted fitting practices, i.e., similar to the procedures advocated for a quadrilateral socket (*1*).

• The mold is smoothed and prepared for vacuum lamination.

LAMINATION

• The thigh-shell lay-up requires a minimum of two layers of 1/2 oz. Dacron felt, plus four layers of nylon stockinette for a small thigh shell with a circumference of 12 in. or less.

• Additional reinforcement with fiberglass is advisable for larger sizes.

• The shell is laminated in the usual fashion with a 90-percent-rigid, 10-percent-flexible resin mixture, using the vacuum method.

ORTHOTIC COMPONENTS

• 1 ea. laminated thigh shell.

• 1 ea. steel tube 5/8 in. outside diameter, 1/16 in. wall thickness, 1/2 in. inside diameter. Approximate length as measured, ischial tuberosity to floor, plus 2 1/2-3 in.

• 2 ea. wood blocks, approximately 6 in. × 5 in.

- 1 ea. steel rod 1/2 in. × 7 in. (baseplate attachment rod).
- 1 ea. steel plate 3/16 in. × 5 in. (baseplate).
- 1 ea. steel shoe plate approximately 1/8 in. × 1 1/2 in. × 6 in. (depending on actual shoe size).
- 1 ea. steel abduction bar 1/8 in ×1 1/4 in. × 25 in. (approximately), depending on size of child and degree of abduction.
- A rubber walking heel: small, medium or large as indicated.
- An assortment of rivets and machine screws.

ASSEMBLING THE ORTHOSIS

Preparatory to fitting the hip abduction orthosis, the thigh shell is trimmed as follows:

- Distally the medial shell wall is terminated 1 1/2 in. proximal to the adductor tubercle.
- A cutout is made in the lateral wall extending from the level of the greater trochanter distally.
- The remaining portion of the lateral shell extends proximally from the greater trochanter to the iliac crest.
- The posterior and medial proximal trimlines are horizontal when the extremity is in the desired abduction position (35 deg.-45 deg.).
- The anterior proximal trimline extends 1 1/2 in. to 2 in. proximal to the medial and posterior walls and provides compression in Scarpa's triangle, and a bulge for the quadriceps, respectively.
- All edges are well-rounded and smooth.
- The steel tube extension is prepared by flattening one end for a distance of 1 in.
- The flattened portion of the steel tube extension is bent to an angle equivalent to that of the medial proximal thigh shell. This bend will cause the posterior and medial socket trimlines to be horizontal and the tube extension to be vertical.
- A number-9 hole is drilled through the flattened portion of the steel tube and centrally on the medial thigh shell approximately 1 in. inferior to the proximal trimline. The inside of the hole in the thigh shell is countersunk and the tubing fastened to the shell with a 10/32-in. screw and nut.
- A 5/8-in. hole is drilled through the wood block lengthwise and the block is cut on the bandsaw to conform to the abduction angle of the exterior medial wall of the thigh shell.
- The medial portion is contoured on the router to a precise fit and, with a mixture of Solka floc and resin, the wood block is fastened to the medial aspect of the thigh shell and steel tubing.
- The outer contour of the wood block is tapered and rounded towards the steel tube and refinished with several coats of resin.
- An appropriate size rubber walking heel is selected. The baseplate is cut and shaped to the upper dimensions of the rubber walking heel.
- One and one-half inches at one end of the 1/2 in. × 7 in. steel rod is heated and bent to a 90-deg. angle. This 1 1/2-in. portion is then welded to the center of the steel baseplate prepared in the step above (Fig. 4).
- The abduction bar is attached to the anterior portion of the steel baseplate with one 10/32-in. screw and nut.

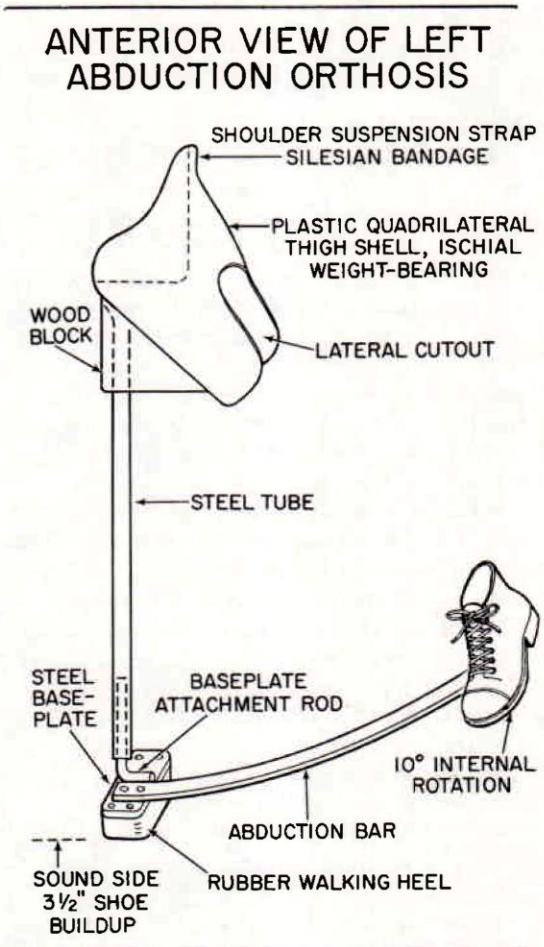


Fig. 4. Anterior view of left abduction orthosis.

• The rubber walking heel is attached to the steel baseplate with 6/32-in. screws and nuts applied at all four corners.

• The steel tube is cut to proper length and the steel rod, baseplate, rubber walking-heel assembly is inserted but not fastened.

• A wood buildup of 2 1/2 in. for a small child or 3 1/2 in. for a larger one is prepared and attached to the shoe on the sound side. A rocker contour is provided on the sole portion and the sole and rubber heel are attached to the buildup. (A Neoprene rubber buildup can also be used.)

• The other shoe is prepared for attachment to the abduction bar by removal of the heel from the boot. The steel shoe plate is shaped so that it fits to the outer contours of the shoe sole. The shoe plate should extend from the metatarsal heads to the center of the heel. The shoe plate is riveted to the shoe. (The shoe is not fastened to the abduction bar at this time.)

• The shoulder-suspension webbing strap and fasteners are prepared and attached to the orthosis.

The entire hip-abduction orthosis is now ready for fitting.

FITTING AND ALIGNMENT

• With the patient supine on a fitting table the leg with the foot in plantar flexion is slipped through the thigh shell.

• The shoulder-suspension strap is fastened.

• Both shoes are applied.

• The length of the orthosis is checked and adjusted as necessary. The pelvis on the affected side will appear slightly higher than the other due to abduction of the extremity. The orthosis should not be shortened excessively at this time but should be double-checked statically with the patient standing.

• With the patient standing between walking rails, the fit of the orthosis is rechecked.

• The ischial tuberosity is checked to be sure that it is properly located on the shelf portion of the posterior thigh shell.

• The pubic ramus and adductor longus are checked to be sure that adequate relief has been provided and adjustments are made if indicated.

• The orthosis should be considered to be too short if the patient flexes the sound extremity excessively during weight-bearing or mid-stance.

