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Orthotics and Prosthetics

Journal of the American Orthotic and Prosthetic Association

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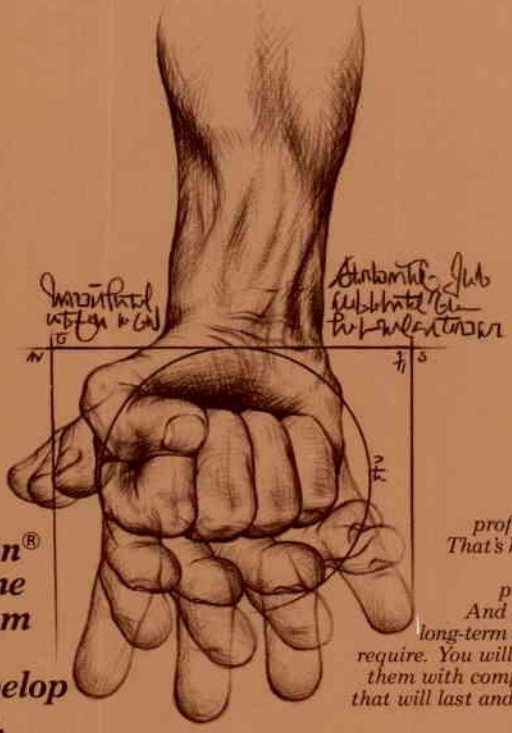

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1980, April 10-15, "Third International Congress on Physically Handicapped Individuals Who Use Assistive Devices." Hotel Galleria Plaza, Houston, Texas, U.S.A.

1980, April 17-19, AOPA Region IV Meeting, Mobile, Alabama.

1980, May 8-11, Region II and III Meeting, Playboy Club, Great George, New Jersey.

1980, May 15-18, AOPA Region V Meeting, Ramada Inn, Akron/Canton, Ohio.

1980, June 6-8, AOPA Region IX Meeting, Ilandia Hyatt House, San Diego, California.

1980, June 11-13, AOPA Regions VIII & X Meeting, Four Season Motor Inn, Albuquerque, New Mexico.

1980, June 16-20, Interagency Conference on Rehabilitation Engineering, Sheraton Center, Toronto, Canada.

1980, June 19-22, AOPA Region VI and VII Meeting, Thunderbird Motel, Bloomington, Minnesota.

1980, June 22-27, World Congress of Rehabilitation, International Winnipeg Convention Center, Winnipeg, Canada.

1980, September 14-20, AOPA National Assembly, New Orleans Marriott, New Orleans, Louisiana.

1980, September 28-October 4, Third World Congress (ISPO), Bologna, Italy.

1981, January 27-February 1, AAOP Round Up Seminar, Fountainebleau Hilton, Miami, Florida.

1981, October 28-November 1, AOPA Assembly, Sahara Hotel, Las Vegas, Nevada.

1982, February 14-20, AAOP Round Up Seminar, Royal Sonesta Hotel, New Orleans, Louisiana.

1982, May 6-9, Region IV Meeting, Nashville, Tennessee.

1982, May 13-16, Region II and III Meeting, Ceasar's World, Atlantic City, N.J.

1982, October 17-24, AOPA Assembly, Hyatt Regency, Kansas City, Missouri.

INFORMATION FOR AUTHORS

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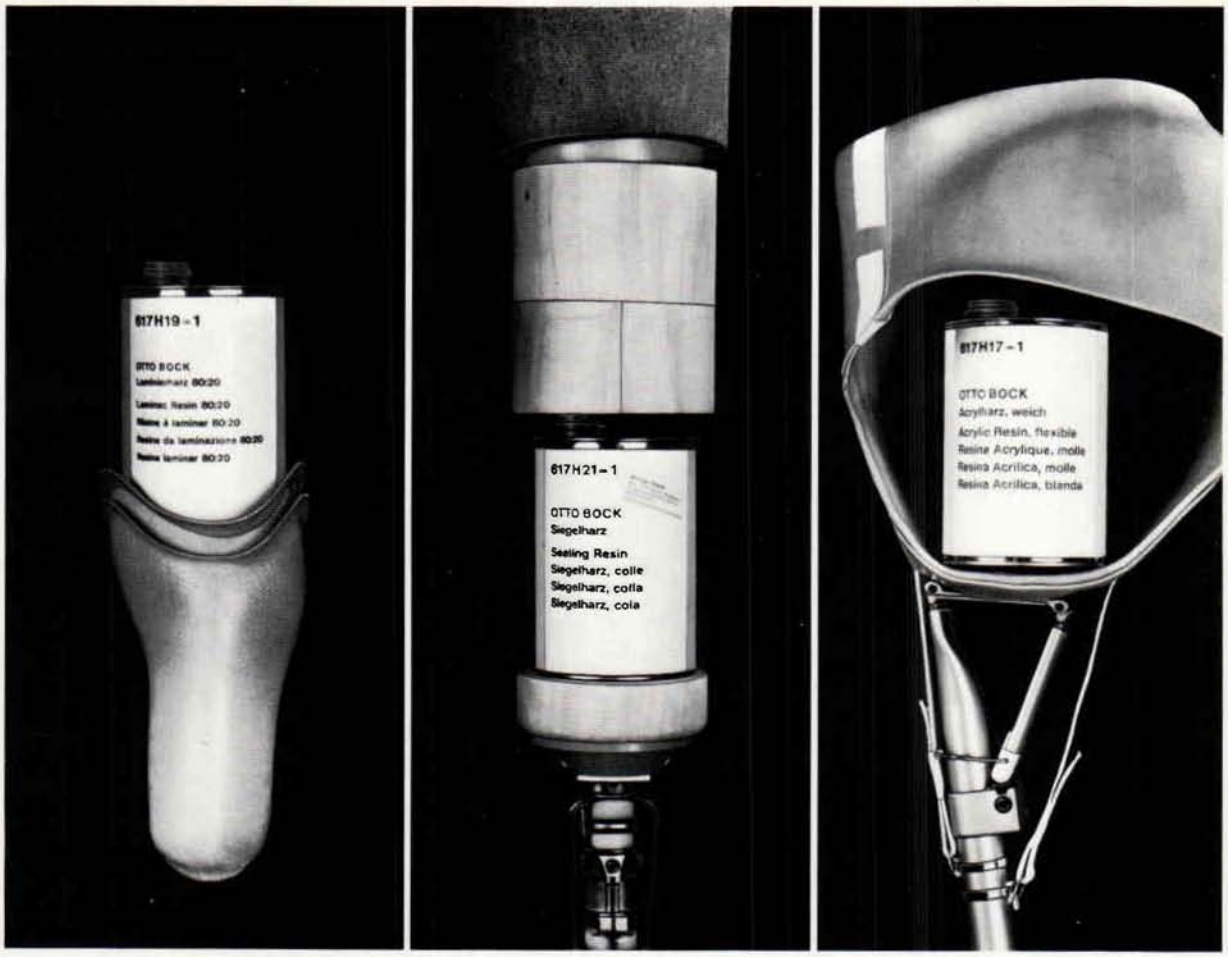

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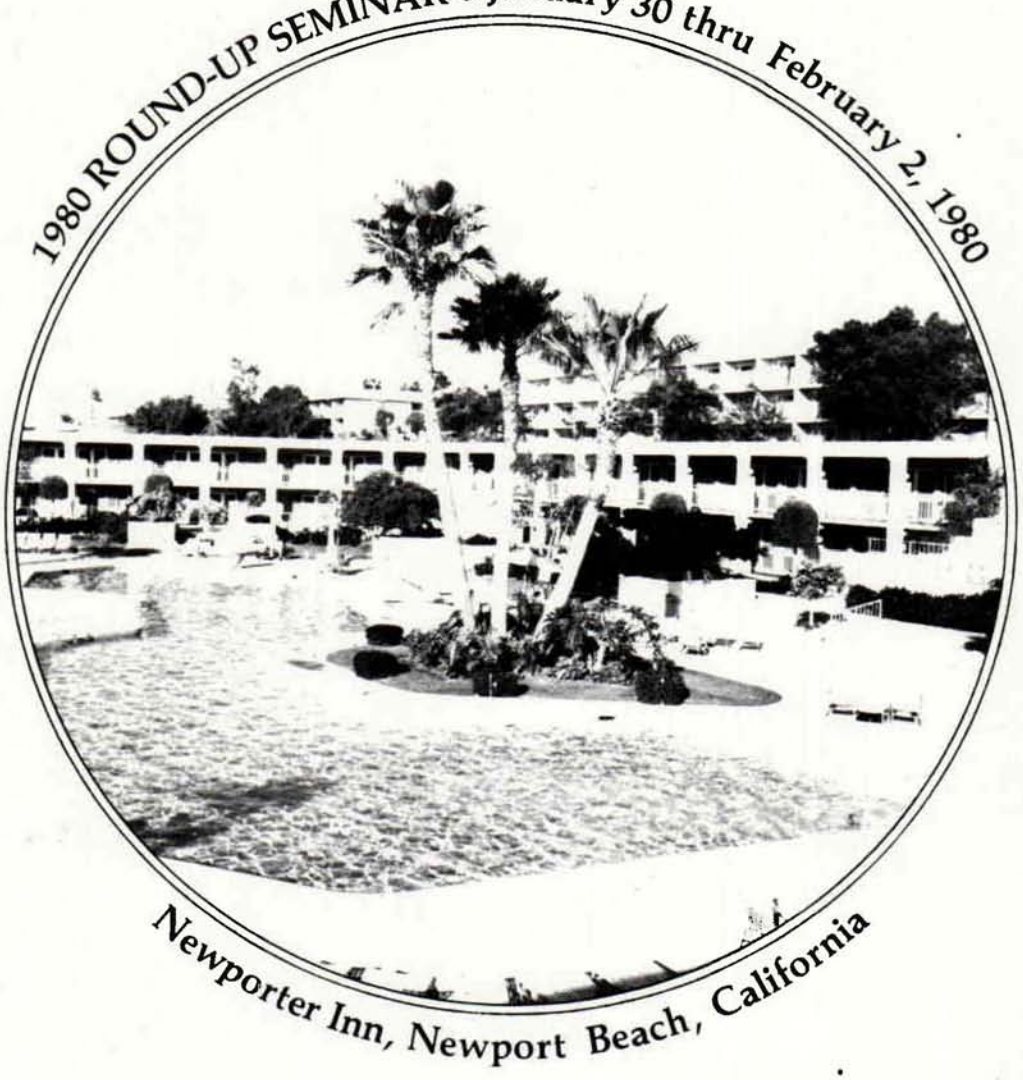

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Commentary

I have been asked by the Chairman of the Editorial Board, Michael Pecorella, to write an article about this particular column in the December issue of the journal. The editorial board, and particularly its chairman, have felt that this column entitled 'COMMENTARY' has not had a varied group of authors. In scanning back issues of the journal, it became apparent to me that the only ones with access to the column were members of the editorial board or officers of one of our organizations. Quite often the articles were reviews of past activities or articles on future plans.

The members of the editorial board felt that this column would better serve the profession if it were used as a sounding board with a wide and varied base of authors.

Kurt Marschall wrote in the June 1979 issue that "the field of Prosthetics and Orthotics has moved in giant strides in the last three decades. New materials have been introduced, new techniques have been developed, resulting in new fitting methods and complete redesign of our Prosthetic-Orthotic armamentarium". With this vast amount of change in our profession we undoubtedly have individuals who have many innovative ideas and opinions of the profession overall or a particular segment of the profession. These are the ideas and comments we would like you to share with your fellow practitioners.

I would hope that you would feel free to write the national office with articles for this column. Also, I will be contacting individuals around the country and requesting them to write an article on a particular subject for this column. Again, we are looking for articles with varied subject matter whether they are controversial, historical, or statistical. Thank you for your participation in advance.

Thomas R. Bart, C.O.
Member of the Editorial Board

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Orthotics and Prosthetics, Vol. 33, No. 4, pp. 3-10, December 1979

The Influence of Heel Design on a Rigid Ankle-Foot Orthosis

DAVID R. WIEST, M.S., R.P.T.[1]
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ERNEST L. BONTRAGER, M.S.[3]
MICHAEL J. QUIGLEY, C.P.O.[4]

In the past decade measurements have been obtained on the forces exerted by ankle-foot orthoses (AFO's) on the lower limb. This quantitative information has been used to assess the effect of the orthosis on stability, mobility, and weight transfer of the patient. Orthoses which block plantar flexion impart a destabilizing knee flexion force with weight acceptance (1). As the normal unbraced limb is loaded following heel strike, the foot plantar flexes passively to 15 degrees because posterior protrusion of the heel helps create a lever between the point of floor contact and the axis of the ankle. Because the ankle is a freely moving joint, the immediate effect of the heel lever in response to initial floor contact is to cause the forefoot to rotate towards the floor. The controlled drop into plantar flexion serves as a shock absorbing mechanism that lessens the impact of initial contact with the floor.

When the ankle is "locked" in a rigid orthosis, the leg and foot pivot forward as a unit about the point of heel contact. The orthosis imparts to the posterior tibia a flexor bending moment at the knee or a tibial advancement torque. To maintain knee extension, the torque must be resisted either through muscular force or the orthosis must be modified to absorb some of the torque.

Tibial advancement torques have been measured quantitatively with strain gauges or tensiometers attached to the uprights of an orthosis. Lee (1) found that with a 90 deg plantar flexion stop there were two prominent pushing forces exerted by the calf band against the posterior calf, a force at heel strike and the other at push off. Lehman et al. (2) demonstrated that heel lever action at weight acceptance can be lessened by the insertion of a cushion wedge into the heel of the shoe as proposed by Eugene F. Murphy (3), or by cutting off the end of the heel.

To decrease destabilizing tibial advance torque a number of methods are used. The ankle joint can be plantarflexed but this causes toe clearance problems during swing phase and knee hyperextension during stance phase. More commonly a heel modification is used to decrease the destabilizing force at the knee during weight acceptance. The use of a heel modification allows the orthotist

to decrease this force without compromising alignment.

Four methods of heel modification are frequently used to decrease destabilizing forces at heel strike:

- *SACH Heel*—This is an adaptation of the prosthetic SACH foot. A wedge of polyurethane foam is inserted in the posterior heel section and normal heel topping material is placed over it. This arrangement is very effective and durable, but requires a more extensive shoe modification than other solutions.
- *Beveled Heel*—The posterior heel is simply ground off at an angle. This expedient is effective, but many patients complain about the appearance and about having their new shoes altered by grinding material away.
- *Crepe Heel*—The entire heel of the shoe is replaced with a latex foam (crepe) material. It has good absorption qualities but tends to wear down quickly. Certain types of crepe will also leave marks on floors.
- *Standard Factory Hard Rubber Heel*—Patients usually prefer this type for cosmetic reasons.

This study was conducted in order to determine the relative effectiveness of the four methods with respect to decreasing the destabilizing forces at heel strike.

Methods

Subjects

A group of nine normal adults, four men and five women, were selected for the study. Their ages ranged from 19 to 46 years and each fitted comfortably into men's size 7-½B oxford-type shoes. None had a history or presence of orthopedic or neurological disorders affecting the lower limbs.

Heel Design and Instrumented Orthosis

The subjects walked in an AFO locked at 90 degrees with each of the four heels under study:

Fig. 1. Anterior view of instrumented bichannel adjustable locking AFO.

- SACH—made with a medium density polyurethane center (the same material used for prosthetic SACH feet).
- Beveled—a hard rubber heel with the posterior edge rounded off. The bevel began 1 cm from the bottom of the heel and extended forward 3.5 cm from the posterior edge of the heel, creating an angle with the floor of approximately 20 deg.
- Crepe—made of latex and had an 'A' Shore hardness of 40.
- Hard Rubber—a standard factory heel with an 'A' Shore hardness of 74.

The heels were tested in a random but predetermined order to eliminate learning effects which might bias the data.

The shoes for the left side had adapted heels and stirrups with short shanks for attachment to a bichannel adjustable locking (Bicaal) type AFO (Fig. 1). The orthosis was adjustable in height and width to fit each subject properly. Strain gauges mounted on each upright made it possible to measure the bending moments exerted on the orthosis in the anterior and posterior directions of the sagittal plane during walking. On all subjects tested the moment arm extending from the ankle to the calf band was 25.4 cm.

Electrogoniometers, Force Plate and Foot Switch System

Knee and ankle electrogoniometers were used to measure sagittal motion of these joints (Fig. 2). The goniometers consisted of a double parallelogram linkage with a linear potentiometer attached to the proximal arm of the linkage. An overhead cable connected the instrumented orthosis and electrogoniometers to an FM analog tape recorder that provided a direct graphical readout.

The lateral, progressional, and vertical forces were measured as the subject walked across a force plate that was concealed with tiles.

The foot switch system provided quantitative information about the foot-floor pattern. Gait characteristics were calculated by relating the foot-switch data to time as the subject walked along a measured walkway. Contact-closing switches were placed in an insole under the heel, the heads of the first and fifth metatarsals, and under the great toe. The signals from the heel and metatarsal areas were coded as voltage levels. The resulting voltages were coded electronically so that the normal sequence for floor contact was displayed on paper as a staircase of equal height voltage steps. The toe switch presented an oscillatory pattern which could be superimposed on any of the other levels. All gait information was transmitted from the subjects to the recording system via a digital VHF radio telemetry system, recorded on video and analog tape, and printed on photosensitive paper.

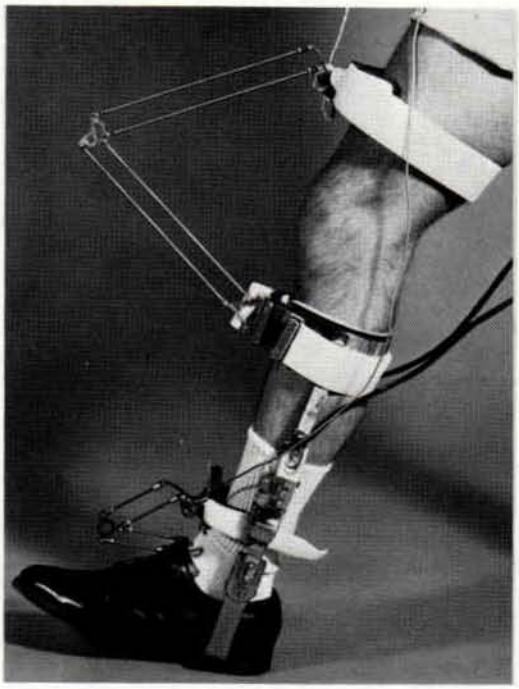

Fig. 2. Lateral view of instrumented AFO, knee and ankle goniometers.

Heel Hardness and Compressibility Testing

Heel durometer was determined by using a Model 302 Trionic Rubber Hardness Guide (Trionic Co. of America, Los Angeles, California). A force of 100 pounds was applied to the posterior edge of the SACH, crepe, and hard rubber heels at an angle of 20 deg which is similar in magnitude and angle of loading in normal walking. Linear deflection resulting from heel compression was measured for these three heel designs using a Rimac Spring Tester (Rinck, McIlwaine, Inc., New York, N.Y.).

Test Procedure

The subjects were given several minutes to become accustomed to walking with the orthosis and other electronic recording devices. Data were collected on two "runs" for each heel as the subject walked along the walkway. If the subject did not strike the force plate with the test limb, the test was repeated until adequate contact was made. No explanation was given to the subject.

Analysis of Data

Four consecutive heel strikes of the left limb were analyzed from both runs for each heel design. Data from each heel type were kept separated and a mean value was calculated for each dependent variable over all subjects. Heel designs were then compared to determine whether differences were not due to chance by using a "paired 't' test" at an acceptable level of significance of p .05. Variables measured and tested for significance among heel designs included:

1. heel contact tibial advancement torque;
2. knee flexion in response to loading;
3. ankle motion within the orthosis;
4. force plate recordings of lateral, progressional and vertical forces at heel contact;
5. stride length;
6. cadence;
7. velocity;
8. gait cycle duration;
9. single limb support time for both limbs; and
10. double limb support time.

Results

The magnitude of tibial advancement torque was determined by establishing a zero baseline while the subject was without the orthosis and by measuring the deflection from the baseline to the peak resulting from heel strike. The SACH, beveled, and crepe heels all had a shock absorbing quality and the tibial advancement torque imparted by these heels was significantly less than that of the hard rubber heel (Fig. 3). The hard rubber heel imparted a knee-flexion torque of 24.8 Newton meters (Nm). The torque produced by the SACH heel was 17.1 Nm, a 31 percent decrease when compared to the hard rubber heel. The beveled heel produced a torque of 18.8 Nm (a 24 percent decrease) and the crepe heel created a 21.8 Nm torque or a 12 percent decrease (Fig. 4). The reduction in the torque was the result of shortening the lever about the joint. By beveling the heel, the heel lever was shortened 1.3 cm. Heel compressibility tests demonstrated that the heel lever can also be shortened 1.3 cm in the SACH heel by applying a force of 445 N (100 pounds) to the posterior edge of the heel. When the same force

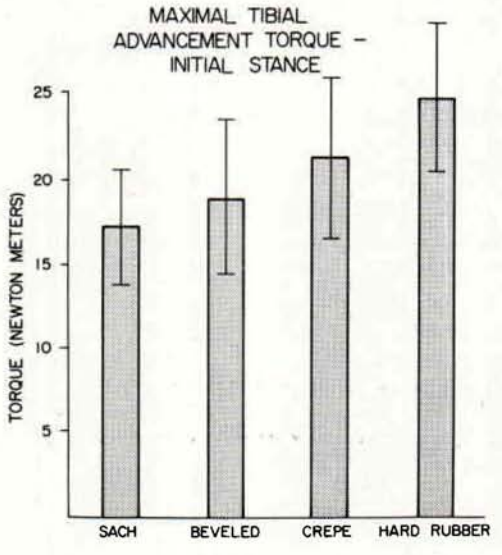

Fig. 3. Comparison of tibial advancement torques.

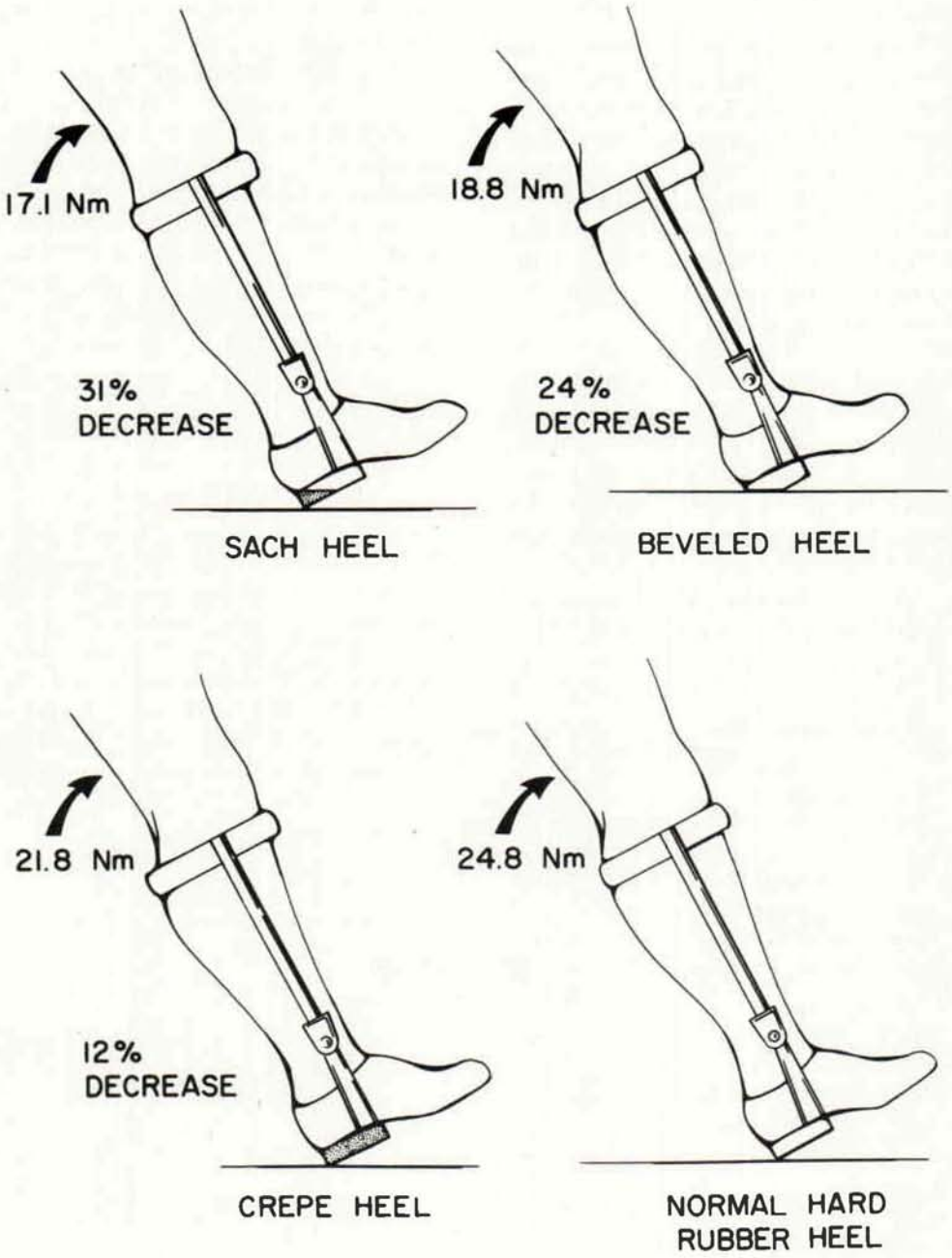

Fig. 4. Loading response knee flexion torque for heel types tested.

was applied to the crepe heel and the hard rubber heel, the heel levers were shortened 0.9 cm and 0.2 cm respectively. Thus, there is a direct relationship between heel lever length and tibial advancement torque. A comparison of tibial advancement torques for each heel design demonstrates a significant difference in all cases except when comparing the SACH to the beveled heel.

Every subject demonstrated a longer stride length when walking with a crepe heel than a beveled heel. This would indicate that stride length increases with a longer heel lever. Stride length tended to be shorter with the hard rubber heel than with a crepe or SACH heel, perhaps because of excessive knee flexion torque. In seven of the nine subjects tested, double limb support time was longest with the hard rubber heel (Table 1).

There were no significant differences among heel designs when considering knee and ankle motion, lateral, progressional and vertical forces, cadence, velocity, gait cycle duration, and single limb support time. It was observed that the subjects walked at a normal cadence with all heel designs but velocity was less because of a corresponding average decrease in stride length. Gait cycle duration and left single limb support time were normal.

There was an average of nine degrees of ankle motion within the locked AFO. A minimal percentage of the ankle motion occurred at heel contact but this motion was not affected by heel design. Most ankle motion occurred as the subject's center of gravity moved over the forefoot (maximal dorsiflexion) to toe off (maximal plantar flexion) of the braced extremity. This motion could have been decreased with a long shank which extended from the heel to the metatarsal heads.

Discussion

Trunk advancement is accomplished by changes in the foot-floor-ankle relationship of the stance limb. Perry (4) describes this relationship in terms of

GAIT AND FORCE MEASUREMENTS	HEEL DESIGN			
	SACH	Beveled	Crepe	Hard Rubber
Gait Characteristics				
Velocity (cm/sec)	121.1 ± 12.2	122.5 ± 14.7	125.7 ± 14.8	122.0 ± 13.2
Stride length (cm)	133.1 ± 8.2	131.0 ± 7.8	135.2 ± 9.1	132.5 ± 6.8
Cadence (steps/min)	109.0 ± 9.0	112.0 ± 12.0	112.0 ± 11.0	111.0 ± 10.0
Gait cycle duration (sec)	1.07 ± .10	1.08 ± .13	1.09 ± .11	1.09 ± .10
Single limb support				
braced limb (%gc)	39.7 ± 1.6	39.9 ± 1.9	40.2 ± 1.7	39.2 ± 1.6
unbraced limb (%gc)	41.7 ± 2.4	41.6 ± 2.8	42.4 ± 2.5	39.9 ± 3.2
Double limb support (%gc)	18.5 ± 2.6	18.6 ± 2.2	17.6 ± 2.0	20.9 ± 3.1
Knee flexion as result of limb loading (degrees)	12.0 ± 5.0	11.0 ± 4.0	12.0 ± 5.0	11.0 ± 6.0
Force Measurements				
Tibial advancement torque at limb loading (Newton)	17.1 ± 3.3	18.9 ± 4.6	21.2 ± 4.8	24.8 ± 4.4
Lateral force (Newton)	48.9 ± 10.7	49.4 ± 8.9	53.8 ± 16.0	48.5 ± 8.9
Progressional force (Newton)	80.5 ± 22.7	85.4 ± 20.0	86.7 ± 13.3	74.3 ± 15.6
Vertical force (Newton)	676.0 ± 89.0	681.0 ± 89.0	681.0 ± 93.0	681.0 ± 98.0

Table 1. Gait and force measurements of normal subjects walking in locked AFO with four heel designs. Mean values of nine women and women.

three rockers, each serving to advance the swing limb through part of the total arc. The initial rocker occurs during limb loading and allows forward rotation of the tibia as a result of the heel level action. Tibial advancement torque is a measurement of this initial rocker magnitude. Since a majority of the patients for whom a rigid AFO is prescribed have marginal knee stability, added tibial advancement torque is objectionable. It has been demonstrated in this study and by Lehman (2) that tibial advancement torque can be reduced by use of a cushion or beveled heel. Limb loading compresses the heel, thereby shortening the length of the heel lever and provides a shock absorbing effect as well as a substitute for loss of plantar flexion in loading response. Modification of the heel is only effective for patients who initially contact the floor with the heel and will therefore have no effect on patients with a toe-first or flat-foot gait.

Midstance rocker action occurs during the midstance phase of the gait cycle or while the foot is flat on the floor. Trunk advancement in this phase results from a forward motion of the tibia through an arc of 25 degrees. Fixed ankle plantar flexion blocks the mid-stance rocker action entirely. Therefore, the degree of trunk advancement that can be accomplished during midstance is dependent upon the amount of substitution available at the hip or knee. If the knee lacks hyperextension range or the patient cannot afford hip flexion because his extensor muscles are too weak to support this posture, the patient will have a step-to rather than a step-through gait. The normal subjects tested had a 12 percent decrease in stride length when walking with a locked ankle orthosis because of diminished midstance rocker action.

Terminal rocker action occurs during terminal stance as a result of body advancement over the forefoot with the ankle locked. Terminal heel rise combined with a forward roll of the tibia during weightbearing is the sign of adequate terminal rocker action. Rigid ankle bracing can provide for adequate terminal rocker action even with minimal plantar flexion strength.

Summary

Four different heel modifications on shoes attached to a rigid ankle-foot orthosis were tested on nine normal patients. The purpose of the study was to determine which type of heel modification was most effective in decreasing tibial advancement torques generated from initial contact through the loading response phases of gait. The heel modifications were compared to a normal hard rubber heel on the same orthosis.

- The SACH-type Heel was the most effective of the four heel modifications. Knee flexion movement decreased to 17.1 Nm, a 31 percent decrease when compared to the hard rubber heal.
- The Beveled Heel effectively decreases knee flexion movement to 18.8 Nm by providing a shorter heel lever arm, a 24 percent decrease when compared to the hard rubber heel.
- The Crepe Heel absorbed shock by a significant amount, providing only a 21.8 Nm torque to the knee, a 12 percent decrease when compared to the hard rubber heel.
- The Hard Rubber (normal) Heel imparted the most destabilizing knee flexion torque, 24.8 Nm.

These heel modifications are recommended for patients who initially contact the floor with the heel and who may have knee instability problems due to muscular weakness or proprioceptive impairment and should not be used automatically on every rigid ankle-foot orthosis.

Footnotes

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Knee Cylinder

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For a variety of reasons it is not uncommon to wish to hold the knee firmly in a position of maximum extension for an extended period of time. This may occur following surgery or after reduction of a severe flexion contracture. One way of doing this is to apply a plaster-of-Paris knee cylinder. In some instances a more attractive alternative, though, is the use of a thermoplastic knee cylinder, because it is lighter, more durable, easier to keep clean, and it can be removed periodically for skin care and therapy to the knee.

In some instances a knee orthosis of more conventional design, including knee joints and plastic shells, may be considered, but there are a number of factors that may weigh against its use. Unless the foot is to be included, suspension must come from points above the knee, mechanical joints are required, and the posterior opening necessary to permit flexion makes it difficult to obtain adequate suspension and rotary stabilization. The presence of an anterior opening about the bony prominences of the knee makes it difficult to control properly the pressure that must be distributed in this area to prevent flexion.

Spasticity in its severer forms not only makes it difficult to control pressure about all edges of the orthosis, but makes it difficult to lock the joints of the orthosis and keep them locked. In such cases a knee cylinder that totally encloses the knee will not only prove to be safer and more comfortable, but also will prove to be more effective. Lastly, the possibility of "window edema" about the openings of the knee cannot be overlooked.

Orthosis Design

The orthosis (Figs. 1 and 2) consists of anterior and posterior sections that overlap medially and laterally and extend distally to about two inches proximal of the medial malleolus and proximally to a point about one inch distal of the ischial tuberosity. The proximal and distal edges should be rounded outward so as to avoid excessive pressure in these areas. Anteriorly directed forces will be created in the posterior proximal and distal areas and appropriate material should be removed to facilitate this. The posterior section should be of polypropylene to provide the stiffness necessary. The anterior section can be made of either polypropylene or polyethylene, and it can be padded, if desired, with closed cell polyethylene foam during the fabrication procedure.

About the knee, modification is best

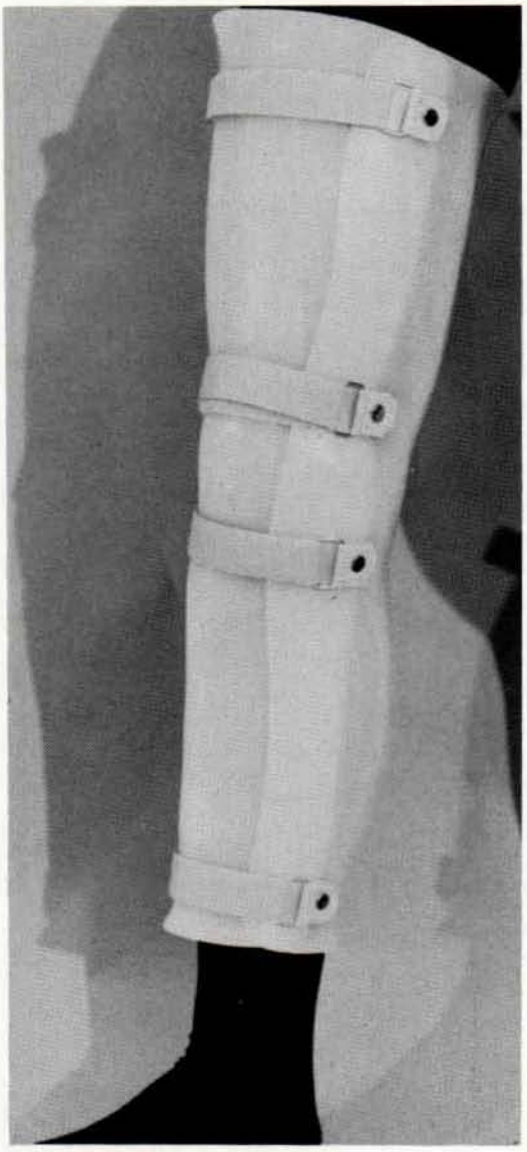

Fig. 1. Antero-medial view of the knee cylinder.

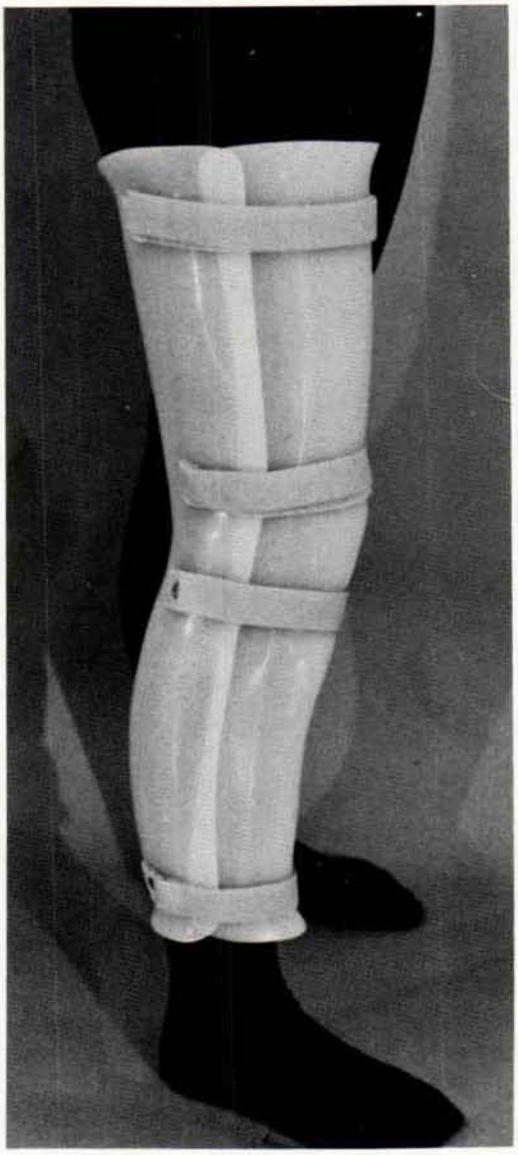

Fig. 2. Lateral view of the knee cylinder.

thought of as for a suprapatellar/supracondylar PTB prosthesis (Figs. 3 and 4). Material will be removed medially and laterally proximal to the bony structures of the knee to provide suspension, and, similarly, material should be removed from over the medial tibial plateau to "lock in" the orthosis and prevent pistoning. The posteriorly directed corrective force will be distributed over the quadriceps tendon, the patellar tendon, and to both sides of the tibial crest distal to the tibial condyles. Appropriate relief will be added over the patella, adductor tuber-

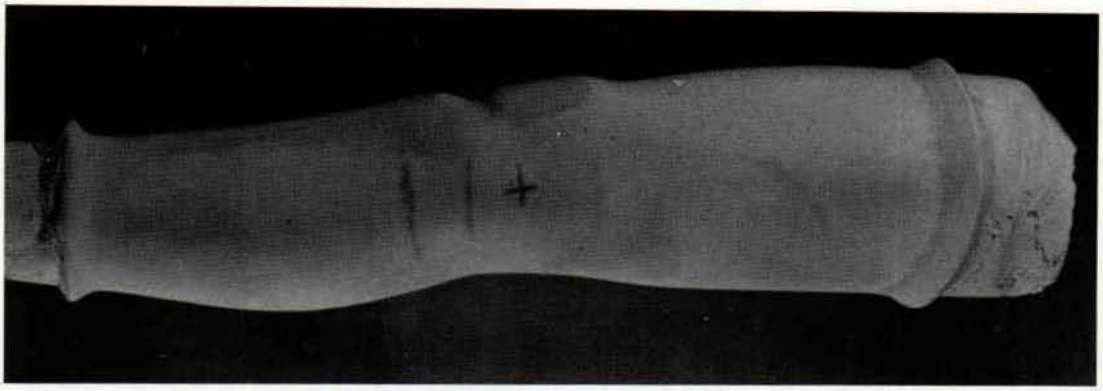

Fig. 3. Medial view of modified model showing proximal and distal buildups for flares, as well as the modification of the knee.

cle, lateral femoral condyle (if necessary), tibial tubercle, tibial condyles (if necessary), tibial crest, and fibular head. In addition, relief can be made posteriorly about the knee.