• The abduction bar is adjusted with bending irons to an appropriate angle so that the shoe of the suspended extremity just touches the bar but without weight bearing. The foot is rotated internally 20 deg. on the abduction bar and the position on the shoe is marked.

• With the abduction bar internally rotated between 7-10 deg. on the steel baseplate, the position is marked by scribing through the second attachment hole with an awl.

• The baseplate and rubber walking heel are checked to be sure that they follow the line of progression. A mark is made on the steel tube to indicate the precise positioning.

• Any complaints of discomfort should be noted and investigated.

• The patient is placed back on the fitting table and the shoe and orthosis are removed.

FINISHING AND DELIVERY

All components previously held temporarily by screws should now be securely riveted in their marked positions, viz:

• the abduction bar to th baseplate.

• the rubber walking heel to the baseplate.

• the abduction bar (with excess material removed) to the shoe.

Two #13 holes, two in. apart, are drilled through the steel tubing and the rocker-assembly steel rod, and the parts securely fastened with two 3/16-in. steel rivets.

The orthosis is reapplied to the patient.

PATIENT INSTRUCTIONS AND GAIT TRAINING

At final checkout it may become necessary occasionally to add a Silesian bandage to counteract rotational instability and/or to maintain the orthosis in good contact at the lateral proximal thigh-shell extension. In most instances the need for this addition is the result of a loosely fitted socket. A temporary felt or leather liner in the thigh shell may eliminate this problem also. The general guideline here is an adequate fit which is nevertheless loose enough to accommodate future growth, since the orthosis might be worn for a period of up to two years and perhaps even longer. In our experience it has seldom been necessary to replace a socket to accommodate growth.

We initially fitted the trouser leg into the thigh shell in the case of a boy; added considerable pad-

ding inside the well-padded thigh shell in the case of a girl. The padding is gradually removed as growth occurs. Boys eventually may wear their trousers over the orthosis by splitting the seam medially to allow the orthosis to pass through. Velcro or zipper closure is provided.

Optimum alignment and positioning of the femoral head, in conjunction with an economical and rugged orthosis, are the basic considerations in the design of this orthosis which contains no moving mechanical parts.

Maintenance of the orthosis requires occasional replacement of the rubber walking heel, shoulder-suspension strap, or Silesian bandage, plus the unavoidable shoe changes and lengthening repairs. Otherwise, the maintenance costs are rather minimal considering the activity level and abuse to which the orthosis will be subjected. Instances have been recorded where children ride bicycles, climb trees and play baseball while wearing the hip-abduction orthosis.

It has been mentioned repeatedly by some prescribing physicians that the shoe buildup on the sound side is unnecessary. Indeed, we have fitted a small number of children who have done well without the customary shoe buildup on the sound side because it enhances the chances for "cheating."

Without the buildup, the child can place the involved leg, including the orthosis, into adduction. The knee on the sound side is flexed slightly, thus allowing weight-bearing through the abduction bar and the involved limb.

With the buildup in place, the flexion required about the sound knee obviously would have to be so great that it could not be retained comfortably for any significant period.

Of course, proper parental supervision, guidance, and strict discipline will help in controlling these abuses, but since children should not be taken for granted, every effort should be made to assure success even though it means adding the bulk and weight of the buildup to the system.

The patient and his parents are instructed concerning the importance of carrying weight-bearing forces through the ischial tuberosity on the posterior thigh shell (Fig. 5). No compromise is acceptable since violation of this requirement renders the orthosis ineffective. The patient has to be instructed to lean over the orthosis while bearing weight on the involved side so as to increase the amount of hip abduction. Initially, walking attempts tend to bring the orthosis into abduction, and of course tripping results. Gait training by a qualified physical therapist is essential to good management of the patient. The child should be encouraged to pursue all normal activities so long as weight-bearing through the ischial tuberosity is maintained. In a matter of days the child should be able to balance and walk with one crutch and within two weeks should walk about freely without assistive devices.

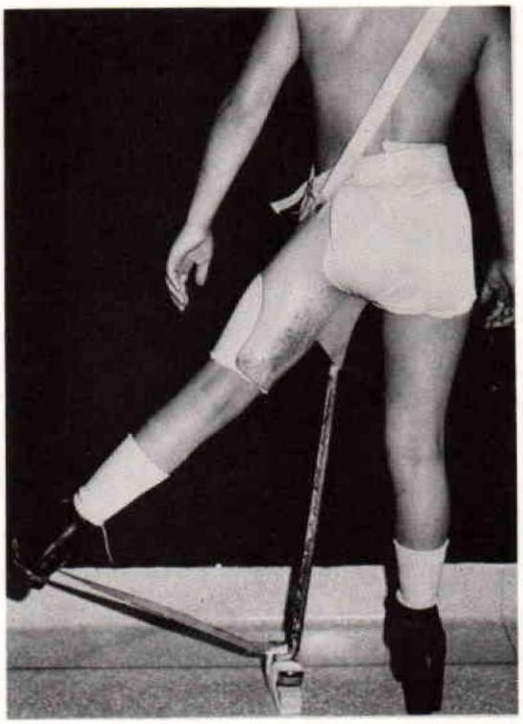


Fig. 5. Posterior view of the orthosis showing the ischial weight-bearing seat.

Upon delivery of the hip-abduction orthosis, the patient is requested to return to the prescribing physician for a general checkout that should include a standing weight-bearing pelvic x-ray to ascertain good femoral head positioning and alignment in relation to the acetabulum (Fig. 1).

In follow-up clinic visits all x-rays should include the entire pelvis so as not to miss any bilateral hip involvement.

REFERENCES

1. Anderson, Miles H., John J. Bray, and Donald F. Colwell, (Raymond E. Sollars, ed.), *V.A.P.C. Total-Con-*

tact A.K. Technique, Prosthetic-Orthotic Education Program, UCLA, May 1963.

2. Babb, Frank S., and A. Bruce Sundberg, Clinical notations on Perthes' disease—Outlook best for children under five. *Braces Today*, July 1972.

3. Babb, Frank S., and A. Bruce Sundberg, Perthes' disease: Notes on treatment, Judicious use of rest, splint, and early ambulation, *Braces Today*, August 1972.

4. Bobechko, W. P., C. A. McLaurin, and W. M. Motloch, Toronto orthosis for Legg-Perthes disease, *Artif. Limbs* 12:2:36-41, Autumn 1968.

5. Curtis, Burr H., and Siegfried W. Paul, The Newington brace for ambulatory management of Legg-Calve-Perthes syndrome from Newington Children's Hospital, Newington, Conn., submitted to *J. Bone and Joint Surg.*, 1974.

6. Glimcher, M. J., E. L. Radin, and M. M. Amrich, The design of a new style ischial weight-bearing brace for use in the treatment of Legg-Perthes disease, *Orth. and Pros.* 24:3:11-20, September 1970.

7. Hammon, B. T., and John Charnley, Jr., The sphericity of the femoral head, *Med. & BioEngg.* 5:445-453, 1967.

8. Inman, V. T., Functional aspects of the abductor muscles of the hip, *J. Bone and Joint Surg.* 29-A:607-619, July 1947.