Four Velcro straps (Figs. 1 and 2) are attached to the anterior sections, two about the knee, one proximally and one distally. In applying the orthosis the strap immediately proximal to the knee should be fastened so that the orthosis settles into place properly relative to the bony prominences of the knee, and so that correct suspension is obtained. The strap immediately distal to the knee should then be fastened followed by the other two straps. Once all four are fastened, each strap should be readjusted individually in the same order to obtain maximum correction and proper pressure distribution. Once this is done the orthosis should be grasped about the knee and moved proximally and distally, and rotated from side to side. If the orthosis fits properly and has been applied properly, there should be no discernible motion between the orthosis and the skin and the two should move as one over the underlying bones. It is intended that the orthosis will be worn over a length of stockinet or hose, as is the case for all such orthoses.

Casting

The patient is positioned supine on the edge of the table or bed with the limb

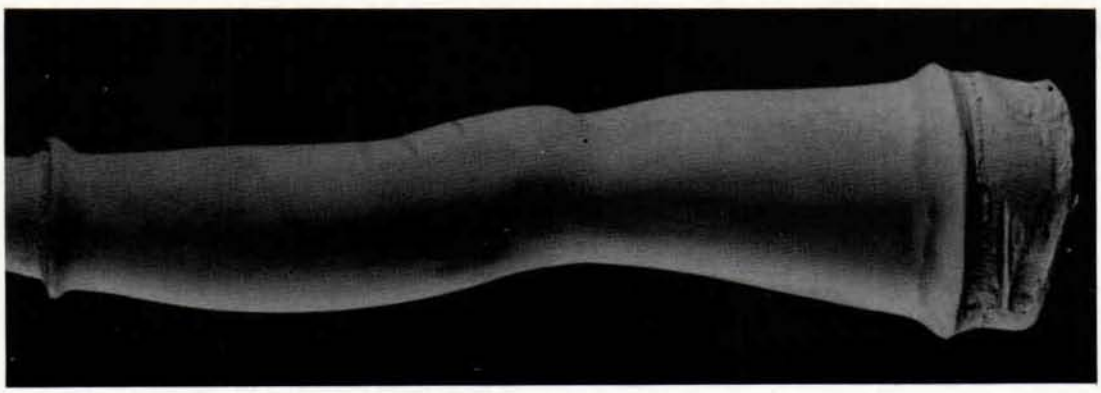

Fig. 4. Posterior view of modified model showing indentation proximal to the adductor tubercle.

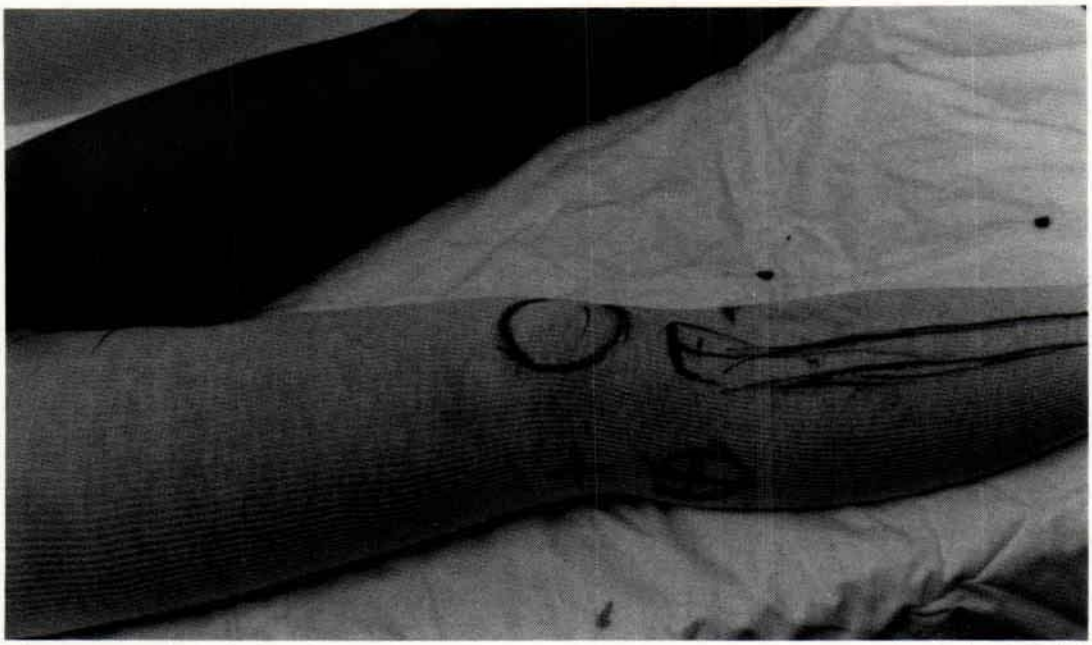

Fig. 5. Antero-lateral view of the patient's knee showing the bony prominences outlined with indelible pencil.

supported by the assistant holding it about the ankle. The procedure should be explained to the patient to reassure him and elicit his cooperation and the orthotist and his assistant should practice the procedure and position with him. The assistant will provide firm sustained traction distally while the orthotist molds the contours about the knee for suspension and pressure distribution, and holds the knee in a position of maximum extension. Firm traction held over sustained periods will relax the muscles, thus facilitating correction. To prevent clonus, sudden and jerky movements of the knee should be avoided.

Cotton stockinet is applied to the leg from the ankle to the groin. A plastic tube or webbing is positioned underneath it for protection of the patient during subsequent removal of the cast. Some prefer to position this directly over the tibial crest on the theory that relief will be added here later while others prefer to position the tube in other more fleshy areas where the contours are less critical. Indelible pencil is used to mark the bony prominences of the knee (Figs. 5 and 6) and the proximal and distal edges. Some modifications can be avoided if felt strips, skived on one edge, can be positioned under the stockinet at the proximal and distal edges to facilitate formation of the radii later. The limb is wrapped with elastic plaster-of-Paris bandage and reinforced with rigid bandage. While the bandage sets, the orthotist and assistant hold the knee in extension and mold the contours as rehearsed (Fig. 7). Careful attention to detail at this point will save considerable trouble in subsequent modification of the positive model. Once set, the cast is split, removed (Fig. 8), closed, and filled with plaster of Paris.

Fig. 6. Antero-medial view of the patient's knee showing the bone.

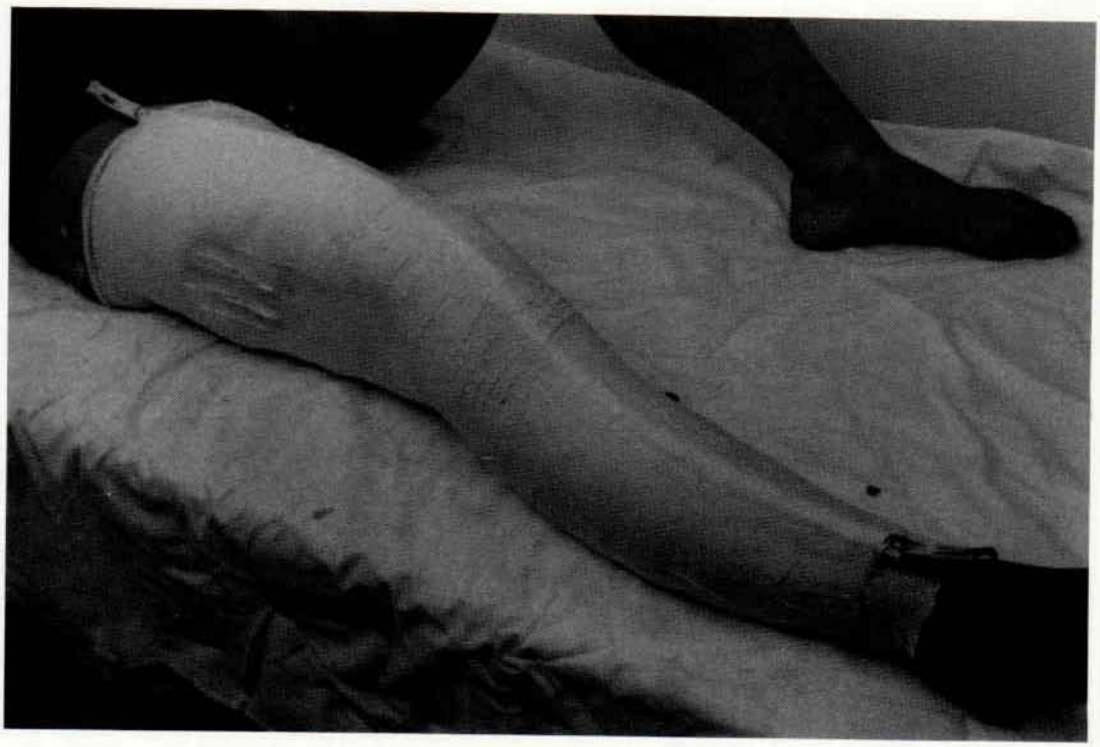

Fig. 7. Cast on the patient, after it has hardened, showing the plastic tube anteriorly and strong finger indentations laterally.

Fig. 8. Medial view of the cast once it has been removed from the patient showing indentation proximal to the adductor tubercle.

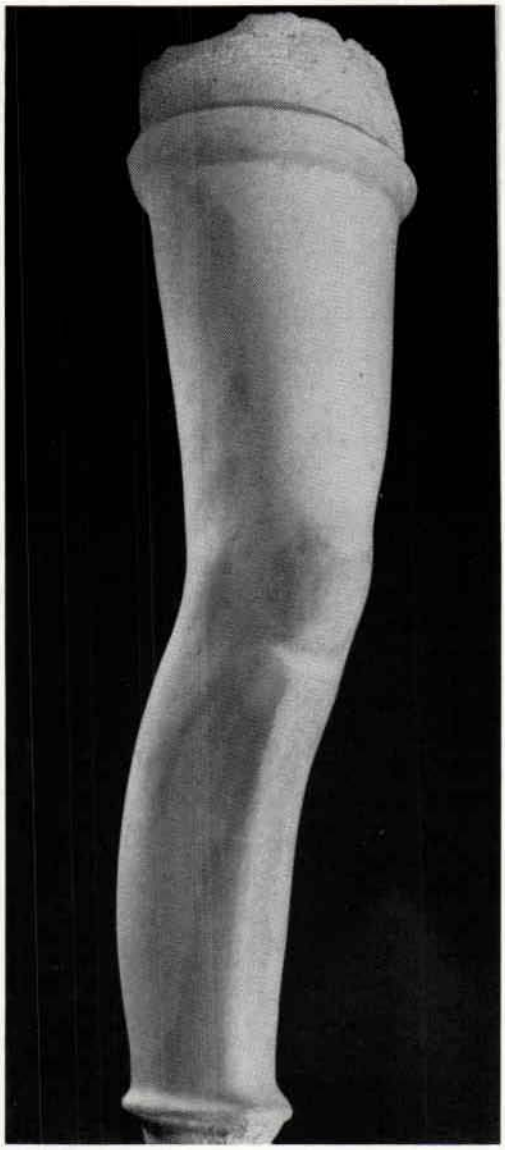

Fig. 9. Positive model ready for forming of orthosis.

Fabrication

The positive model is smoothed up overall, modified as necessary for correction and suspension, and appropriate reliefs added (Fig. 9). Once the model is modified and smoothed it is dried and a nylon hose added for vacuum forming of the posterior section (Fig. 10), which can be done either by hand draping or in conjunction with a frame and platen. This is most commonly made with polypropylene, but in the absence of spasticity and in the presence of edematous changes it can be made with polyethylene for addi-

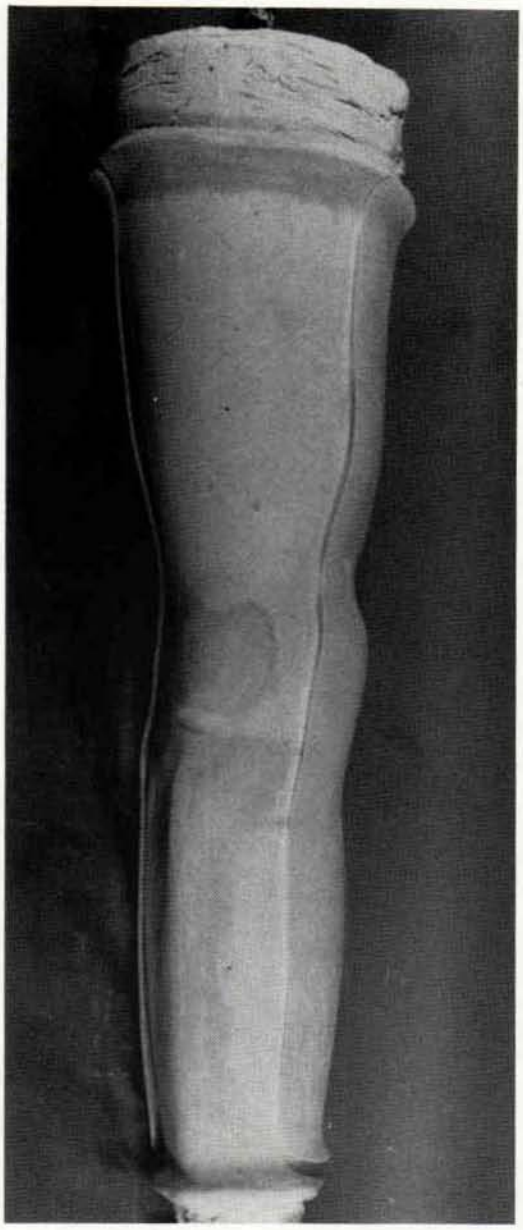

Fig. 10. Posterior section of the orthosis once it has been vacuum formed, trimmed, smoothed, and re-applied to the model for vacuum-forming of the anterior section.

Fig. 11. Anterior section vacuum formed, trimmed, and reassembled on the model with the posterior section.

tional circumferential flexibility. Padding can be added to the posterior section as well as to the anterior section if desired, but it must be borne in mind that padding makes an orthosis even warmer than it is without it. Once the posterior section has cooled and been trimmed, the anterior section is fabricated in a similar

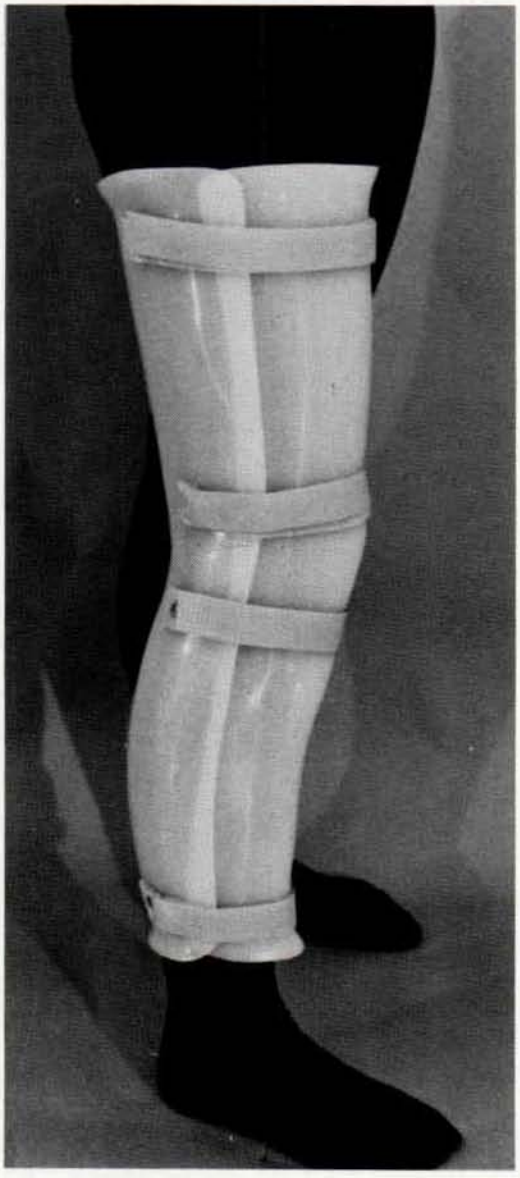

Fig. 12. Completed orthosis on the patient.

fashion (Fig. 11). Finishing of the orthosis proceeds in the usual way (Fig. 12). No specific instructions are given here for modification of the positive model or fabrication of the orthosis as it is believed that adherence to the design philosophy given earlier and general fabrication procedures described elsewhere, will prove sufficient and avoid needless time-consuming and condescending repetition of basic instructions. Attention in particular is drawn to *Lower-Limb Orthotics* (1).

Summary

Considerations for the prescription and design of a thermoplastic bivalved knee cylinder orthosis are given. In addition, the casting procedure is described and some general instructions for the fabrication of the orthosis are given.

Footnotes

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Crutch Walking and Functional Grasp in the Congenital Triple Amputee

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The purpose of this report is to describe our experience in management of the child with congenital absence of both legs and the left forearm and hand. In the treatment program it was difficult to reconcile independent crutch walking with functional grasp and the modifications of the prosthesis which made this possible are useful and of interest.

Case Report

F.R. is a ten-year old child born of a normal pregnancy. There is no history of maternal illness, injury or drug ingestion. At birth he was found to have a complete bilateral lower-limb amelia with a congenital absence of the left forearm and hand (Fig. 1). He was neurologically intact.

At eight months of age he was provided with a "bucket" prosthesis and allowed to stand. At sixteen months, pylons were attached to the bucket and at six years of age, after the pylons had been lengthened several times, he was provided with knee joints. Since that time, he has worn a bilateral hip-disarticulation socket with free hip joints, manual locking knees and Sach feet (Figs. 2 and 3).

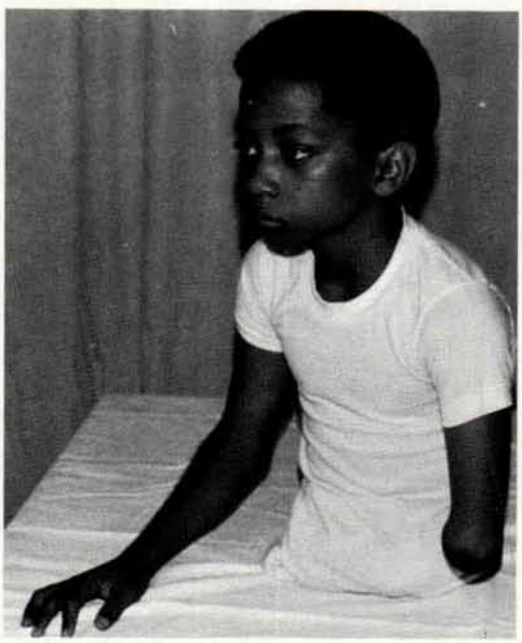

Fig. 1. Photograph of the patient showing the extent of the complete amelia of both lower limbs and the congenital absence of the left forearm and hand.

The problem arose in reconciling the dual functions of weight-bearing on the left upper limb during use of a crutch and grasp of the hook.