9. Paul, J. P., Bio-Engineering studies of forces transmitted by joints, in *Biomechanics and Related Bioengineering Topics*, R. M. Kenedi (ed.), Permagon, London, 1965, pp. 359-368.

10. Petrie, Gordon, Paper presented at an orthopedic conference, Vancouver, B.C., Canada, October 1967.

11. Radin, E. L., and M. M. Amrich, Limitations of chimpanzees as subjects in brace design experiments, *Bull. Pros. Res.* 10-12:205-212, Fall 1969.

12. Rydell, N. W., Forces acting on the femoral head prosthesis, *Acta Orthop. Scand.* Suppl. 88, 1966.

13. Salter, Robert B., Personal communications, 1968.

14. Sweigart, James E., Crutches for hip abduction appliances, Brings bases of crutches closer to patient's legs, *Braces Today*, January 1973.

15. Tachdjian, M. A., and L. D. Jouett, Trilateral socket hip abduction orthosis for the treatment of Legg-Perthes' disease, *Orth. and Pros.* 22:2:49-62, June 1968.

Descriptors: Children; Legg-Perthes disease; orthosis.

Orthotics and Prosthetics, Vol. 28, No. 3, pp. 57-60, September 1974

CUSTOM-FOAMED TOE FILLER FOR AMPUTATION OF THE FOREFOOT

John W. Potter, C.O.[1], and James E. Sockwell[2]

In the fabrication of orthopedic shoes for the transmetatarsal, Chopart, and other forefoot amputations, provision of the toe filler is time-consuming, and therefore it is sometimes not fabricated as accurately as might be desired. Pressure point problems then arise, and often they are difficult to correct.

In the fabrication of orthopedic shoes, a last and usually a cast of the stump are available (Fig. 1). From the combination of these two, a very accurately fitting toe filler can be fabricated.

Apply a light coat of either petroleum jelly or green soap to the front part of the last. Wrap the last with one roll of 3-in. or 4-in. wide plaster-of-Paris bandage from the toe to a point at least 1 in. posterior to the end of the stump (Fig.2). Allow

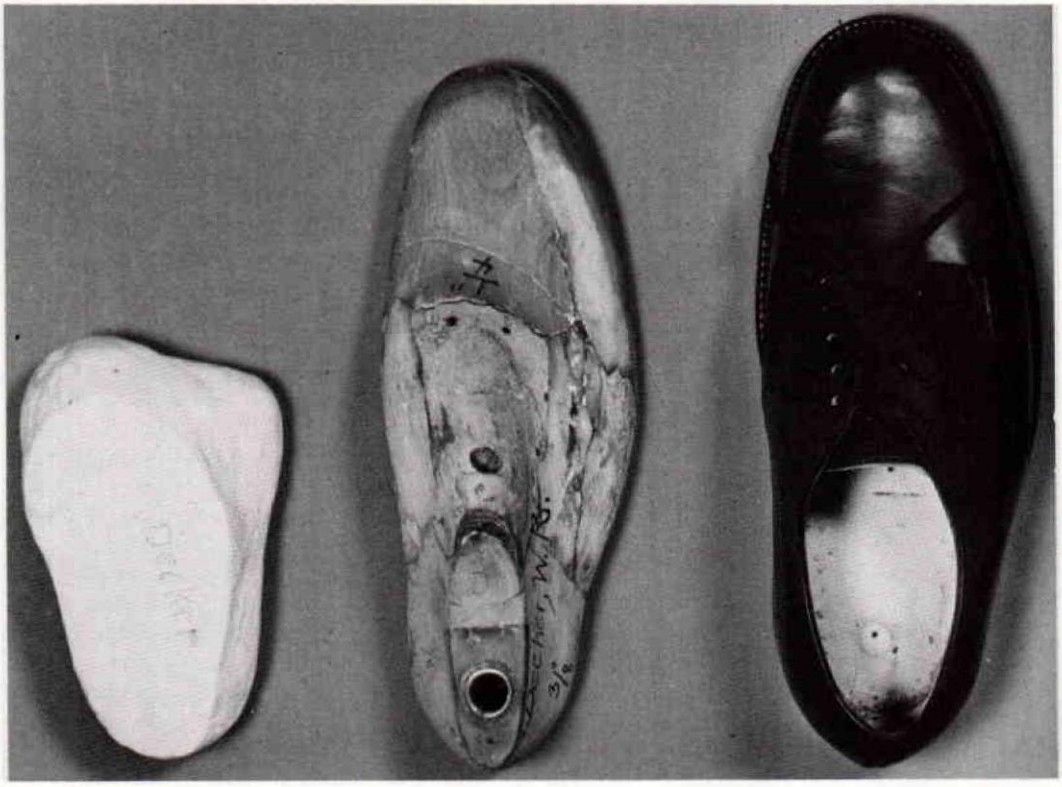


Fig. 1. Positive model, or cast of Chopart amputation stump; last for the orthopedic shoe; and the orthopedic shoe.

[1]Chief, Orthotics Laboratory, VA Hospital, 4500 South Lancaster Road, Dallas, Texas 75216.

[2]Orthotist (Shoe), Orthotics Laboratory, VA Hospital, 4500 South Lancaster Road, Dallas, Texas 75216.

the plaster to just set. Make two alignment marks on each side of the last, proceeding from the upper to the sole side. With a sharp knife, cut through the plaster bandage at the division line of