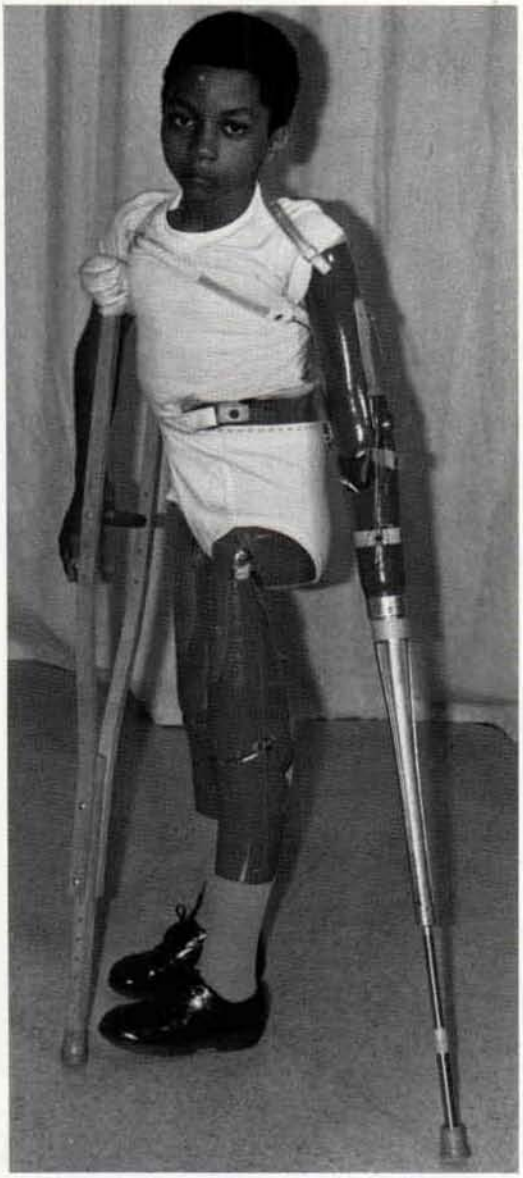

Fig. 2. Photograph of the patient standing in the hip-disarticulation socket using a conventional crutch in the right hand and the "pylon" crutch attached to the left elbow-disarticulation prosthesis.

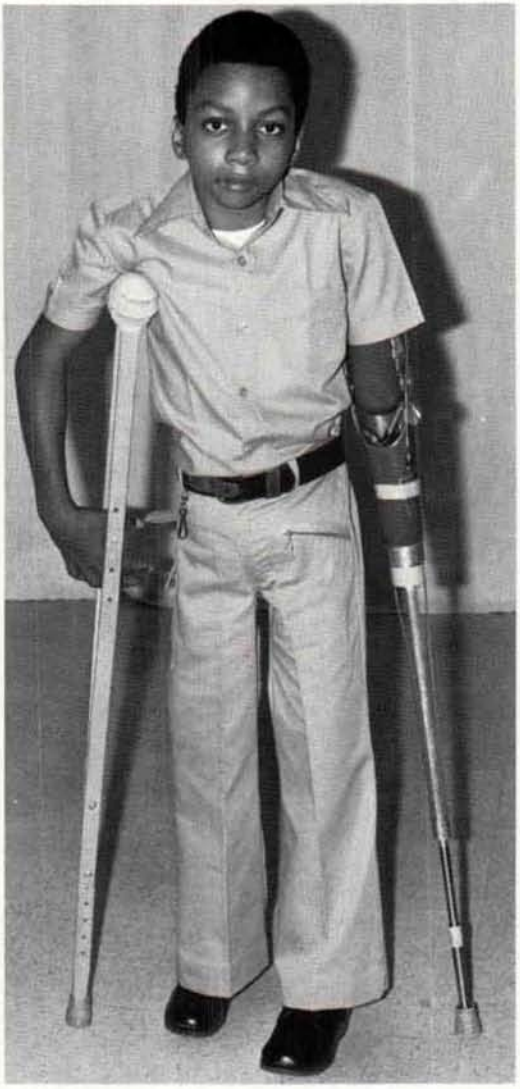

Fig. 3. Front view of the patient clothed and ambulating with a four-point gait using prostheses and crutches.

The patient was taught to ambulate with a swing-through gait with two crutches, one of which is held in his right hand while the other is secured in the elbow disarticulation arm (Fig. 3). While walking he carries the Dorrance hook inside the forearm of the prosthetic limb. When he is in the sitting position, he can unscrew the crutch and insert the hook into the arm. After attaching the cable, he can activate the terminal device for functional grasp (Figs. 4 and 5). At the age of ten and one-half years he has been

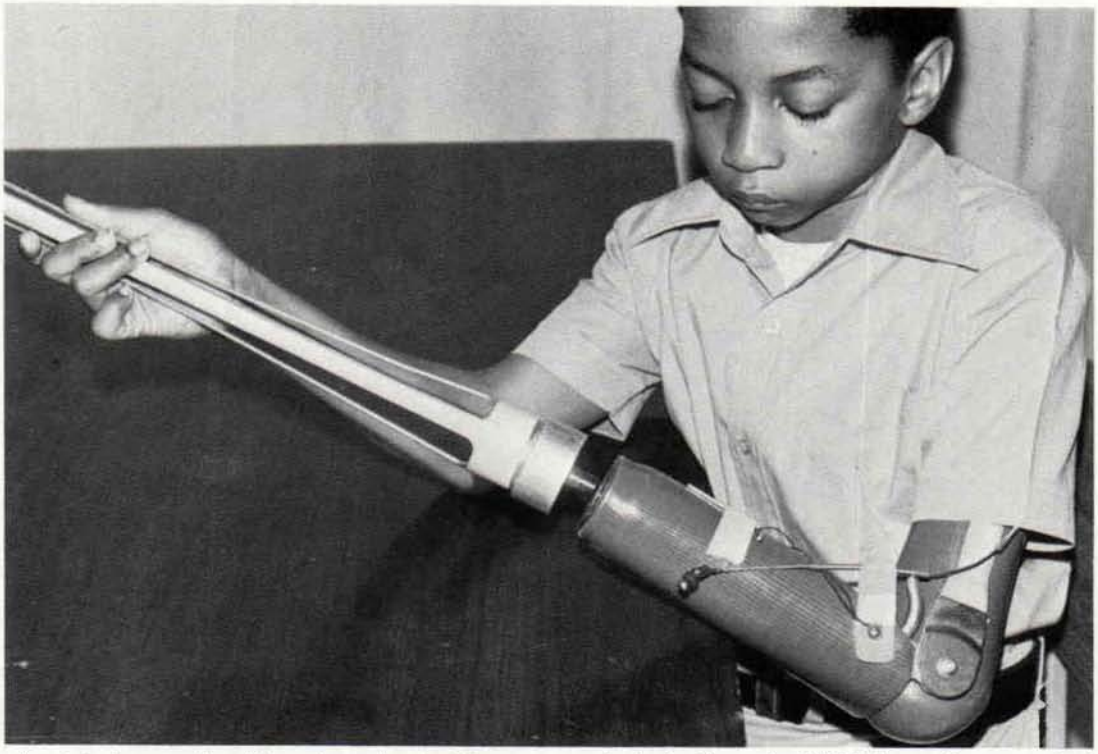

Fig. 4. In the seated position, the patient is able to remove the "pylon" crutch which is inserted as a terminal device for the elbow-disarticulation prosthesis. The standard hook is kept in the hollow forearm of the prosthesis. The heavy duty outside-locking elbow is used. A small Allen-head wrench needed to lock the hook in place is taped to the forearm unit.

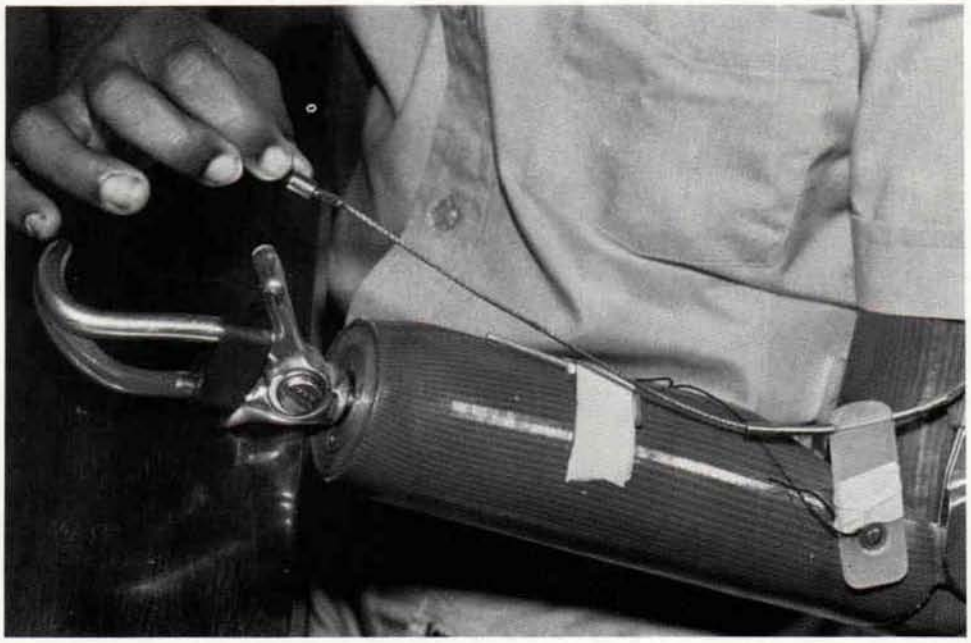

Fig. 5. The patient is able to assemble the terminal device and attach the cables without assistance. He has excellent function with a standard child-size hook.

"mainstreamed" into regular classes and attends the fifth grade with normal children.

Discussion

Relatively few reports have dealt with the rehabilitation of the congenital triple amputee with lower limb amelia and absence of a forearm and hand. The bilateral hip-disarticulation socket prosthesis has had prior application for this type of malformation but ambulation in such patients is difficult particularly when there is only one functional upper limb (1, 2). In the case of the patient described in this report the problem was solved by providing the individual with two interchangeable terminal devices. The patient became adept at their use possibly because of their application very early in life. With an increase in weight and activity, modification of the elbow and the upper limb prosthesis became necessary to prevent frequent breakdown and time away from active use of the prosthesis.

Footnotes

[1]The Amputee Clinic, Children's Hospital of Philadelphia.

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Clinical Application of RTV Elastomers

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Urethane elastomers have been used extensively in prosthetics and orthotics for more than twenty years for the fabrication of expanded urethane SACH feet and cosmetic covers, hydraulic and pneumatic ring seals, and various high-impact resistant components in articulated mechanisms. Utilization of urethane elastomers has been confined generally to industrial or wholesale application, primarily because of the precise and demanding environmental control systems necessary to insure proper vulcanization. Atmospheric pressure, prepour temperature and postcure elevation, as well as proportional exactness of the multicomponent systems have made this elastomeric group impractical for application in clinical laboratory or resale fabrication. However, recent developments in urethane elastomers have increased greatly the practicality of clinical application. It is the purpose of this article to discuss the new developments, and to illustrate their applications in clinical prosthetics and orthotics.

The word elastomer means synthetic rubber, or rubber-like material, and pertains primarily to physical, rather than chemical, molecular configuration. Urethanes are the most widely used elastomers because of their incredibly high tensile strength, chemical inertness, abrasion resistance, and adhesive qualities. Unlike flexible plastomerics, such as polyester and epoxy resins, urethanes are resilient, having the capacity to absorb force by stretching, and then returning to their original shape and size after the force has been reduced. This resiliency, or forgiving quality, is often useful in the successful design and fabrication of prosthetic and orthotic appliances.

Unlike the widely used Silastic elastomers, such as Dow 384 and 385, urethanes are highly resistant to abrasion, have a high tensile strength, and, thus, are not nearly as susceptible to wear and tear as other elastomers. Urethane elastomers are not only cohesive, as Silastics are, but they will adhere to almost all other materials. Its adhesive qualities make it ideal for flexible lamination because of the extensive chemical association with the nylon or fiberglass reinforcement agent.

The specific urethane elastomer discussed in this article is called Lynadure[1]. Basically, it is a formulation of flexible epoxy plastomers and medium density urethane elastomers. This particular combination of epoxies and urethane results in a material possessing the best qualities of both components, and which is best described as resilient plastic. Working temperature is between 40 and 120 deg F. It is a two-component system, with a mixing ratio of 10 parts compo-

nent-A resin to 3 parts component-B curing agent. No exotic mixing or metering equipment is necessary. The components can be mixed by hand in an uncontrolled environment. Working time, or "pot life", is about 7 minutes. Demolding time at room temperature is 45 minutes, which can be reduced significantly with heat. Complete vulcanization and detoxification can be achieved by postcuring at 180 deg F. for 4 hours. The viscosity of Lynadure can be raised to any extent by adding fillers such as cellulose acetate fibers, microballoons, glass beads, etc. The viscosity can be lowered by adding up to 50 percent TGW primer to component A prior to mixing with component B. Thinning will help facilitate rapid saturation of thick laminations.

Clinical Applications

The discussion of RTV urethane elastomer application will be limited here to partial foot prostheses and wrist immobilization orthoses. Figure 1 represents prosthetic socket treatment for a transmetatarsal amputation. Talocrural, subtalar, intratarsal and tarsal-metatarsal joints are left intact and functional. Therefore, the UCBL insert approach (1, 2) to foot stabilization is appropriate in designing the prosthetic socket. Not only does the UCBL insert type socket provide adequate support to the foot, but it also provides an ideal foundation on which to build a prosthesis. The primary objective in providing a transmetatarsal prosthesis is to protect the integrity of the part of the foot that is left, and provide for some degree of flexion and extension through the artificial metatarsal-phalangeal joints. The lamination technique can be considered to be an air cushion socket in reverse.

The rigid portion is laminated first with 10 percent 4134 and 90 percent 4110 polyester resin, and allowed to cure. Prior to this first lamination a prefabricated tongue (1½"-2" wide) is secured in place on the model (Fig. 2) before application of the inner PVA bag. This is to facilitate a smooth interfacing of tongue and socket against the limb. A new PVA sleeve is applied and the nylon proximal portion of the insert is impregnated with Lynadure (Fig. 3) thinned by adding between 10 and 25 percent TGW Primer. The monoelastic SACH foot is then contoured and attached to the socket. Figure 4 represents a monoelastic molded urethane SACH foot contoured on the superior surface to accommodate the inferior configuration of the UCBL insert socket.

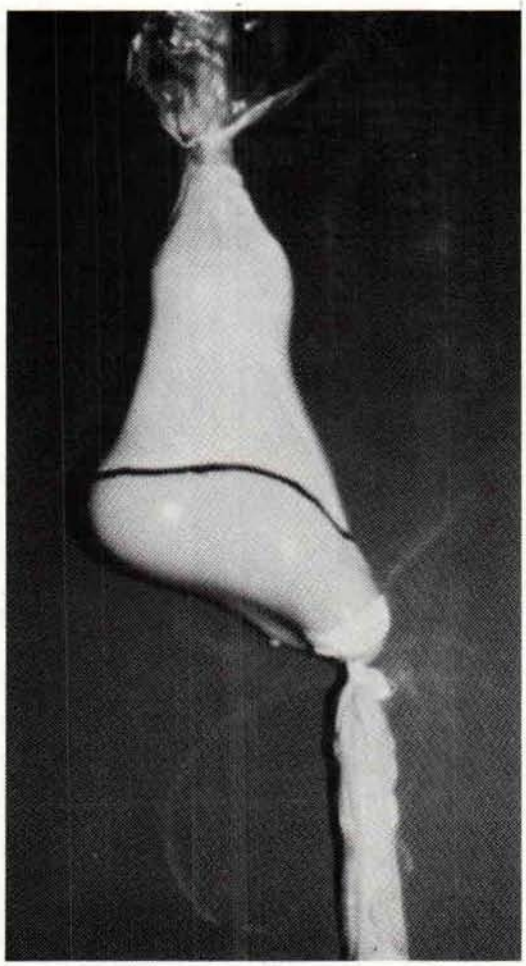

Fig. 1. Use of Lynadure in providing prosthesis for transmetatarsal amputation.

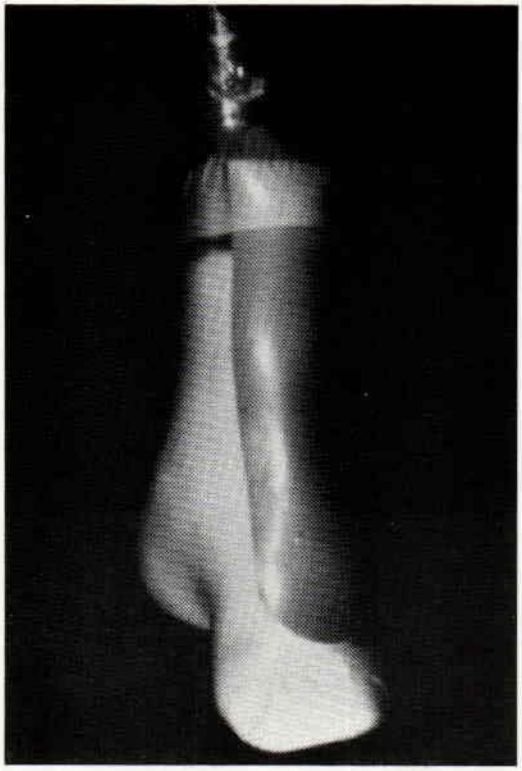

Fig. 2. Prefabricated tongue secured in place on the model before the first lamination.

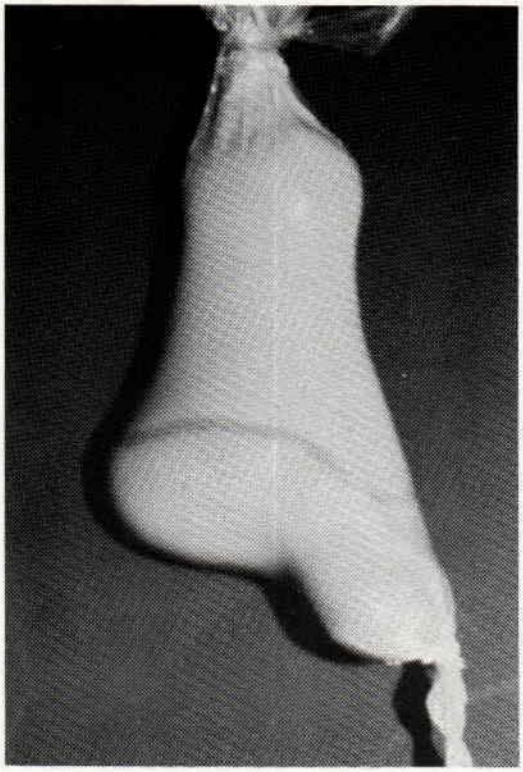

Fig. 3. Photograph of assembly showing the flexible proximal portion of socket and the rigid distal portion.

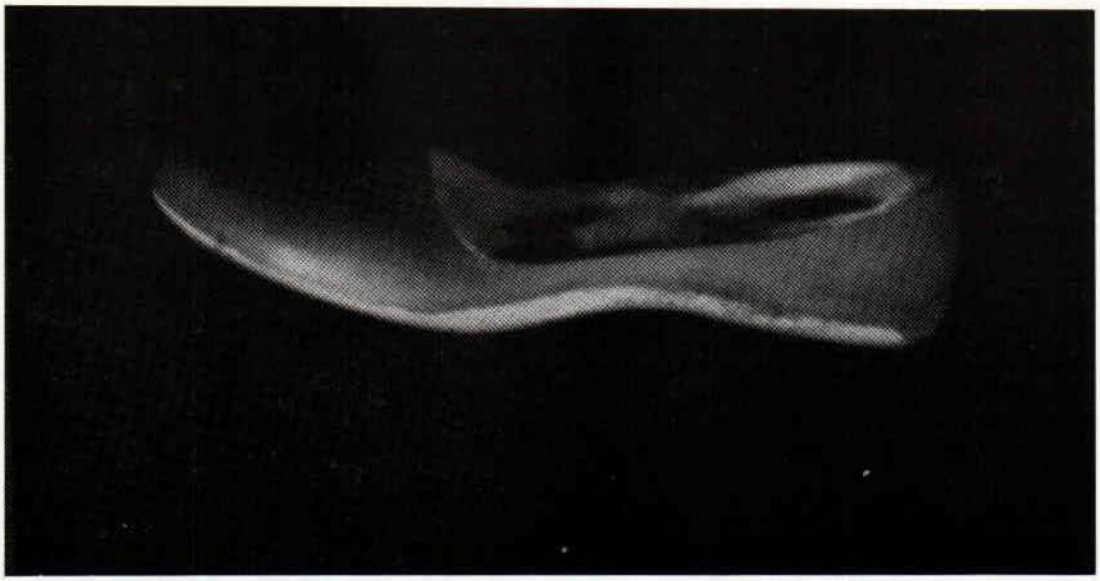

Fig. 4. A monoelastic SACH foot that has been contoured to match the inferior surface of a UCBL shoe insert type of socket.