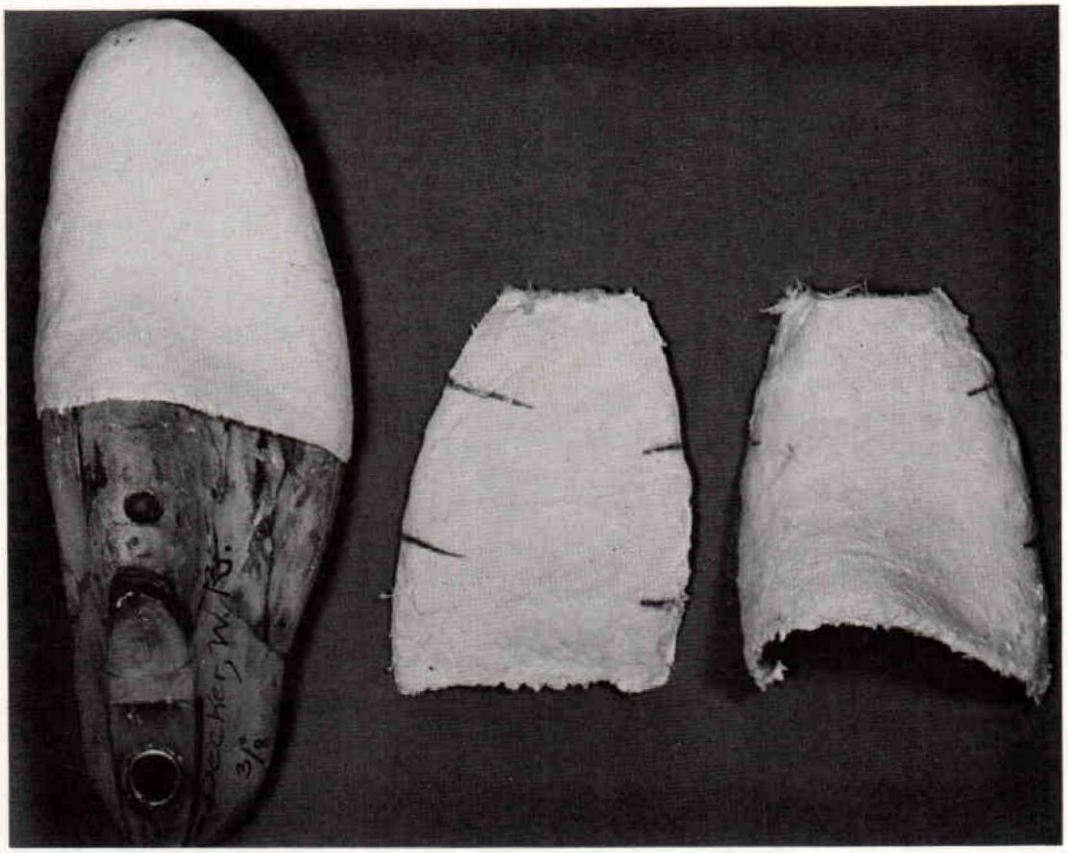


Fig. 2. *Left*, plaster-of-Paris bandage wrapped over the forefoot of the last. *Right*, the two parts of the mold removed from the last. Note the alignment marks.

the sole, leaving about an inch of the toe attached. Allow plaster to harden before trying to separate it from the last so that the cast will not be distorted.

Carefully remove the cast from the last. The two parts removed are shown in the right part of Figure 2. Glue a piece of orthopedic cow- or horsehide, smooth side to the plaster, to the inside of the sole of the plaster mold. (Rubber cement works well.) Trim the leather liner to the margin of the plaster. Coat the upper part of the mold with Modern Foil[3]. Align the marks, and wrap with another 3-in. or 4-in. wide plaster bandage.

After the plaster has hardened, saw 1/2 in. off the toe of the cast, forming a hole through which foam can be poured.

The cast of the foot is cleaned and any large holes on the forward portion are filled. It is not necessary for the cast or mold to be dry when these procedures are carried out. A piece of thin orthopedic cow- or horsehide is stretched and tacked, with the rough side out, over the forward part of the cast, and the excess part is stretched around the heel. Enough leather should be available to cover the heel portion of the insert.

The mold is now aligned on the cast. When alignment is correct, the two parts are tacked or stapled together (Fig. 3), and the proximal edge is wrapped tightly with contact-type vinyl tape.

Mix an estimated amount of 384 Dow Corning RTV rubber and about 5 percent 386 foam. Thin with up to 10 percent 360 medical fluid. This ratio

[3]Modern Foil: A brand of dental mold release available from Patterson Dental Supply, 5315 North Central Expressway, Dallas, Texas 75205.

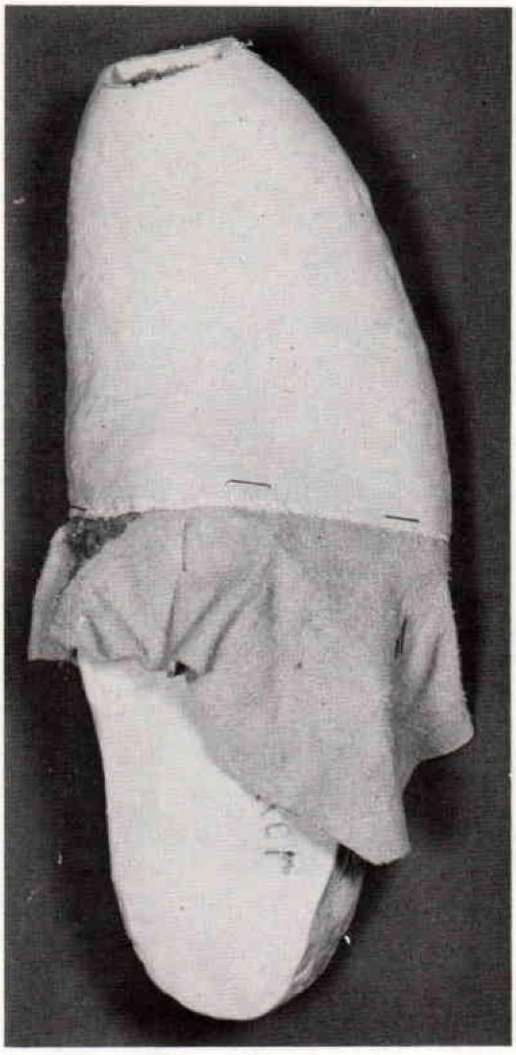


Fig. 3. The assembly, consisting of positive model of the stump, leather covering over distal portion of model, and plaster mold, ready for pouring of the foam.

has a low ratio of expansion, and if the mold is not filled a second pouring will be necessary, but it will bond satisfactorily.

Clamp the foot in the toe-up position in a vise. Add to the foam 384 activator in accordance with the manufacturer's directions, and then add 3 or 4 drops of 386 activator, If too much activator is used, the mixture will foam excessively and the resulting filler will be too soft. Stir thoroughly but quickly, and pour into the mold. Allow the foam to set for 10 to 15 minutes after it has hardened because at first it is very tender.

Carefully remove the mold so that it can be saved for use again. Trim the leather flush to the edge of the foam. The foam edge can be sanded to achieve feather edges where necessary. The filler can be glued to the insole with a Silicone adhesive recommended by the manufacturer, or if the horsehide is incorporated in the sole of the filler (Fig. 4, *right*), contact cement may be used.