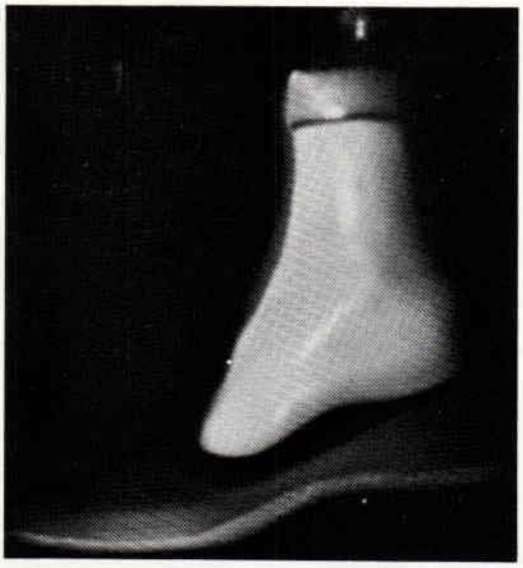

Fig. 5. The correct relationship between the SACH foot and the shoe insert type of socket.

Figure 5 illustrates the correct relationship between the SACH foot and socket. The void between the two surfaces, including the length discrepancy between the extended socket and the ideal location of the artificial MP joints can be filled with Lynadure mixed with fillers (Fig. 6). This also permanently adheres the foot to the socket. The Lynadure is allowed to cure and is smoothed by sanding. Figure 7 illustrates the final lamination of the foot and socket. The SACH foot should be sized by brushing on a thin layer of Lynadure to minimize the migration of air from the foot into the lamination. Usually two layers of IPOS stockinet or two Knit-Rite cosmetic hose will suffice as reinforcement, depending on the structural specifications for the final lamination. Additional reinforcement can be added to the plantar surface of the SACH foot, particularly through the "toe break"

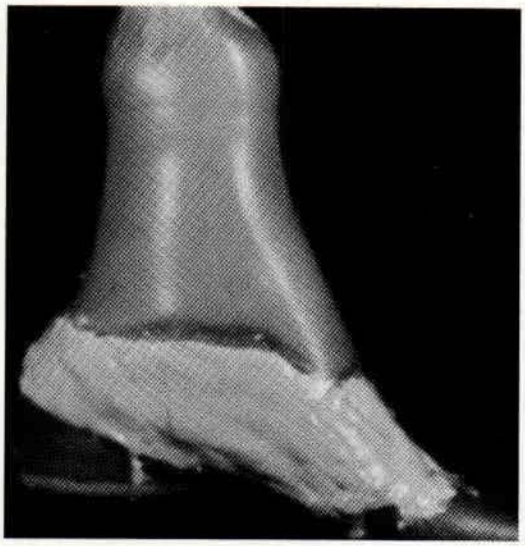

Fig. 6. The voids are filled with a mixture of Lynadure and microballons, glass beads, etc., which also forms a bond between foot and socket.

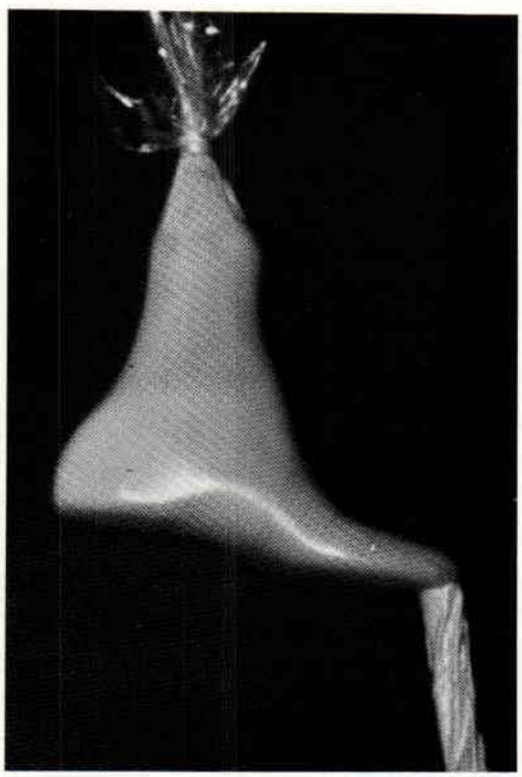

Fig. 7. Final lamination stage.

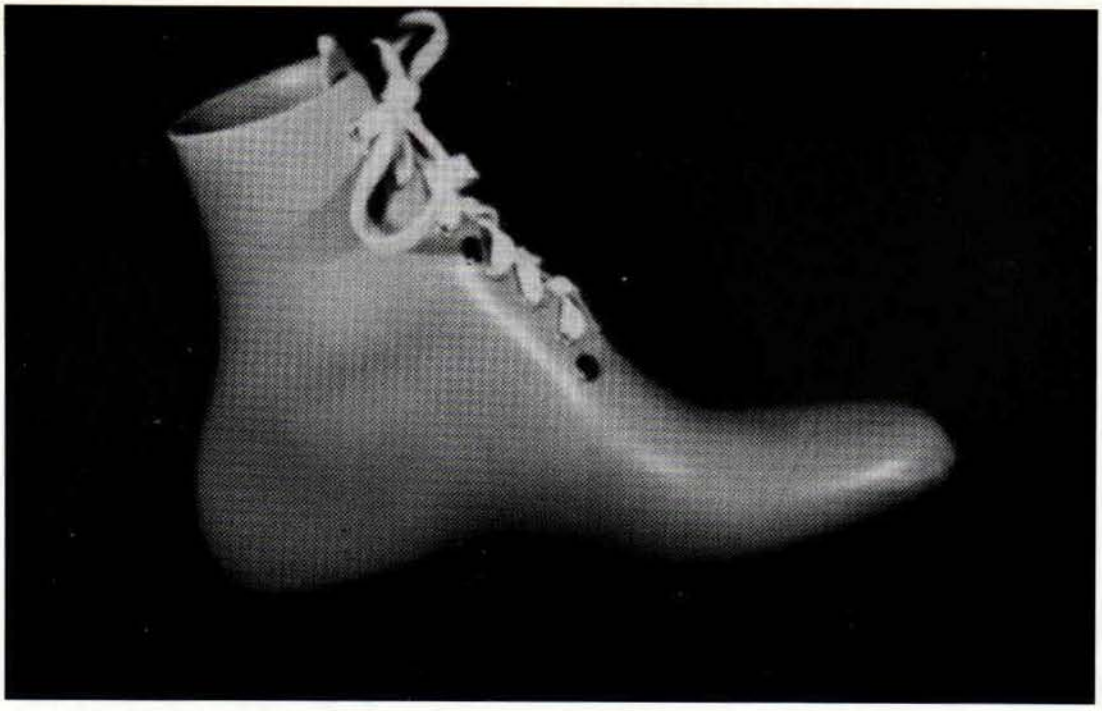

Fig. 8. The finished prosthesis with laced closure.

area. Figure 8 represents the finished prosthesis with a frontal lace closure.

It is important to recognize the fact that all material used in this fabrication sequence are chemically compatible. The final lamination not only chemically adheres to the polyester socket, but also to the urethane SACH foot, making it essentially one piece. Because Lynadure is flexible and resilient, it does not interfere with the normal function of the foot. Because the abrasion resistance and tensile strength of Lynadure is so great, the cross-section of the prosthetic socket can be greatly reduced from that of Silastic lamination, and, thus, permits easy insertion and withdrawal of the prosthesis in and out of the shoe. Subsequent modification of the socket is facilitated by the heat sensitive characteristic of Lynadure. Over pressure sensitive areas, the Lynadure can be heated, and stretched. After cooling, the socket wall will maintain its new dimension.

Figure 9 represents a positive cast for an orthosis for a traumatic and permanent medial displacement of the carpals relative to the forearm, with a related neuropathy. This particular orthosis will have a dorsal lacer opening, so the closure tongue should be placed over the dorsum of the hand, wrist, and forearm before application of the inner PVA bag as seen in Figure 10. Neolon or padded vinyl can be sewn over the cast and tongue as interfacing (a liner). The seam should be over the center of the tongue so that it can be cut away after lamination (Fig. 11). Directly over the tongue and interfacing, 2-4 layers of nylon stockinet are laminated with Lynadure (Fig. 12). In this application, the Lynadure can be thinned as much as 50 percent, depending on the degree of flexibility required of the orthosis. After the Lynadure has cured (about 45 minutes at room temperature), it can be cut off the cast and outfitted with the appropriate

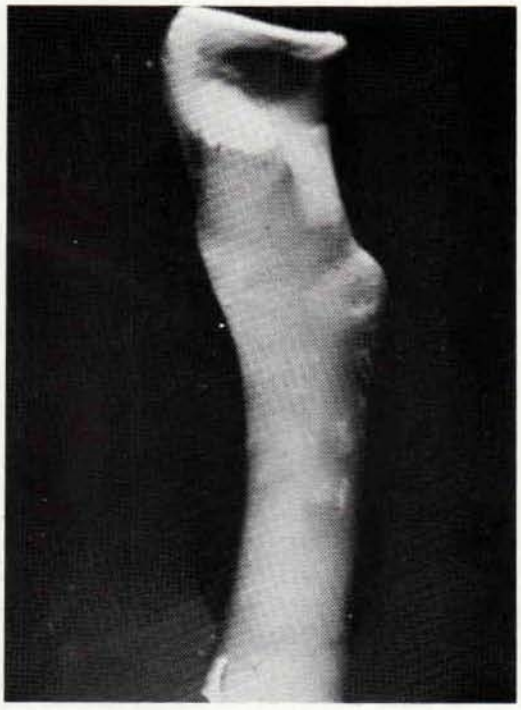

Fig. 9. Positive cast for an orthosis for medial displacement of the carpals.

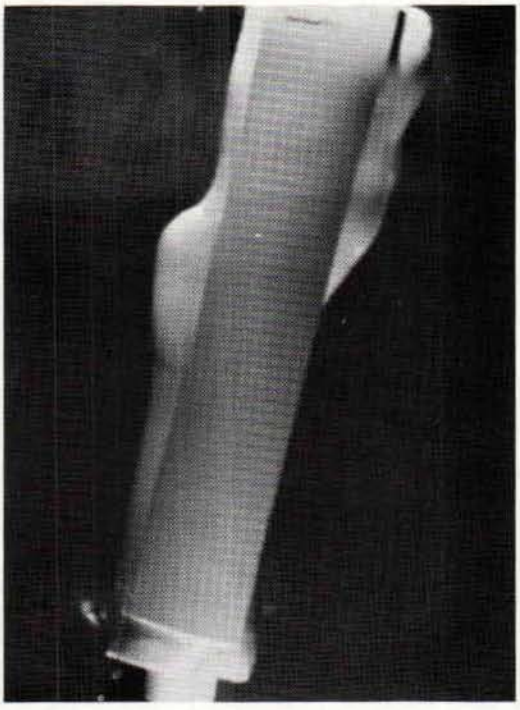

Fig. 10. The closure tongue for the orthosis is placed over the dorsum of hand, wrist, and fore-

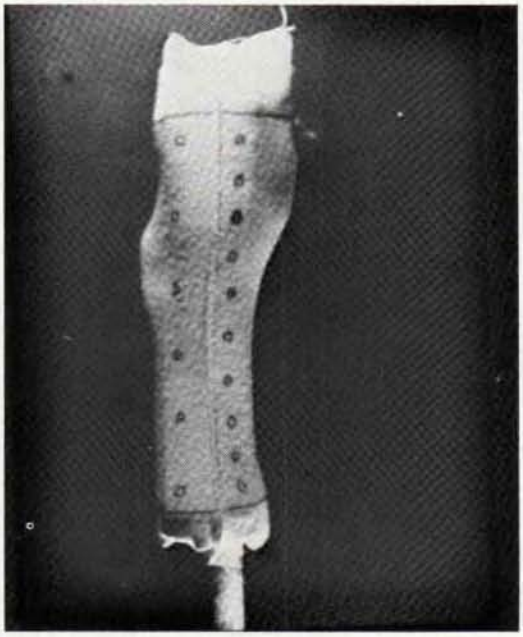

Fig. 11. Padded vinyl is sewn over the cast and tongue to provide an interfacing. The seam should be over the center of the tongue so that the vinyl can be cut away easily after lamination.

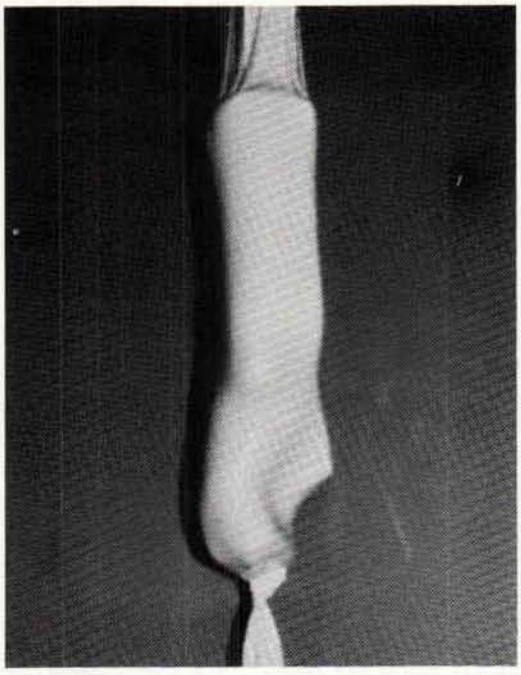

Fig. 12. Two to four layers of nylon stockinet are laminated over the cast with Lynadure.

closure system (Fig. 13). Because Lynadure adheres directly to the interfacing, no sewing or glueing is necessary, except for the tongue. Any amount of stabilization or freedom of motion through the wrist and hand can be controlled by the trimlines, tension of the closures, durometer of the Lynadure, and cross-sectional thickness of the lamination. As in the partial foot prosthesis, modifications can be made by heating the lamination, and pushing it outward to the desired position. Accessibility permitting, modifications can be made by cutting or sanding the lamination.

Summary

The qualitative description of Lynadure and the two clinical applications mentioned in this article should give the reader some insight as to the unique characteristics of Lynadure, and its potential applicability in clinical prosthetics and orthotics. The urethane elastomeric group is rather new to our field, and its ultimate usefulness depends on the imagination and resourcefulness of individuals willing to examine new materials and their practical applications. Lynadure is currently being evaluated by the Veterans Administration as a molding rubber for cosmetic restorations. It is also being tested as a material suitable for extractable air cushion socket inserts. Applications in soft sockets have proved very successful.[3] In regard to integumental application, Lynadure can be brushed directly over the endoskeletal urethane foam covering (USMC, Hosmer/Dorrance, Otto-Bock) to increase the resistance of the foam to tearing, discoloration, and water absorption.

Footnotes

[1]Medical Center Prosthetics, Inc., 6955 Almeda Road, Houston, Texas 77021.

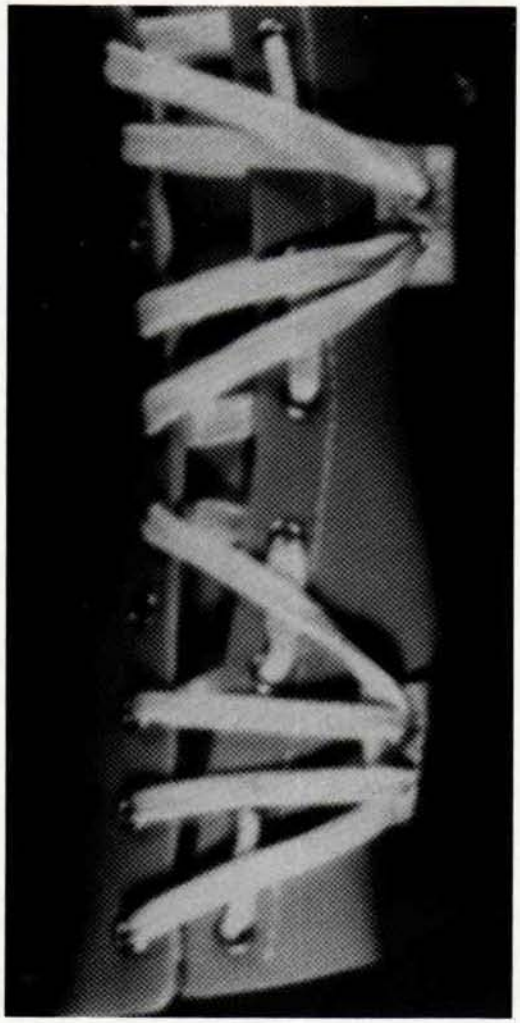

Fig. 13. The finished orthosis.

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Orthotics and Prosthetics, Vol. 33, No. 4, pp. 30-38, December 1979

Clinical Evaluation of an Acrylic Latex Material Used as a Prosthetic Skin on Limb Prostheses[1]

CARLTON FILLAUER, C.P.O.[2]
MICHAEL J. QUIGLEY, C.P.O.[3]

Clinical evaluation of new devices and techniques, whether conducted formally or informally, is a necessary step in the evolution of a device or technique from the idea stage to widespread use on patients. In some cases, manufacturers conduct their own clinical evaluations by distributing the devices to selected orthotists-prosthetists and requesting their opinion after fitting a number of cases. In other instances the developer may have a great amount of clinical experience with the device and therefore not go outside for an evaluation. Government agencies usually require a formal evaluation that consists of a protocol involving a recommended number of patients, an even geographic distribution of patients, initial and follow-up data collection forms, a pre-determined time table, and a final report.

Evaluations are particularly difficult in the field of orthotics and prosthetics because laboratory, or bench testing, is usually inadequate inasmuch as patient reactions cannot be obtained. Furthermore, there are usually so many dependent variables involved in prosthetics and orthotics application that a scientific study is impractical, if not impossible.

This is a result of a formal clinical evaluation of an acrylic latex prosthetic skin developed for the Veterans Administration by Fred Leonard, Ph.D. at George Washington University for use over limb prostheses. The evaluation was a function of the AAOP Research Evaluation Committee.

The Need for a Prosthetic Skin

One of the stated advantages of modular endoskeletal prostheses is that the foam cover is soft, pliable, and "lifelike." Unfortunately, problems associated with the foam cover have been one of the major contraindications for using endoskeletal prostheses. Foam covers are very soft and pliable, but tear easily, stain easily, absorb water, and are not flesh colored. Cosmetic hosiery must be worn over the foam to protect it and to provide a flesh color, but the hosiery needs to be replaced frequently because it also tears, stains, and absorbs water. Owing to these problems endoskeletal prostheses are provided only to patients who consider cosmesis extremely important and who will not be participating in activities that tend to harm the foam cover, such as sports, working in dirty areas, working near water, and kneeling. In the past few years development of a prosthetic skin to protect the foam cover has been a high pri-

ority. In the past, a number of major chemical companies were contacted by the National Academy of Sciences, and government agencies concerning this problem, but until now no solution was forthcoming.

The Acrylic Latex Prosthetic Skin

The acrylic latex prosthetic skin developed by Dr. Leonard consists mainly of Hycar liquid latex pigment and a dilutent (water), which is applied by either a brush or spray.

Tests undertaken at George Washington University showed that the material did coat the surface of the foam satisfactorily leaving a texture that was not unlike that of human skin. In tests comparing foam coated with the acrylic latex to uncoated foam, the coated foam did not appear to change in hue after one hundred and sixty hours of exposure to ultraviolet light, whereas the uncoated foam changed from yellow to a brownish hue rather rapidly. The material also displayed a high resistance to staining, and it was recommended that methanol or soap and water be used to clean the material. The stress-strain properties of the acrylic latex material proved to be greater than that of the underlying foam substrate. Further tests indicated that the peel strength of the coating is greater on a urethane foam than on vinyl foam.