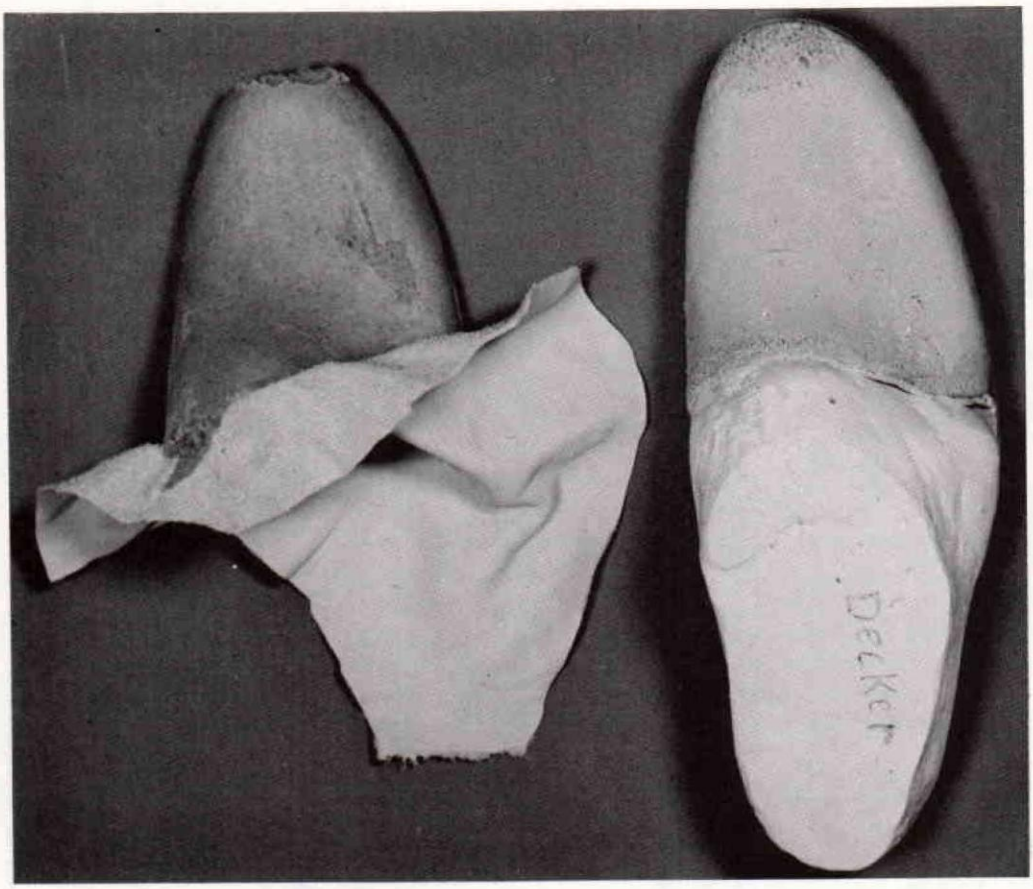


Fig. 4. *Left*, the filler and leather liner before trimming. *Right*, the finished insert fitted to the positive model.

The leather that was covering the cast of the foot can be trimmed and fastened to the heel portion of the inner sole with a contact cement.

With this method, we have not had the usual problem of forefoot pressure points, because an accurate impression of the foot is molded into the toe filler. If it is felt some relief is necessary, the cast of the foot may be modified before foaming to provide for the relief.

Softer density foam in contact with the foot has not proven to be any more successful than when all of the filler is of the firm density.

The procedure may be used in shoes other than orthopedic types by using a standard shoe last of the proper size or a SACH foot for the model, and then aligning on a leather insole that has been fitted to the shoe. In most cases a longitudinal support built into the insole will be needed. Also, a toe-to-heel shank should be installed in the shoe.

NEW PUBLICATIONS

GAMES, SPORTS AND EXERCISES FOR THE PHYSICALLY HANDICAPPED. Ronald C. Adams, Alfred N. Daniel and Lee Rullman. Lea & Febiger, Philadelphia, 1972; 254 pp.

As stated in the preface, this book was written for therapists, teachers, students, and the physically handicapped. Games, sports, and exercises are specifically recommended for a number of disabling conditions, including amputations, quadriplegia, hemophilia, cerebral palsy, and scoliosis. A brief description of each condition is presented along with precautions that one should be aware of while planning activities for a disabled person.

Although this book is not of direct value to the prosthetist or orthotist, there are many equipment modifications described that enable a patient to enjoy a wider range of activities. These modifications include a simple adapter device that enables a patient with an upper-limb prosthesis to handle a bow and arrow, an additional device to help this patient play badminton, rifle and pistol holders, adapted rein bars for horseback riding, a swivel cue holder, and a three-track skiing outrigger.

This book would be a good reference for the orthotist or prosthetist who is occasionally confronted with the problem of designing and fitting adapted sports equipment for his patients, but would be of greatest value to physical and occupational therapists.

Count Fields, C.O.

MANUAL OF MECHANICAL ORTHOPAEDICS. Alfonso Tohen Z., M.D. Translated from Spanish by Robert W. Milam, M.D., and Enrique Lopez, M.D. Charles C Thomas, Publisher. Springfield, Illinois. 319 pp.

This text presents a description of prosthetic and orthotic systems and components with the intention of formulating a succinct "quick reference manual" for those who are instrumental in the rehabilitation of the physically disabled.

Included in the book are illustrations covering many varied orthotic and prosthetic devices. The approach applied in the explanation of the orthosis or prosthesis is merely to name the components and state the average indication for patient use. The art work and pictures however are not elaborate and at times are oversimplified and outdated.

One would use this book as an elementary catalogue that does not dwell on theory, biomechanical principles, and current concepts in orthotic and prosthetic patient management.

Mark Yanke, C.O.

UNDERSTANDING THE SCIENTIFIC BASES OF HUMAN MOVEMENT. Alice L. O'Connell and Elizabeth B. Gardner, The Williams and Wilkins Company, Baltimore, 1972, 264 pp.

Well written and illustrated text on kinesiology that "attempts to interpret and apply some of the expanding knowledge of neurophysiology to the field of motor performance. It includes four chapters on the neuromuscular bases of movement (Chapters 10 to 13), to supplement the too often scanty coverage of such information in undergraduate curricula. The inclusion of Section III on proprioceptive reflexes is unique with this text and is presented to provide a background for enlarging the scope of kinesiological analysis. The final chapter deals with speculative postulations of reflex involvement in certain skills. It is offered in the hope that it may encourage the kinesiologist to include consideration of this aspect of human movement in his analysis and research, to recognize and investigate reflexes which may be assisting a performance, and to identify those which may be interfering and require voluntary inhibition. With such information available, he should

be better equipped to understand the difficulties encountered by the beginner in learning a new skill, and why the use of one method or technique produces better results than another. He can then improve the best of the older techniques and design new and more effective methods based on his expanded knowledge." *From the author's Foreword.*

THE METRIC SYSTEM GUIDE—Volume I, J. J. Keller & Associates, Inc., $59.00.

In anticipation of the U.S. conversion to the metric system, J. J. Keller & Associates, Inc., has announced the publication of "The Metric System Guide—Volume I." This is the first and only such guide in the United States, and deals with orientation and structure of metrication in this nation.

The executive binder edition provides the basic background information necessary for understanding and evaluating the problems involved in metrication for America. "The Metric System Guide—Volume I" parallels the announcement by such major industries as General Motors, International Harvester, and the California School System to go metric. Its planning, research, and development have been several years in the making. From introduction to glossary, the first volume contains 15 comprehensive parts designed for specific background in the use of the metric system. It is first in a series of volumes on the Metric System; to be used individually or collectively.

The "Metric System Guide Bulletin," designed to present up-to-date information of the metric system, will be published monthly by Keller.

A fully descriptive brochure relative to the Series may be obtained by phoning 800-558-5011 Toll Free, or by writing J. J. Keller & Associates, Inc., 145 West Wisconsin Avenue, Neenah, Wisconsin 54956.

TECHNOLOGY AND THE NEUROLOGICALLY HANDICAPPED.

This 281-page publication consists of papers given at a conference cosponsored by the United Cerebral Palsy Research Foundation and the National Aeronautics and Space Administration, September 8-10, 1971, and held at the NASA Ames Research Center, Moffett Field, California. The Chairman and Co-Chairman of the conference were Dr. Lee Arnold, Department of Aeronautics and Astronautics, New York University, and Dr. John Billingham, Life Science Directorate, NASA Ames Research Center, respectively.

Although few recommendations are offered in this collection of papers, the proceedings are a good source of reference to much of the research efforts in rehabilitation engineering in the United States. As the title might suggest, emphasis at this conference was on electrical engineering and electronics applied to problems of the physically handicapped.

Copies of the report may be obtained from the United Cerebral Palsy Foundation, 66 E. 34th Street, New York, New York 10016.

YOU CAN DO IT FROM A WHEELCHAIR. Arlene E. Gilbert, Arlington House, New Rochelle, New York, 1973, 144 pp., $6.95.

The author has been confined to a wheelchair by multiple sclerosis since 1965. Most of the text is concerned with duties of a housewife and some recreational activities.

EQUIPMENT FOR THE DISABLED. The National Fund for Research into Crippling Diseases, Nuffield Orthopaedic Centre, Oxford, England.

The third editions of Section 5—Personal Care, and Section 6—Leisure and Gardening, of this 10-volume series were published in November and December 1973, respectively, and are currently available from:

The National Fund for Research into Crippling Diseases
Vincent House, 1 Springfield Road
Horsham, Sussex RH12 2PN, England

Each section has 55 pages and is available at £1.05 (including postage and packaging).

RESOLUTION CONCERNING THE METRIC SYSTEM

The following resolution was adopted by the Board of Directors of the American Orthotic and Prosthetic Association at its meeting in San Diego October 3, 1973:

WHEREAS by Act of Congress it has been determined that the United States should proceed towards adoption of the metric system as used almost universally throughout the rest of the world, and

WHEREAS the technological professions and many segments of the health professions have commonly used the metric system over an extended period of time, and

WHEREAS it is important for members of the orthotic/prosthetic professions to interact with their colleagues in the medical and technological communities for optimum patient service be it hereby

RESOLVED that the American Orthotic and Prosthetic Association endorses the use of the metric system by its members and other orthotic and prosthetic practitioners in the United States, and in witness of this endorsement and Association urges the editors of its journal *Orthotics and Prosthetics* to commence the dual reporting of weights and measurements in both the English and metric systems at the earliest possible date with the objective of employing the metric system solely by the time of the 29th Volume in 1975.

METRIC SYSTEM
Conversion Factors

LENGTH

Equivalencies

angstrom	= 1 x 10^{-10} meter (0.0 000 000 001 m)
millimicron*	= 1 x 10^{-9} meter (0.000 000 001 m)
micron (micrometer)	= 1 x 10^{-6} meter (0.000 001 m)

To Convert from	To	Multiply by
inches	meters	0.0254†
feet	meters	0.30480†
yards	meters	0.91440†
miles	kilometers	1.6093

AREA

To convert from		
square inches	square meters	0.00063616†
square feet	square meters	.092903

VOLUME

Definition

1 liter = 0.001† cubic meter or one cubic decimeter (dm^3)
(1 milliliter = 1† cubic centimeter)

To convert from	To	Multiply by
cubic inches	cubic centimeters	16.387
ounces (U.S. fluid)	cubic centimeters	29.574
ounces (Brit. fluid)	cubic centimeters	28.413
pints (U.S. fluid)	cubic centimeters	473.18
pints (Brit. fluid)	cubic centimeters	568.26
cubic feet	cubic meters	0.028317

MASS

To convert from	To	Multiply by
pounds (avdp.)	**kilograms**	**0.45359**
slugs‡	kilograms	14.594

FORCE

To convert from	To	Multiply by
ounces-force (ozf)	newtons	0.27802
ounces-force (ozf)	kilogram-force	0.028350
pounds-force (lbf)	newtons	4.4732
pounds-force (lbf)	kilogram-force	0.45359

*This double-prefix usage is not desirable. This unit is actually a nanometer (10^{-9} meter = 10^{-7} centimeter).
†For practical purposes all subsequent digits are zeros.

STRESS (OR PRESSURE)

To convert from	To	Multiply by
pounds-force/square inch (psi)	newton/square meter	6894.8
pounds-force/square inch (psi)	newton/square centimeter	0.68948
pounds-force/square inch (psi)	kilogram-force/square centimeter	0.070307

TORQUE (OR MOMENT)

To convert from	To	Multiply by
pound-force-feet	newton meter	1.3559
pound-force-feet	kilogram-force meters	0.13826

ENERGY (OR WORK)

Definition

One joule (J) is the work done by a one-newton force moving through a displacement of one meter in the direction of the force.

1 cal (gm) = 4.1840 joules

To convert from	To	Multiply by
foot-pounds-force	joules	1.3559
foot-pounds-force	meter-kilogram-force	0.13826
ergs	joules	1×10^{-7}†
b.t.u.	cal (gm)	252.00
foot-pounds-force	cal (gm)	0.32405

TEMPERATURE CONVERSION TABLE

To convert °F to °C $\quad °C = \frac{°F - 32}{1.8}$

°F	°C
98.6	37
99	37.2
99.5	37.5
100	37.8
100.5	38.1
101	38.3
101.5	38.6
102	38.9
102.5	39.2
103	39.4
103.5	39.7
104	40.0

*A slug is a unit of mass which if acted on by a force of one pound will have an acceleration of one foot per second per second.

INFORMATION FOR AUTHORS

ORTHOTICS AND PROSTHETICS
INVITES THE SUBMISSION OF ALL ARTICLES AND MANUSCRIPTS
WHICH CONTRIBUTE TO ORTHOTIC AND
PROSTHETIC PRACTICE, RESEARCH, AND
EDUCATION

All submitted manuscripts should include:

1. THE ORIGINAL MANUSCRIPT AND TWO COPIES. If possible, the duplicate manuscripts should be complete with illustrations to facilitate review and approval.
2. BIBLIOGRAPHY. This should be arranged alphabetically and cover only references made in the body of the text.
3. LEGENDS. List all illustration legends in order, and number to agree with illustrations.
4. ILLUSTRATIONS. Provide any or all of the following:
   a. Black and white glossy prints
   b. Original drawings or charts

   Do *not* submit:
   a. Slides (colored or black & white)
   b. Photocopies

PREPARATION OF MANUSCRIPT

1. Manuscripts must be TYPEWRITTEN, DOUBLE-SPACED and have WIDE MARGINS.
2. Indicate FOOTNOTES by means of standard symbols (*).
3. Indicate BIBLIOGRAPHICAL REFERENCES by means of Arabic numerals in parentheses (6).
4. Write out numbers less than ten.
5. Do not number subheadings.
6. Use the word "Figure" abbreviated to indicate references to illustrations in the text (. . . as shown in Fig. 14)

PREPARATION OF ILLUSTRATIONS

1. Number all illustrations.
2. On the back indicate the top of each photo or chart.
3. Write the author's name on the back of each illustration.
4. Do not mount prints except with rubber cement.
5. Use care with paper clips; indentations can create marks.
6. Do not write on prints; indicate number, letters, or captions on an overlay.
7. If the illustration has been published previously, provide a credit line and indicate reprint permission granted.

NOTES:

—Manuscripts are accepted for exclusive publication in ORTHOTICS AND PROSTHETICS.
—Articles and illustrations accepted for publication become the property of ORTHOTICS AND PROSTHETICS.
—Rejected manuscripts will be returned within 60 days.
—Publication of articles does not constitute endorsement of opinions and techniques.
—All materials published are copyrighted by the American Orthotic and Prosthetic Association.
—Permission to reprint is usually granted provided that appropriate credits are given.
—Authors will be supplied with 25 reprints.