Need for a Clinical Evaluation

Although laboratory results on the prosthetic skin sounded promising, a number of questions remained unanswered. Past experiences have demonstrated that laboratory testing of materials can often be misleading and that clinical evaluation of a technique or device is necessary to determine practicality, if for no other reason. In this case, it had not been demonstrated that the material would be sufficiently flexible, yet strong enough, to function about the knee joint in above-knee prostheses. Preliminary testing of the material at Rancho Los Amigos Hospital suggested that the original technique for coating above-knee prostheses with the acrylic latex prosthetic skin was unsatisfactory and that a new technique needed to be developed. Other areas that required investigation under clinical conditions were patient acceptance, fabrication time, cost effectiveness, durability for use with endoskeletal upper-limb prostheses, chemical handling problems, and uses of the material in other areas of orthotics and prosthetics.

Fabrication Technique

The acrylic latex material is available in one-quart containers in three different base colors. Combinations of the base colors can provide very accurate color matching for each patient. A shade guide (Fig. 1) is provided which contains seven different color swatches along with instructions for combining the base colors to obtain the shades shown. The shade guide should be used in the same way that color swatches are used for cosmetic gloves on prosthetic hands. The proper shade is determined during patient evaluation and casting, using both sunlight and interior lighting to determine a good compromise in color. The darker color is always added to the lighter color because it is easy to make the material darker but very difficult to make it lighter after it has been made too dark. Between 200 and 300 grams is usually sufficient to cover a below-knee prosthesis (Fig. 2).

The foam cover that is to be coated with the acrylic latex material should be finished as smoothly as possible. One cosmetic stocking[4] should be pulled snugly over the prosthesis and foam cover, an overhand knot is put in the stocking

SHADE GUIDE FOR ACRYLIC LATEX COATING.						
						
#1	#2	#3	#4	#5	#6	#7
BASE	MIX: 3 PARTS #1 1 PART #5	MIX: 2 PARTS #1 2 PARTS #5	MIX: 1 PART #1 3 PARTS #5	BASE	MIX: 1 PART #5 3 PARTS #7	BASE

Fig. 1. Shade Guide. The shade guide uses flesh colors ranging from very light Caucasian to dark Negroid. The color is matched to the patient's skin and mixed according to the directions. Before this acrylic latex was available, color matching an endoskeletal prosthesis was a difficult and expensive process.

about the prosthesis, and the assembly is suspended in a well ventilated area for ease of application and drying (Fig. 3) as well as fume removal.

Acrylic latex can be painted on without dilution. If it is to be sprayed on it should be diluted with water. Before applying the acrylic latex to the prosthesis, the sock is dampened with water. The acrylic latex is painted on as smoothly as possible to avoid streaks. Each coat takes approximately two hours to dry, but this time can vary widely depending upon factors such as heat, ventilation, and humidity. The second and third coats of acrylic latex can be applied without any treatment to the initial layer. However, if streaking or uneven surfaces appear on any layer they should be sanded smooth before the next layer is applied. A total of three or four layers of acrylic latex material is used depending upon the preference of the prosthetist.

Fig. 2. Mixing the acrylic latex. The proper color is determined by matching the shade guide to the patient's skin. Instructions on the shade guide (Fig. 1) explain the proper ratios to mix. About 200-300 grams of acrylic latex are required to coat a below-knee prosthesis. (Courtesy of the Veterans Administration Prosthetic Center).

The best finish is obtained when the final layer is sprayed on with a conventional spray gun (Fig. 4A). When a spray gun is not used the final layer should be smoothed with a wet finger, similar to smoothing plaster, approximately thirty minutes after it has been applied (Fig. 4B). After the final layer has been applied it is preferable to allow the prosthesis to dry over night. In this study the actual labor involved in applying the acrylic latex prosthetic skin varied from 45 to 90 minutes.

The prosthetic skin is finished by either trimming it with a sharp knife at the proximal edge of the socket, pulling it

Fig. 3. One dampened cosmetic stocking is pulled over the SACH foot and foam cover (in the example, a Hydra-cadence cover is shown). The stocking is tied at the top and suspended. The acrylic latex is then painted, on, using smooth, even strokes. Each layer should be sanded lightly when drying is uneven before application of the next coat. Three or four coats are required, with a drying time of one to two hours between coats. (Courtesy of the Veterans Administration Prosthetics Center).

back slightly and gluing it down with contact cement or, when an insert is used, lapping it over the top of the socket and gluing it to the inside edge of the socket (Fig. 5).

The patient is instructed to clean the prosthesis with soap and water or with alcohol whenever it picks up dirt. The patient should also be told that, although this material is much more resistant to ultraviolet rays than foam, prolonged exposure to direct sunlight may darken the color.

The prosthetic skin is waterproof. If the patient is to wear the prosthesis in or near water, he should make sure that there are no peeling or open areas in the skin which would allow water into the prosthesis, because once water gets into the foam it will not dry out satisfactorily. In addition, if a colored sock worn over the prosthesis gets wet, the dye from the sock may stain the prosthetic skin permanently.

Evaluation Plan

The evaluation protocol stated that the acrylic latex prosthetic skin would be applied to a minimum of sixty prostheses with a minimum follow-up of two months per prosthesis. The evaluators would consist of twelve certified prosthetists chosen in a manner to provide a wide geographic distribution, a variety of clinical settings (VA and non-VA), and a variety of climates. The project coordinator would be responsible for holding the initial planning meeting, contacting the prosthetist-evaluators and maintaining control of the evaluation forms. A timetable was established that set the total length of the project at thirteen months.

The initial evaluation meeting took place in Washington, D.C. September 21, 1977. At this meeting it was decided that evaluators would be recruited by inserting an information bulletin in the registration packet of all prosthetists attending the 1977 National meeting of the American Orthotics and Prosthetics Association in San Francisco, and the bulletin would be printed in the Almanac. The twelve facilities and prosthetists chosen to participate were:

Albuquerque Prosthetics, Albuquerque, New Mexico, Robert Bush, C.P.O.

Duke University Medical Center, Durham, North Carolina, Bert Titus, C.P.O.

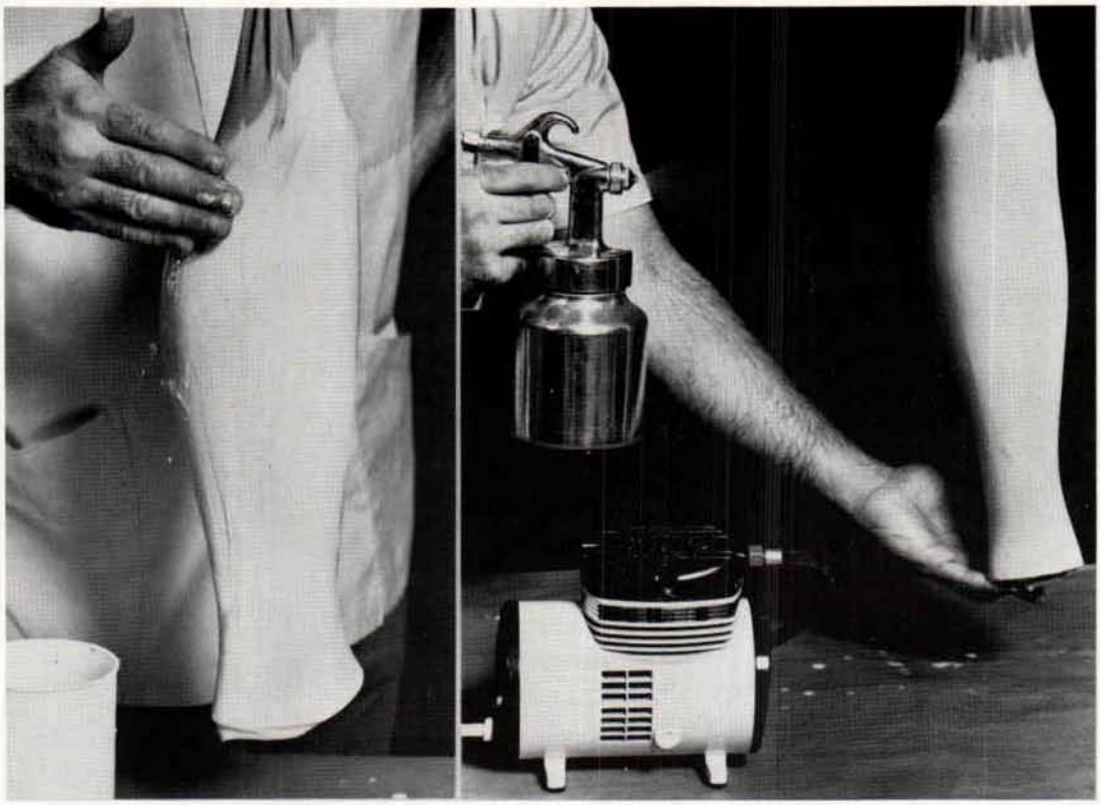

Fig. 4. The last coat can be finished in two ways: Left, about 30 minutes after painting the partially dried latex can be smoothed with dampened fingers or, right, the latex diluted with water can be applied with a spray gun. About six hours (or overnight) are needed for the skin to dry completely. (Courtesy of Veterans Administration Prosthetics Center).

Empire Orthopedic Laboratories, Syracuse, New York, Kurt Marschall, C.P.

Fitzsimmons Army Medical Center, Denver, Colorado, Robert Schleiser, C.P.O.

J.E. Hanger, Orlando, Florida, Hugh Panton, C.P.O.

J.E. Hanger, Philadelphia, Pennsylvania, Charles Wright, C.P.

Hittenbergers, Inc., San Jose, California, John Kintz, C.P.O.

Koeber's Prosthetic and Orthotic Laboratories, Chicago, Illinois, Joseph Smerko, C.P.

Lambert's Limbs and Braces, New Orleans, Louisiana, Claude Lambert, C.P.O.

Orthomedics, Inc., California, Frank Moos, C.P.O., Dan Snelson, C.P., Richard Voner, C.P.O., and Lennart Rosenquist, C.P.

Stonecipher Prosthetics, Arcadia, California, John Stonecipher, C.P.

United Prosthetics, Boston, Massachusetts, Joseph Martino, C.P.O.

The evaluation coordinator, Carlton Fillauer, sent a letter to each evaluator which stated the protocol, namely that

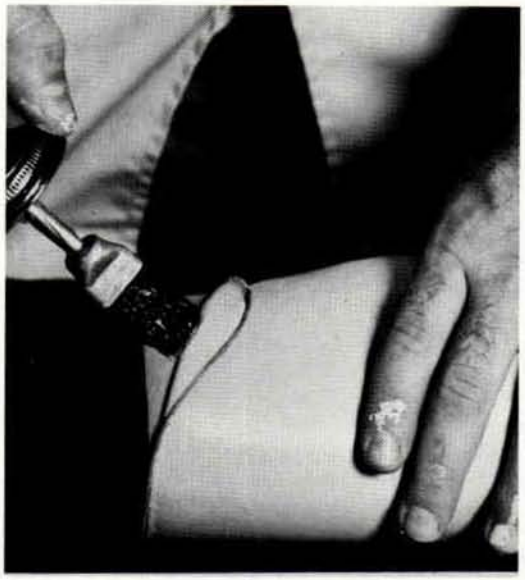

Fig. 5. The prosthetic skin is adhered to the socket by gluing the top one-half inch to the socket with rubber cement. When an insert is used, the prosthetic skin can be folded over the trim line and glued inside the socket.

each prosthetist should fit a minimum of five patients with prostheses using the prosthetic skin and should complete the initial evaluation form and three follow-up forms for each patient over a two-month period. Mr. Fillauer also provided the evaluators with the acrylic latex laterial and an instruction manual which was prepared by Bert Koralnik, C.P. and John Fanelli of the Veterans Administration Prosthetic Center. A letter was sent to the chiefs of the V.A. Clinics in which the participating prosthetists attended (appendix) in order to explain the purpose of the evaluation.

The Method

The acrylic latex prosthetic skin was applied to a total of fifty-two prostheses on fifty-one patients, one being a bilateral. Twenty-two patients were from V.A. clinics. Forty-nine of the 51 patients were followed for periods ranging from two to four months; incomplete information was provided on the remaining three patients. All of the information in this report will therefore be based upon the forty-nine patients who had complete follow-up. An Initial Evaluation form and three Follow-up forms (Figs. 7 and 8) were completed by the evaluator over a two-month clinical trial period. Pertinent data from these forms are summarized in this report.

TABLE 1
Patient Information

Total Number of Patients	48 (one bilateral B/K)
Number of V.A. Patients	22
Types of Prostheses:	
Below-knee	33
Above-knee	11
Knee disarticulation	1
Hip disarticulation	1
Symes'	1
Above-elbow	2
Total Number of Prostheses	49

Distribution of Patients by Level of Amputation

The acrylic latex material that was used during the evaluation was provided by the project coordinator, and was a pre-mixed Caucasian colored acrylic latex that was the consistency of a latex paint. Pigment, a color chart, and directions for varying the color of the material to match the skin of the patient were also provided. In all cases the acrylic latex was painted on a Bock cosmetic stocking and allowed to dry for one to three hours. Usually from three to four coats were required and, in some cases, two stockings were used to provide a heavy duty cover. Only Otto Bock and U.S. Manufacturing Company foams were used during the evaluation.

TABLE 2

	EVALUATION REPORTS RECEIVED			
FACILITY	*Initial*	*Second*	*Third*	*Fourth*
Albuquerque Prosthetics	4	4	4	4
Duke Medical Center	6	6	6	6
Empire Orthopaedic Laboratories	6	6	6	6
Fitzsimmons Army Medical Center*	5	4	4	4
J.E. Hanger - Orlando	11	11	11	11
J.E. Hanger - Philadelphia	1	1	1	1
Hittenbergers, Inc.	1	1	0	0
Koeber's P & O Labs	4	4	4	4
Lamberts Limbs-Braces	4	4	4	4
Orthomedics*	4	4	4	3
Stonecipher Prosthetics	5	5	5	5
United Prosthetics*	1	0	0	0
GRAND TOTAL	52	50	49	48

*One failure experienced — no further reports on this case.

Thirty-three below-knee prostheses were coated with the acrylic latex prosthetic skin. Eleven above-knee prostheses were covered with the prosthetic skin although, in most cases, only the shank was covered. These included Hydracadence, U.S.M.C. modular, IPOS, and Bock endoskeletal systems. In addition, one knee-disarticulation (OHC four bar knee), one hip-disarticulation, and one Symes' prosthesis were covered with the prosthetic skin. Two endoskeletal above-elbow prostheses were also included. Although no complete failures were experienced in the below-knee prostheses, one failure occurred on an above-knee prosthesis and one on the hip-disarticulation prosthesis due to lack of flexibility at the knee. A recommended procedure for applying the prosthetic skin to extend over the knee joint had not been developed, and therefore each prosthetist was left on his own when applying the prosthesis to this group of patients.

TABLE 3

Advantages

- Does not tear—extremely durable
- Matches skin color
- Not necessary to wear stocking over leg
- Washable with soap and water or methanol
- Retains soft, pliable texture of foam
- More resistant to ultra violet discoloration than foam

Disadvantages

- Drying time extends elapsed fabrication time by one day
- More difficult to make adjustments
- Foot may peel if worn barefoot, but it can be patched
- Can be stained by dye in sock if it gets wet
- Technique for covering the knee joint not preferred

Summary of Results

The time required to apply the prosthetic skin to a prosthesis was considered a problem by some of the prosthetists as it could delay the delivery time for the pros-

thesis by one day. The actual time spent by the prosthetist or technician in applying the material to the prosthesis, not including drying time, varied between 45 and 90 minutes. When drying time is included, this figure increases from six to twelve hours, as the prosthesis is generally left to dry over night.

Most of the color matching problems were caused because the prosthetist improperly mixed the materials. These problems were alleviated after the prosthetists became more familiar with the technique.

In one case the prosthetic skin wore out when the patient wore the prosthesis barefoot in the sand. Four other cases of peeling were reported, but none were considered serious.

One patient complained that the prosthetic skin was discolored from the dye in his sock after the sock got wet. The prosthetic skin has a tendency to pick up dirt but can be washed with soap and water. Many patients commented on the natural feel of the material and liked the ability to wash the prosthesis like their own limb. They also liked the fact that there was no need to wear stockings over the prosthesis.

In general, it was felt that the advantages of the prosthetic skin (durability, cosmesis, etc.) far outweighed the few problems that occurred during the evaluation, particularly for below-knee prostheses.

Conclusions and Recommendations

The final meeting of the evaluation coordinator, chairman of the AAOP Research Evaluation Committee, and three of the evaluators was held in Chattanooga, Tennessee on August 16, 1978. Specific conclusions and recommendations made were:

1. Based on the results of this evaluation the acrylic latex prosthetic skin was found to provide a superior coating for foam covered endoskeletal prostheses when compared to previous methods, and therefore this material should be recommended for application on below-knee prostheses.

2. The acrylic latex material should be made available commercially to prosthetists, premixed in two or three base colors, and should be provided with a shade guide and a one page instruction sheet.

3. Further work is required to develop a technique for applying acrylic latex or a similar material on foam covers that extend above the knee and for other articulated prostheses, i.e., hip-disarticulation prostheses, above-elbow and shoulder-disarticulation prostheses. Although some of the evaluators felt they had succeeded in using this material over prosthetic knee joints, all felt that the techniques could be improved substantially. The greatest need for a prosthetic skin is for above-knee prostheses, and therefore the development of this technique should have a high priority.

Summary

The American Academy of Orthotists and Prosthetists Research Evaluation Committee conducted an evaluation of an acrylic latex material as a coating or skin for foam-covered endoskeletal prostheses. The material was originally developed at George Washington University with fiscal support from the VA. Twelve prosthetists from various parts of the United States participated. Each was requested to apply the prosthetic skin to five prostheses, including prostheses fitted to patients in their respective VA clinics. Complete follow-up information on forty-nine patients has been reported. Twenty-two of these patients were veterans treated in VA clinics throughout the country.

The prosthetic skin proved to be durable, washable, and cosmetic. It retained

the soft, flexible properties of the foam. Patients commented that it felt lifelike and appreciated not having to wear cosmetic stockings. The ability to wash the prosthesis was another advantage. The acrylic latex prosthetic skin was found to provide improved finish to below-knee prostheses when compared to previous methods.

Problems included difficulties in mixing the proper color, which was solved by changing the technique. Peeling was evident on five prostheses, but was not considered to be a deterrent to use of the covering. Problems associated with staining and ultraviolet discoloration were reported, but were not considered to be significant.

Application of the material varied between 45 and 90 minutes. Total drying time ranged from six to eight hours.

A technique for application of the material to above-knee prostheses needs to be developed further since participants in the evaluation project had mixed results when above-knee prostheses were involved.

Footnotes

[1]This evaluation was conducted by the American Academy of Orthotists and Prosthetists and funded by Veterans Administration contract #V5244P-1583 in response to solicitation #5244-63-77.

[2]Evaluation coordinator, Vice President-Manager, Fillauer Orthopaedic, Chattanooga, Tennessee.

[3]Chairman, AAOP, Research Evaluation Committee, Director, Orthotics-Prosthetics Education, USC Department of Orthopaedics, Los Angeles, California.

[4]Otto Bock Orthopaedic Industries, Minneapolis, Minnesota.

Orthotics and Prosthetics, Vol. 33, No. 4, pp. 39-45, December 1979

Femoral Immobilizer

CHARLES H. PRITHAM[1]
MELVIN L. STILLS[2]

During the past ten years orthotics has come to play a role in the treatment of selected patients with fractures of the femur. Fundamentally, the fracture orthosis is used when fractures occur in the mid-third and distal one-third of the femur of non-obese patients after initial healing and alignment has been assured by other means. In addition to use by itself, it can be used for external support of such means of internal fixation as intramedullary rodding or compression plating. The orthosis is not primarily a weight-bearing device, but rather a system that provides stabilization by containing the soft tissues of the thigh in a cylinder. Thus, a measure of weight can be borne through the soft tissues of the thigh.