DEMAND THE FINEST FOR YOUR CUSTOMERS

#607 Hoffman Scrotal Truss. Also available with double front strap. For the Double Truss order #608.

KENDRICK'S

HOFFMAN SCROTAL TRUSS

PRESCRIBED BY PHYSICIANS . . . SOLD WITH CONFIDENCE

Kendrick's #607 Hoffman Scrotal Truss is especially designed for the unusually hard-to-hold hernia. Its wide, extended-top flat pad distributes pressure evenly over a greater area, and easily covers the opening towards the center that is often just beyond the ordinary pad.

The #607 features a hand-sewn pad of soft kid held by an extra strong spring. The Hoffman is scientifically designed to provide greater patient security and self-confidence.

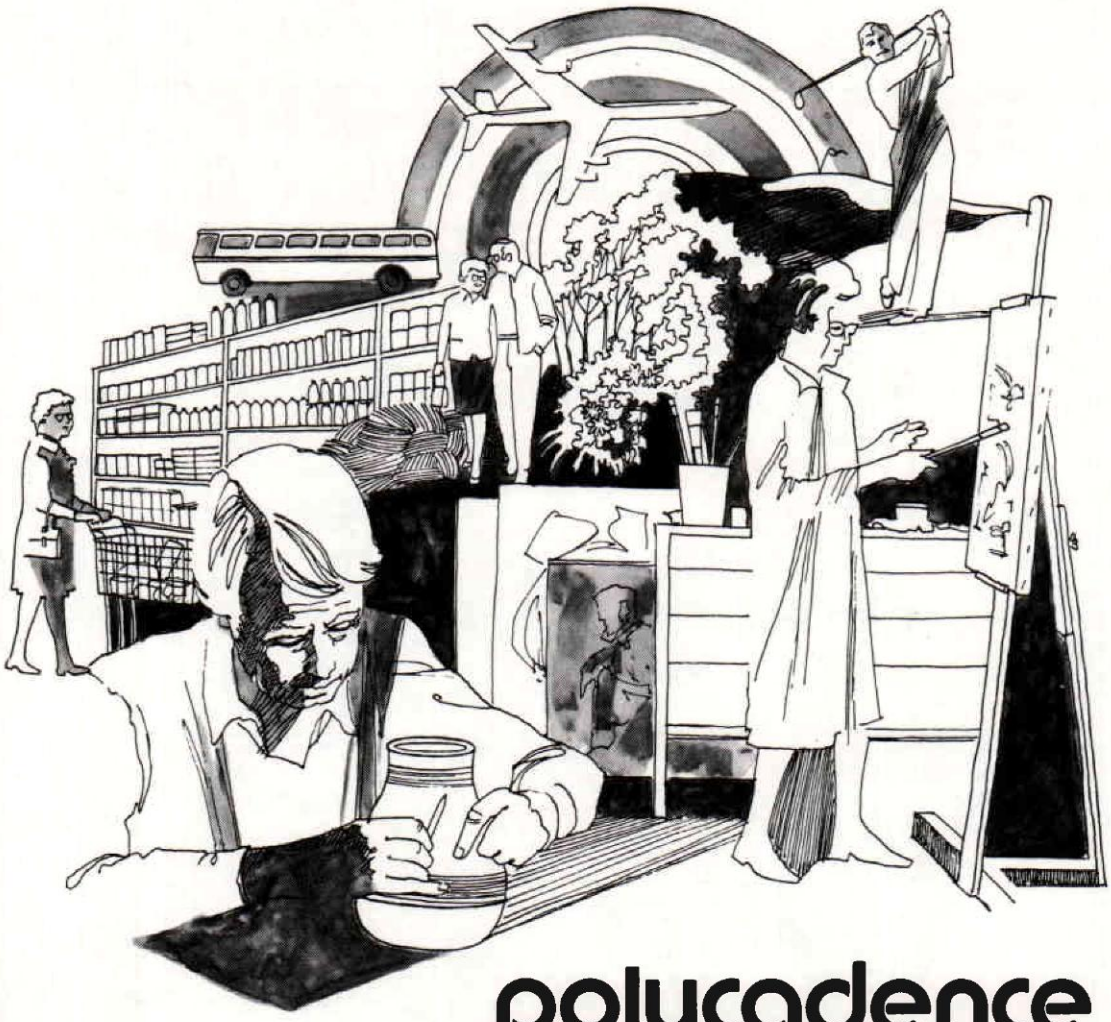
Kendrick features a complete line of trusses. Whether the case be mild or severe, there is a Kendrick truss to fit every hernia correctly. The #607 Hoffman is one of the many Kendrick designs, in stock or custom made, which has increased the comfort of thousands of customers for over 100 years.

Specify surgically correct Kendrick products for your customers. Their confidence in you will result in more frequent repeat sales and higher profits.

You can recommend Kendrick with Confidence

JAMES R. KENDRICK COMPANY, INC.
Philadelphia, Pa. 19144 New York, N. Y. 10016

Kendrick
SINCE 1853



polycadence

a bright, new hope for the geriatric

To be independent and free again. To walk. To adventure and do things with renewed hope. This is now a dream come true for the AK geriatric amputee. Before the Polycadence AK-4 was developed, the geriatric patient had the longest and toughest battle ahead. Lacking both the strength and the courage the geriatric would give up the struggle to cope with the traditional prosthetic appliance. Time and time again the normal history was dependency on others, or the wheelchair. The classic story of the "closet limb". □ With the Polycadence AK-4 the patient achieves very early success in ambulation and a definite psychological lift. From the moment of fitting he gains confidence – in complete contrast to the overcautious steps of most seriously handicapped amputees. □ Ask for our literature, describing our 10 points of difference.

Available from:

Kingsley Manufacturing Co., 1984 Placentia Avenue, Costa Mesa, California 92627, Phone 714/548-6116.

Knit-Rite, Inc., 1121 Grand Avenue, Kansas City, Missouri 64106, Phone 816/221-0206.

PEL Supply Company, 4472 W. 160th Street, Cleveland, Ohio 44135, Phone 216/267-5775.

Southern Prosthetic Supply Co., 947 Juniper Street, N.E., P.O. Box 7428, Atlanta, Georgia 30309, Phone 404/875-0066.

CLASSIFIED ADVERTISEMENTS

Advertising Rates

Regular—First 35 words, $24.00 (minimum). Additional words $1.00 each. Situations wanted advertisements half rate. Space rate additional: 13 × 13 picas-$105.00; 13 × 18 picas-$180.00.

Special—Members of the American Academy of Orthotists and Prosthetists who wish to advertise their availability on a signed or unsigned basis are entitled to do so at the special rate of $5.00 per five line insertion per issue. Each additional line, $1.00.

Mail addressed to National Office forwarded unopened at no charge. Classified Advertisements are to be paid in advance; checks should be made payable to "Orthotics and Prosthetics". Send to: Editor, Orthotics and Prosthetics, 1440 N St., N.W., Washington, D.C. 20005.

ORTHOTICS CHIEF

Certified Orthotics Chief for pioneering orthotics division of this major chronic disease hospital. Must be experienced in lower and upper extremity orthotics, including external power and plastics. Applications to Dr. Charles Long, II, Co-Director, P.M. & R., Cuyahoga County Hospital, Highland View Hospital, Cleveland, Ohio 44122

ORTHOTIC TECHNICIAN

Experienced technician desired—need not be certified. Direct inquiries to Orthotics Department, National Orthopaedic and Rehabilitation Hospital, 2455 Army-Navy Drive, Arlington, Virginia 22206

PROSTHETIST

Post requires an experienced Prosthetist —preferably with a Masters Degree and knowledge of brace making. Must be familiar with modern prosthetic technique, (i.e. total contact quadralateral socket and the patellar tendon bearing prosthesis).

This will be a Training Post for a period of three years at an annual salary of £3,690.

Send applications to:

Hospital Secretary
National Medical Rehabilitation Centre
Rochestown Avenue
Dun Laoghaire
Ireland

ORTHOTIST-PROSTHETIST

Well established facility has immediate full time position open with top pay and benefits. Good opportunity. Must be experienced.

Denver Brace & Limb Co.
5380 W. 38th Ave.,
Denver, Colo. 80212
Phone: (303) 424-4435

CERTIFIED PROSTHETIST

Immediate opening for Certified Prosthetist—Excellent working conditions—sick leave, medical plan, and other benefits. Send salary and qualifications to:

Standard Artificial Limb Co. Inc.
1904 Olive Street
St. Louis, Missouri 63103
1 314-231-1156

WANTED ORTHOTIST AND/OR PROSTHETIST

Old reliable firm.
Good company benefits.
Pension plan.
Paid vacation.
Salary commensurate with experience and ability.
Opportunity for advancement. Good certified practitioners preferred.
All inquiries confidential.

Snell's Limbs & Braces, Inc.
1833 Line Avenue
Shreveport, LA 71101
Phone 318-424-4167

CERTIFIED ORTHOTIST

Well established orthotic facility has full time position available. Many benefits, paid vacation, hospitalization, retirement plan. Salary negotiable.

Mary Free Bed Brace Shop,
1810 Wealthy St. S.E.
Grand Rapids, MI 49506
Phone (616) 459-4688

ORTHOTIC and PROSTHETIC FACILITY

For Sale

Established for over 20 years. In central New Jersey. Offers excellent opportunity for right man or men.

Write: Box 74-4
AOPA
1440 N Street N.W.
Washington, D.C. 20005

RESEARCH PROSTHETIST

U.S.C. Rehabilitation Engineering Center at Rancho Los Amigos Hospital has an opening for a research prosthetist.

He must be interested in research and able to communicate clearly with other medical disciplines.

Certification by the American Board for Certification in prosthetics or prosthetics/orthotics necessary.

Persons who are board eligible but have not yet taken their boards are encouraged to apply.

There is also an opening for a prosthetic assistant who must be innovative and have fabrication experience.

These positions carry extremely good employment benefits and the salary is open.

Contact: Roy Snelson, C.P.O.
Director Prosthetic Engineering
U.S.C. Rehabilitation
Engineering Center
Rancho Los Amigos Hospital
Bonita Hall
7601 East Imperial Highway
Downey, California 90242

PROSTHETIST AND/OR ORTHOTIST

Position available in modern 600 bed health care facility located in northern Virginia area. Prefer person certified or experienced in the field. Willing to send to special courses. Contact Personnel Dept., The Fairfax Hospital, 3300 Gallows Road, Falls Church, Virginia, 22046. (703) 698-3156 E.O.E.

FOR SALE OR BUSINESS OPPORTUNITY

Orthotic, Prosthetic business with good soft goods and rental sales. Fine hospitals within 10 minutes. Well established with doctors. Will consider partnership.

Write: Box 74-3
AOPA
1440 N Street, N.W.
Washington, D.C. 20005

ORTHOTISTS—ORTHOTIC ASSISTANTS—ORTHOTIC TECHNICIANS

Enlarging our staff in progressive orthotic facility. Excellent opportunities. Many fringe benefits. Salary open. We will move you. For this location and others contact:

Dwight E. Carr, General Medical, Orthotic Services, 3232 West Illinois Rd.
Fort Wayne, Indiana 46808
219-432-1528

FOR SALE

ORTHOPEDIC FACILITY: Two fitting rooms; well-equipped office and shop. Located in doctor's office building. Well established orthopedic work for 48 years. Shop located in Louisville's medical center—6 hospitals within 5 minutes walking distance. Husband-wife (owners); 1 experienced helper (9 years); 1 lady (4 years). Want to retire. Stock carried—$12,000. No debts of any kind. Will sell for stock and equipment. Plus business, open for discussion on time payment.

Lindle Orthopedic Brace Shop
Medical Towers South
634 So. Floyd Street
Louisville, Kentucky 40202
1 502-583-2158

ORTHOTIST

Experienced Orthotist, but need not be certified. Good working conditions and benefits. Contact:

Bremer Brace Co., Inc.
1724 S. Orange Avenue
Orlando, Florida 32806

ORTHOTIST

Start from $8,977.00 to $12,167 with advancement to $15,821. Full Civil Service Benefits. Apply:

Veterans Administration Hospital
Richmond, Virginia 23249
or call (804) 233-9631, ext. 225

An Equal Opportunity Employer

PROSTHETIST - ORTHOTIST

Modern East Coast facility looking for qualified Prosthetist-Orthotist to manage or enter into partnership of well established facility. Excellent opportunity. Inquiries confidential.

Write: Box 74-5
AOPA
1440 N Street, N.W.
Washington, D.C. 20005

ORTHOTIST

Experienced Orthotist needed, not necessarily certified. Profit-sharing, retirement plan, and other fringe benefits. Contact:

Braun's Brace & Orthopedic Appliance Co., Inc.
618 N. West 11th Street
Oklahoma City, Oklahoma 73103

ORTHOTIST

We are seeking an Orthotist for our established Orthotic-Prosthetic department. We are a 126 physician clinic located in central Wisconsin at the doorstep of excellent hunting and fishing. This position offers excellent fringe benefits and salary.

Contact: L. R. Stauske
Personnel Manager
Marshfield Clinic
630 S. Central Ave.
Marshfield, WI 54449

CERTIFIED PROSTHETIST

Certified Prosthetist needed for well established modern orthotic and prosthetic facility in Chicago. Attractive location. Good benefits. Salary open. Applications treated confidentially.

Dreher-Jouett, Inc.
210 W. Chicago Ave.
Chicago, Illinois 60610
312-944-3633

CERTIFIED ORTHOTIST

Wanted: Certified Orthotist for George Washington University Rehabilitation Center. Emphasis on vocational rehabilitation and increased productivity, design, construction, and fitting of innovative devices. Submit Resume to BOX 74-6.

AOPA
1440 N Street N.W.
Washington, D.C. 20005

EEO Employer, Affirmative Action Plan

PLAN NOW!

1974 NATIONAL ASSEMBLY

OCTOBER 23-26, 1974

REGENCY ATLANTA

ATLANTA, GEORGIA

The American Orthotic

and

Prosthetic Association

1440 N Street, N.W.
Washington, D.C. 20005

AMERICAN ORTHOTIC AND PROSTHETIC ASSOCIATION
1440 N STREET, N.W.
WASHINGTON, D.C. 20005