Various forms of femoral fracture orthoses have been described, Sarmiento (4) being the most widely publicized. The system used by Sarmiento consists of an Orthoplast® thigh gauntlet molded and sealed in place, polycentric knee joints, calf cuff, and heel cup or shoe attachment. Variations of this basic device have been described. Of particular interest is the work of Mooney et al (2, 3) which includes a prefabricated polypropylene thigh gauntlet (or femoral immobilizer) to be used with roller traction, and with or without polycentric polypropylene knee joints and distal components. The use of a femoral immobilizer by itself has been described by others as well (1), and most frequently used as a very late form of treatment to a healing fracture that needs a measure of support with minimum encumbrance to the patient.

In essence, when the fracture orthosis is not to be a weight-bearing orthosis and when adequate suspension and stabilization can be gained by the immobilizer itself, the knee joints, side members, and other distal attachments can be eliminated with obvious advantages.

Femoral immobilizers have been constructed of various materials in the past by orthotists, therapists, and others, and prefabricated devices are readily available. However, very little has been published in the way of guidelines for the fabrication and fitting of such a device. This article is offered in an attempt to fill this gap.

The foregoing discussion is not intended to be considered as a definitive rationale for the use of such a device, but rather as a general discussion of the theory behind its development and use. Nor is there any wish to claim credit for the development of the device. The intent is solely to describe how we go about fabricating it. The decision to use an immobilizer is to be made by the orthopaedic

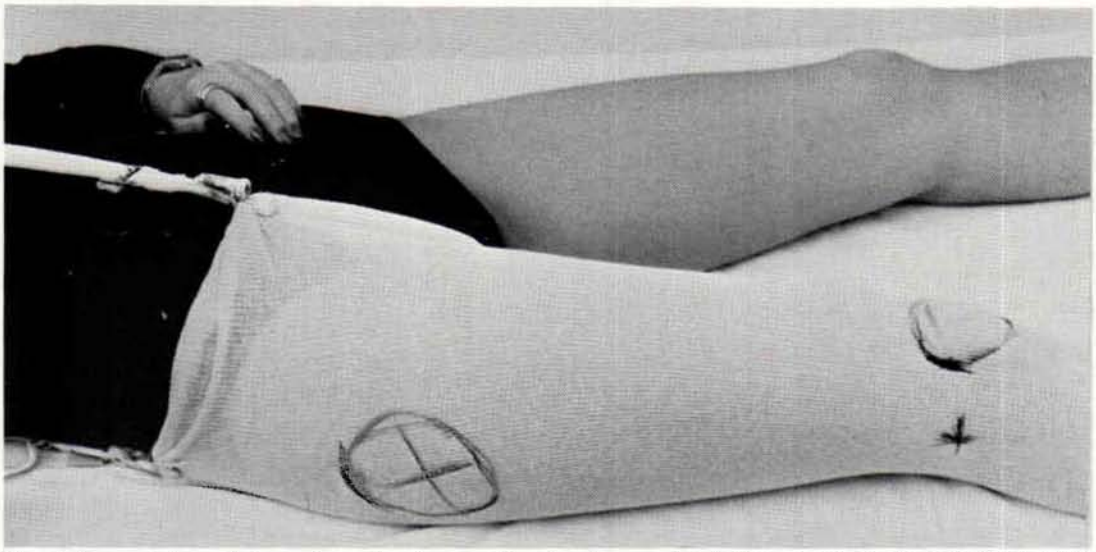

Fig. 1. Lateral view of the patient showing stockinet in place and indelible pencil marks indicating areas where modification of the positive model will be needed.

surgeon on an individual basis in light of his prior experience and knowledge of the literature.

Fabrication

In general, the cast is taken in the same fashion as described in Lower-Limb Orthotics (5) for the thigh portion of a knee-ankle-foot orthosis. Cotton stockinet is applied to the thigh and a tube or strip is secured in place to facilitate removal of the cast later. Indelible pencil (Figs. 1 and 2) is used to mark the following landmarks:

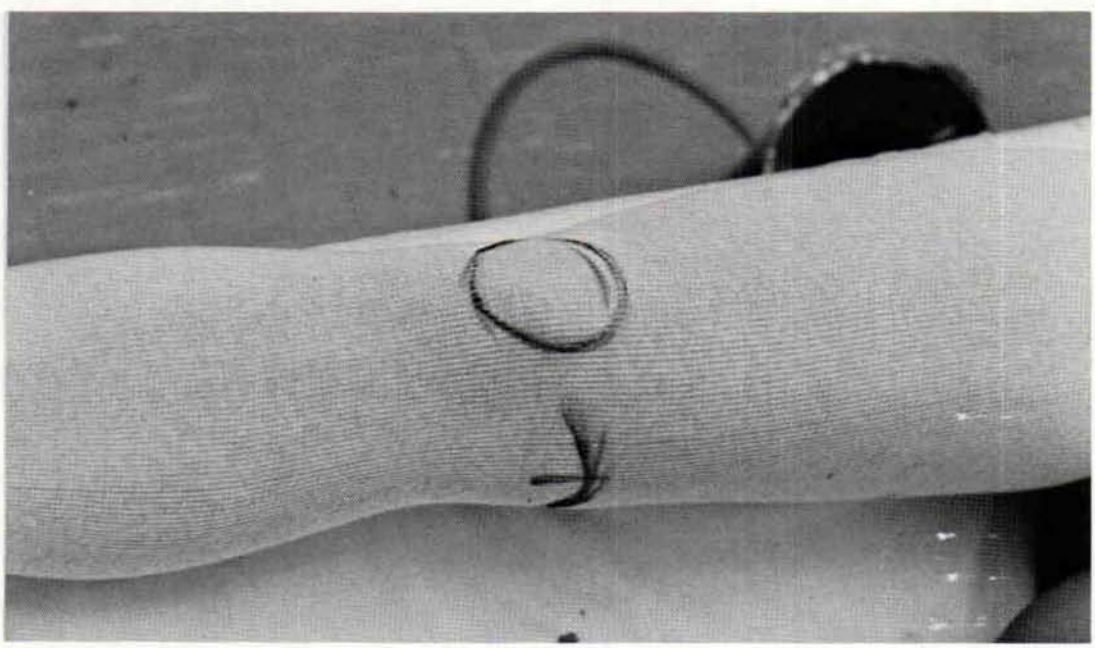

Fig. 2. Medial view showing indelible pencil marks about the patella and adductor tubercle.

1. Patella
2. Adductor tubercle
3. Lateral femoral condyle (when necessary)
4. Adductor longus tendon (when desired)
5. Ischial tuberosity
6. Greater trochanter
7. Fracture site and any skin lesions that require padding or special treatment.

Any dressings should be in place under the stockinet so that due allowance is made for them.

While the assistant holds the limb in an adducted position clear of the couch, the orthotist wraps the thigh with elastic plaster-of-Paris bandage starting from above the knee and proceeding proximally to above the previously marked landmarks. Care should be taken to accentuate the contours about the knee for proper suspension and stabilization. The cast is reinforced, if desired, with rigid plaster-of-Paris bandage, and while it cures the contours of the quadrilateral brim are molded as described in the manual (5). Once set, the cast (Fig. 3) is removed (Fig. 4), sealed, and filled with bulk plaster to provide the positive model (Fig. 5).

In modifying the positive model sufficient material must be removed to provide for the development of adequate overall tension and for the contours proximal to the adductor tubercle and patella for suspension and stabilization (Figs. 5, 6, 7). The ischial seat of the quadrilateral brim should be within a half-inch of the ischial tuberosity with the medial brim somewhat lower so that the brim will provide rotary stabilization with comfort, and therefore it is not necessary to modify this area as extensively as is the case for a prosthesis or weight-bearing orthosis. Adequate clearance and a flared edge must be provided to the distal posterior

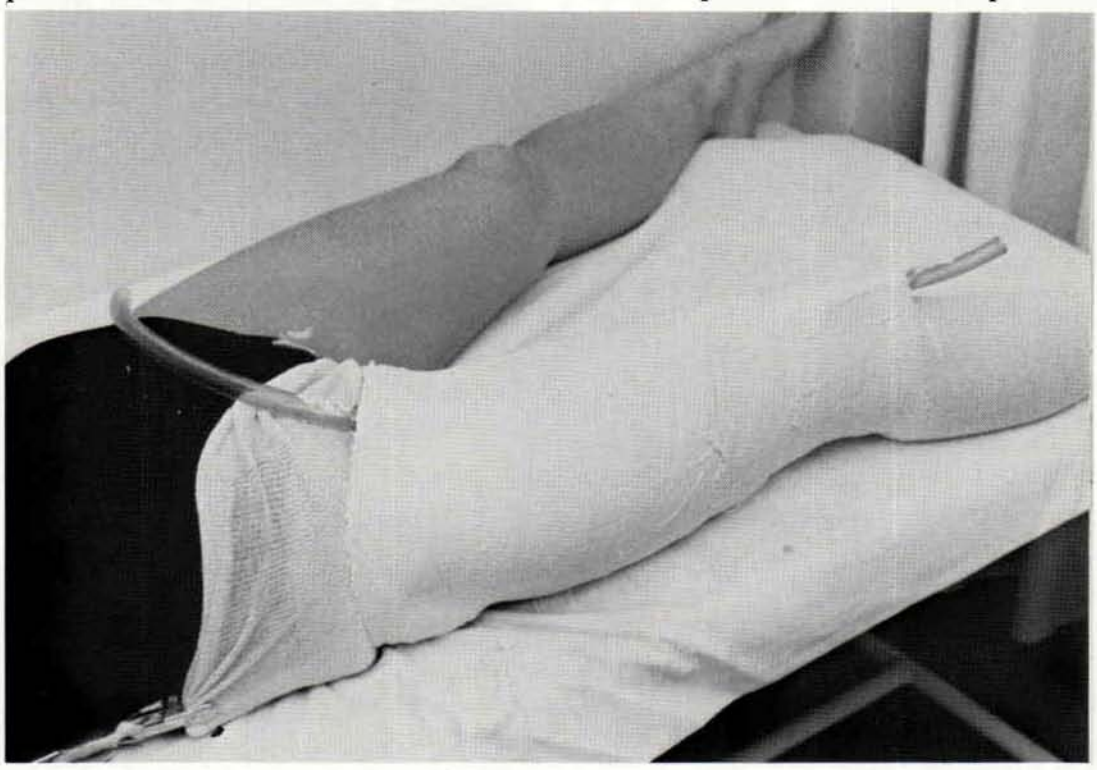

Fig. 3. Lateral view of the completed cast showing plastic tube in place.

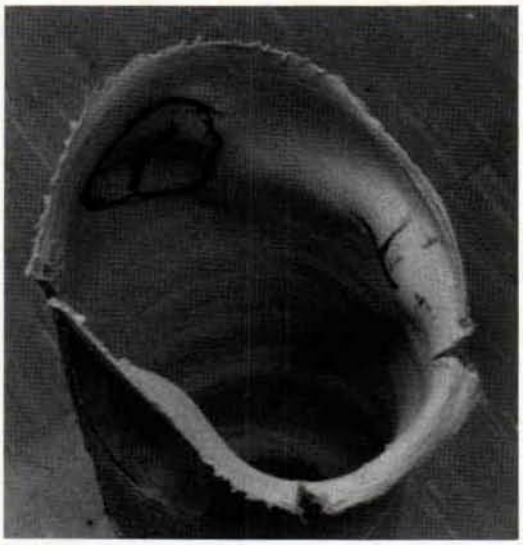

Fig. 4. Proximal brim of the cast after it has been removed from the patient. Anterior and posterior corners have been split to facilitate formation of the medial wall.

edge for flexion of the knee. Relief is added for the adductor tubercle and other sensitive areas.

The anterior tongue (Fig. 8) is vacuum-formed first from ⅛-in. thick polypropylene or polyethylene, and, when cool, trimmed to the mid-lines medially and laterally. The posterior section (Fig. 9) is then vacuum-formed over it from 3/16-in. thick polypropylene, although polyethylene can be used, if desired. When necessary, any portion or all of the orthosis can be padded with polyethylene foam, although it will add substantially to the bulk of the device and will feel warmer to the patient. The posterior section is trimmed medially along a line extending distally from the antero-medial corner, and laterally along a line over the rectus femoris. Proximally, the line of the quadrilateral brim is followed. Distally the trim starts along the proximal edge of the patella, extends distally on either side down over the femoral condyles, and proximally in the posterior area for clearance during knee flexion.

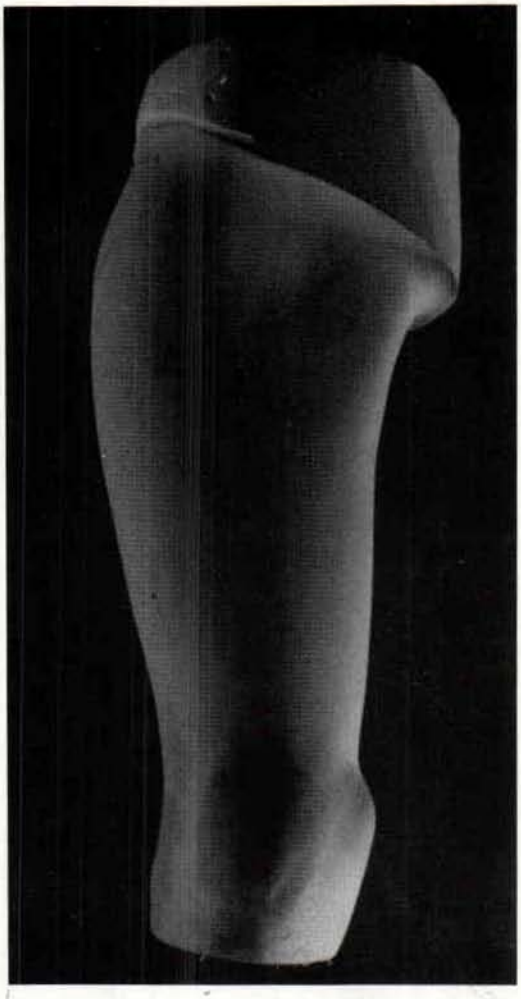

Fig. 5. Anterior view of the modified positive model. A quadrilateral brim has been formed and the adductor tubercle emphasized by removal of material proximal to it.

The tongue is secured inside the posterior section with "rapid-rivets" and four or more Velcro straps and narrow loops are added for closure. The rivets that are used to fasten on the narrow loops or straps can be used also to secure the tongue in place. For best results, the tongue should be fastened in place medially with the opening lateral, and the narrow loops should be medial as well so

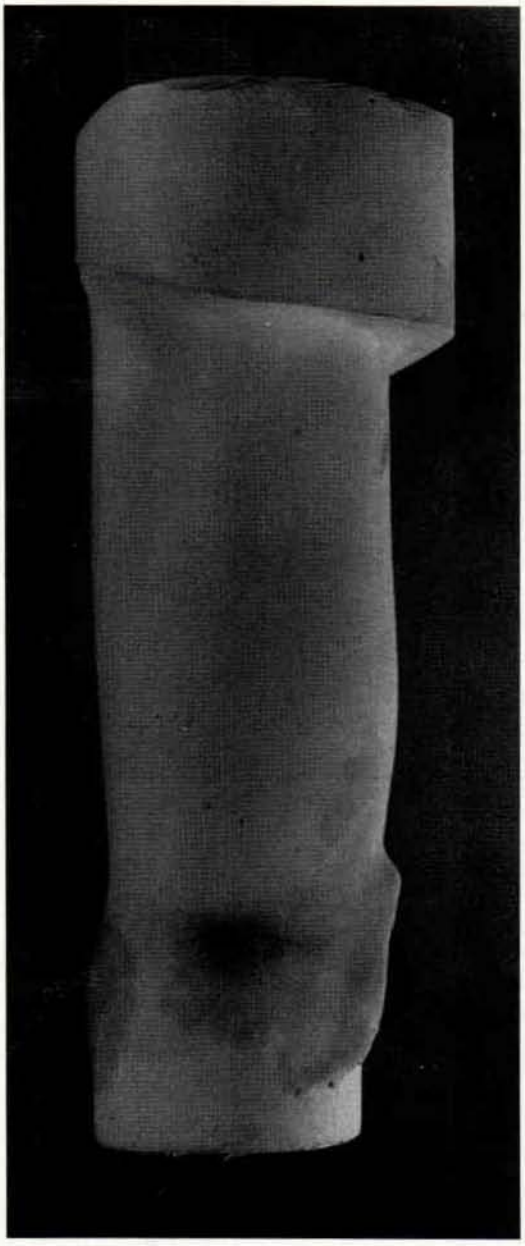

Fig. 6. Medial view showing the posterior proximal seat and the posterior distal flare.

that the free ends of the straps do not irritate the other leg. The distalmost strap should be placed immediately above the patella to insure proper suspension (Figs. 10 and 11).

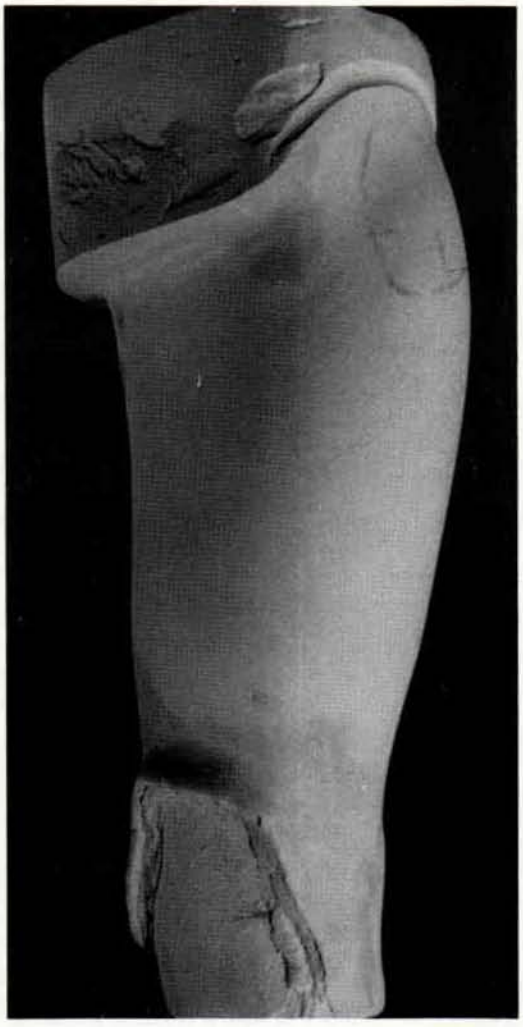

Fig. 7. Lateral view showing the posterior proximal seat and the posterior distal flare.

Before donning the device a barrier stocking is applied over the skin and any dressings present. To prevent skin maceration, the stocking should be changed daily. The distal-most strap should be fastened first while the orthosis is distracted proximally so as to make certain that the device properly settles in place proximal to the adductor tubercle. Considerable tension is needed on this strap with relatively less on the more proximal straps, which should be fastened in order from distal to proximal. Once in place

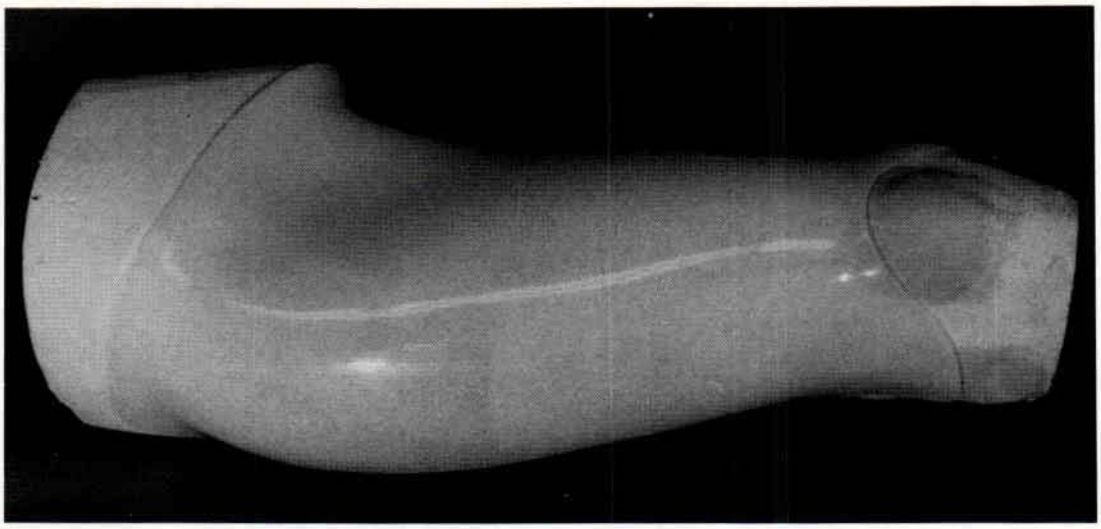

Fig. 8. The anterior section of the orthosis on the model.

the orthosis should be checked for adequate clearance during hip and knee flexion and for comfort medially. Any necessary changes obviously should be made.

There should be no discernible motion between the device and the patient's skin, and the orthosis should not impinge on the adductor tubercle when pulled distally.

The patient and attendants should be instructed on proper donning of the orthosis. It should be emphasized that if discomfort about the adductor tubercle occurs the orthosis is undoubtedly too loose, and should be removed and reapplied in a more proximal location using proper tension on the straps. When sufficient shrinkage takes place with time, the

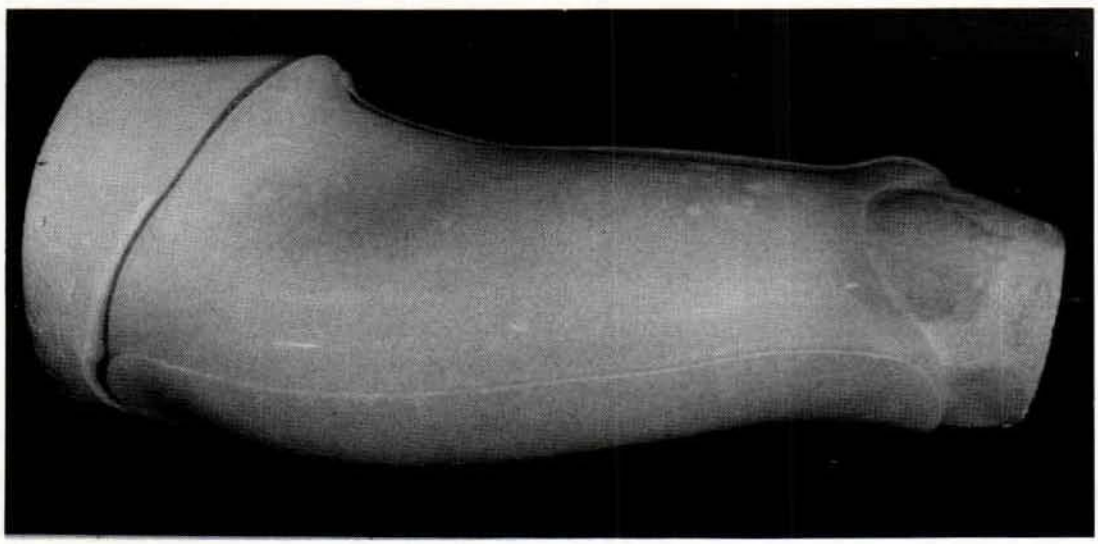

Fig. 9. The anterior and posterior sections of the orthosis on the model.

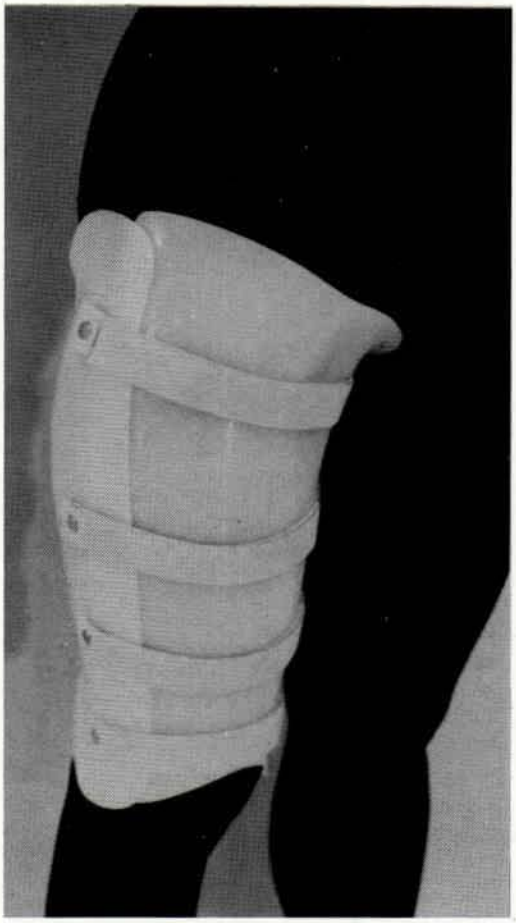

Fig. 10. Antero-lateral view of the completed orthosis on the patient. Note placement of the distal most strap.

tongue can be removed and refitted to close the anterior-posterior diameter.

Summary

Instructions for the construction and donning of a femoral immobilizer are given, as well as some brief guidelines for the rationale underlying its use.

Footnotes

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[2]Division of Orthopedics, University of Texas Health Science Center at Dallas, Dallas, Texas.

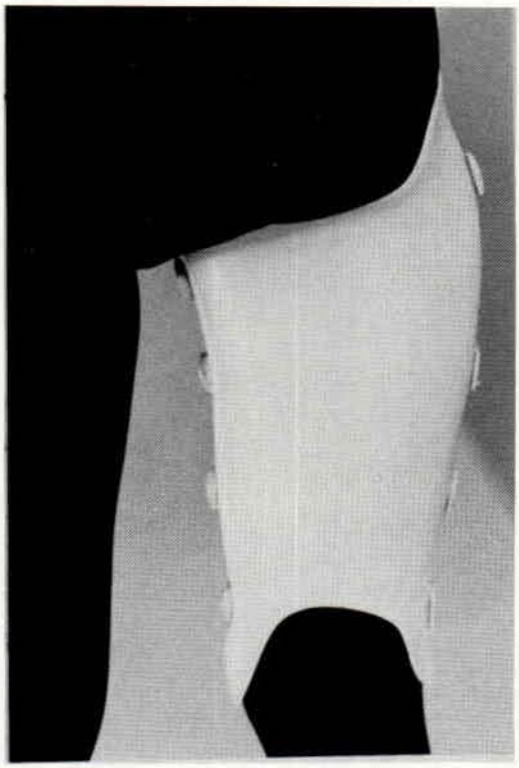

Fig. 11. Posterior view of the completed orthosis on the patient.

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Orthotics and Prosthetics, Vol. 33, No. 4, pp. 46-48, December 1979

Technical Note

The AFO and Ankle Control

The molded ankle-foot orthosis is being used more and more for different types of injuries and disabilities. This article deals with eversion and/or inversion control incorporated in a molded AFO (Fig. 1). This design replaces the metal "short leg" orthosis that is provided with a T-strap.

If this procedure is to be successful, the patient must agree to purchase shoes that fit properly after the orthosis is completed. Usually one size longer and one size wider is sufficient.

The principle behind inversion-eversion control on an AFO is basic leverage. The weight of a person on the plantar surface of the orthosis often creates more torque than the ankle joint complex can resist, thus causing inversion or eversion.

An AFO is used to:

1. Control eversion and inversion of ankle during weight-bearing.
2. Control everted or inverted calcaneus during weightbearing.
3. Control flaccid ankle and forefoot.
4. Maintain alignment of bones of foot during growth years.

Fig. 1. Molded AFO designed especially to provide inversion control.

Casting Procedure

Since there are a variety of ways to use the AFO, it is not surprising that the casting procedure should be varied so as to provide the best end results; for example, casting for an everted calcaneus is slightly different from casting for eversion control. For the everted calcaneus, the calcaneus is in a neutral position between inversion and eversion while the mold is setting. For eversion control of the ankle, depending on the severity of eversion, the calcaneus could be held in position from a neutral position to an inversion position while the mold is setting. For pronation of the forefoot, the toes of the foot are raised while the cast is setting, making sure that the first and fifth metatarsals are flat on the footboard. The mold should be taken on the footboard with a ⅝-in. heel. The foot is positioned in the middle of the footboard with the ankle in

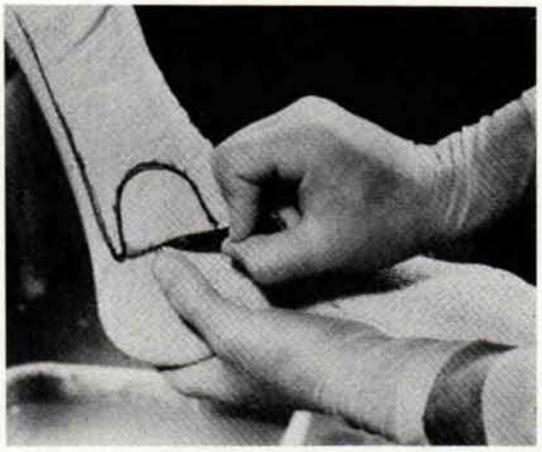

Fig. 2. To obtain eversion control the trim line is established by first determining the center point between the heel cord and the distal edge of the malleolus and drawing a line about the periphery of the malleolus.

Fig. 3. The finished AFO for inversion control.

10 to 15 deg of dorsiflexion, to allow sufficient room for the posterior calcaneus while giving sufficient assistance to dorsiflexion.

Trim Lines

Variations of casting procedures are not great, but the variations in trim lines are many and important. For example, to obtain eversion control of the ankle, or to control an everted calcaneus and still have dorsiflexion assist, the trim line is established by determining the center point between heel cord and the distal edge of the malleolus (Fig. 2), drilling a 5/16-in. diameter hole in the plastic at this low point, and following the periphery of the malleolus. This is the most distal trimline point of the "leaf spring" and the start of the trimline that will control eversion (Fig. 2).

Padding is used at the discretion of the orthotist. When used, a thickness of at least 1/4-in. of padding should be maintained.

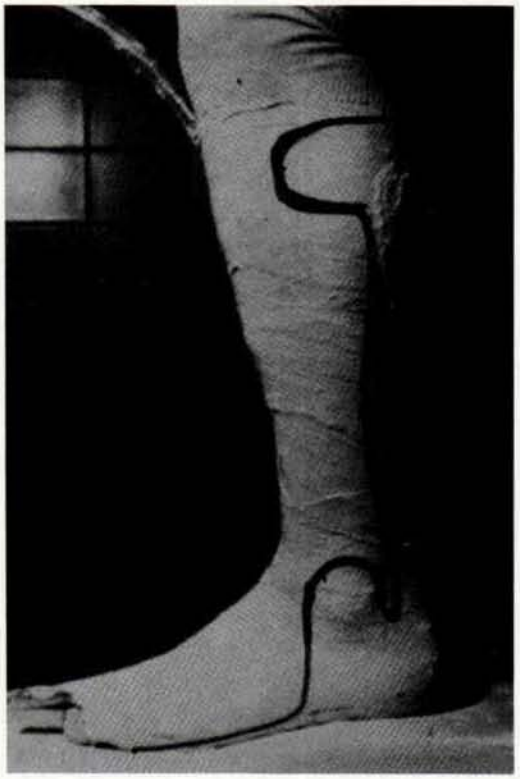

Fig. 4. The lateral trimline for inversion control.

A medial view of the finished orthosis is shown in Figure 3.

The lateral trim line for inversion control is shown in Figure 4.

For a hemiplegic to don the orthosis, it will be necessary to add a circumferential strap just proximal to the ankle controls on the orthosis.

Thickness of Material

To determine the thickness of the plastic sheet to be used, the weight of the patient should be taken into consideration. When the distal trim line is drawn between the malleolus and heel cord, leaving the distal portion of the "leaf spring" approximately 1½-in. wide, a guide for plastic thickness is:

Weight Range of Patient	*Thickness of Polypropylene*
Walking age to 100 lbs.	1/8 in.
100 lbs. to 200 lbs.	3/16 in.
200 lbs. to 300 lbs.	1/4 in.

Robert Smith, C.O.

Orthotics and Prosthetics, Vol. 33, No. 4, pp. 49-50, December 1979

Technical Note

Growth Extensions and Adjustments in Childrens Polypropylene Ankle-Foot Orthoses

For the past five to seven years the use of polypropylene in orthotics has grown enormously in our community. Parents, patients, and medical staffs have, in the main, accepted the change to plastics for their orthotic needs. Less weight and improved cosmesis have been the two most positive factors for acceptance.

The one negative factor with this newer type of orthosis has been lack of adjustability for growth. Many orthoses have been discarded prematurely because adjustments for growth are not possible while adequate, comfortable support is maintained.

We have dealt with this factor for quite some time, and have developed a few procedures that may help alleviate some of these problems.

The ability to continue use of the original orthosis necessarily depends on the growth rate of each patient, and even with the conventional orthosis, periodic evaluation is necessary to determine the advisability of a replacement.

Growth problems occur first at the anterior area of the sole. When the trimline is posterior to the metatarsal heads by a considerable amount, the orthosis tends to dig into the tissue during heel contact, causing an uncomfortable ridge to form behind the metatarsal area; later, the development of the calcaneal area prevents a proper fit because the patient's foot will not seat properly into the heel of the orthosis. When this situation occurs with an orthosis that has been designed to provide medial-lateral ankle stability, the forces become inadequate, and the patient complains of pressure posterior to the malleolus area; the proximal edge of the orthosis then drops below the fibular head and digs into the muscle belly of the gastrocnemius, causing a ridging and digging in the calf area.

To prevent or delay these problems we have altered our fabrication techniques. When fitting an ankle-foot orthosis on a small child where the probability is great that he or she will be a long term user the orthosis, it is lined throughout with Plastizote or a similar material which may be removed and replaced with a thinner liner as the patient grows, which, in turn, is eventually removed and the patient wears the orthosis with no liner.

This procedure allows for the growth and development of the foot without flaring the sides of the orthosis and sacrificing some stability of the ankle. The modifications need to be exact and buildups are kept to a minimum in order to reduce excessive bulkiness, especially for smaller children.

We have prevented the pressure behind the metatarsal heads by attaching a plastic extension that comes up under the metatarsal heads where normal trim lines would be. These extensions can be attached either in the forefoot area of the orthosis or may run the entire length of the orthosis sole, back to the heel.

To solve the linear growth problems,

Fig. 1. A posterior bar is used in a molded polypropylene ankle-foot orthosis to provide linear adjustment for growth.

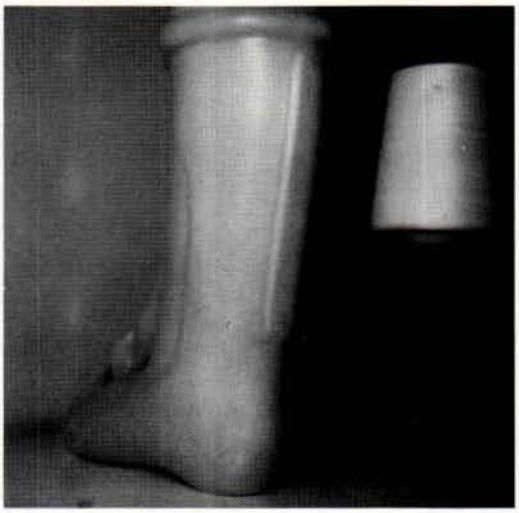

Fig. 2. The aluminum bar shown in Figure 1 is molded into the orthosis during fabrication.

two designs have been used. Our aim is to keep the proximal area of the orthosis distal to the fibular head to provide comfortable and adequate support by applying extension bars to the lateral sides of the orthosis. Also a single posterior extension bar can be used for the same purpose (Figs. 1 and 2). Another design is used by overlapping the plastic in the calf area during fabrication allowing extension proximally in this area, according to patient growth.

This paper is designed only to familiarize the orthotist with some of our efforts to solve the complex growth problems presented to us by these young patients. We know that there are many ways to solve these problems and hope that fellow practitioners will share their experiences and ideas with those of us who are in the field of orthotics.

Peter J. DiMeglio, C.P.O.
Mark Taylor, C.O.
Charles Thomas, assistant
Jim Merchand, assistant

Orthotics and Prosthetics, Vol. 33, No. 4, pp. 51-54, December 1979

Technical Note

Casting Technique for Below-Knee Prostheses

It is obvious to those of us in the field of Prosthetics that the accuracy of the socket fit is dependent largely upon the accuracy of the impression of the residual limb. This note describes a casting technique that has been found to achieve a greater degree of conformance to actual contours of the below-knee residual limb than those previously used.

In the past, casting has been carried out almost universally by means of a circular wrapping technique, a method that works fairly well for the firm, well tapered residual limb, but results in a cast with considerable mediolateral distortion when used on the soft residual limb.

The circular wrap technique was set aside by many prosthetists in favor of the "two-part" technique which utilizes a panel of plaster-of-Paris splints molded over the anterior of the residual limb followed by a circular wrap after the anterior panel has hardened. This technique prevents mediolateral distortion but the panel is not easily held in place and ridges are formed in the finished cast.

The technique which has proven to be most accurate in my experience is a

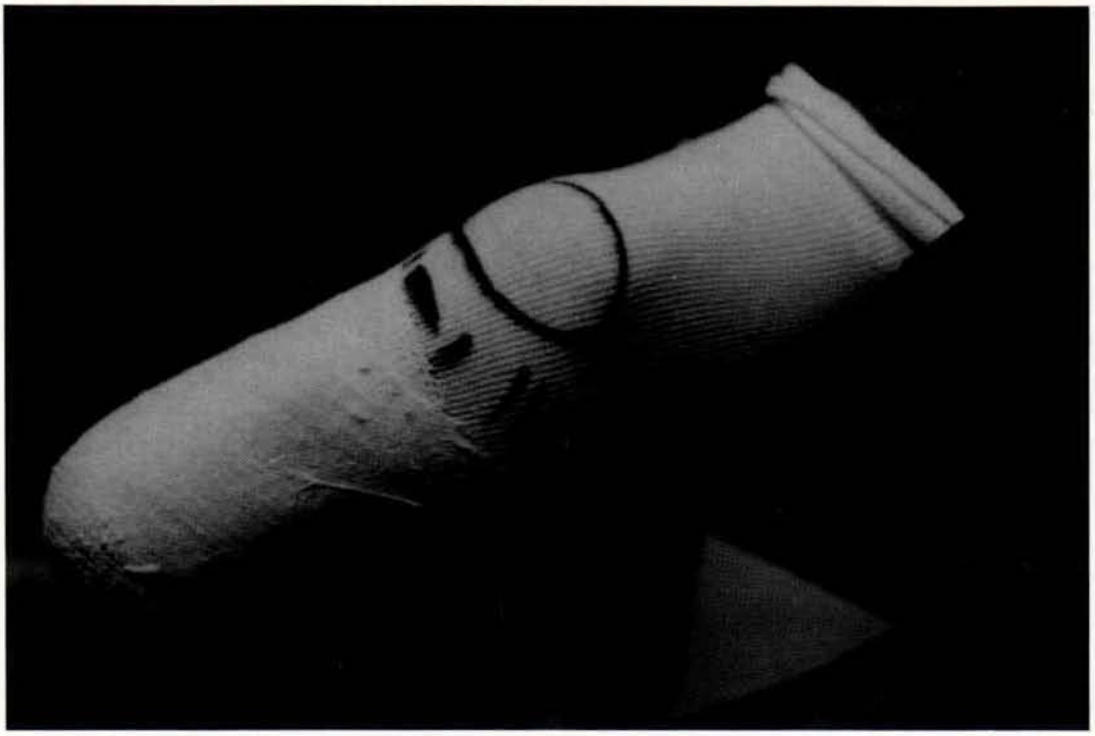

Fig. 1. The first (distal) wrap before molding.

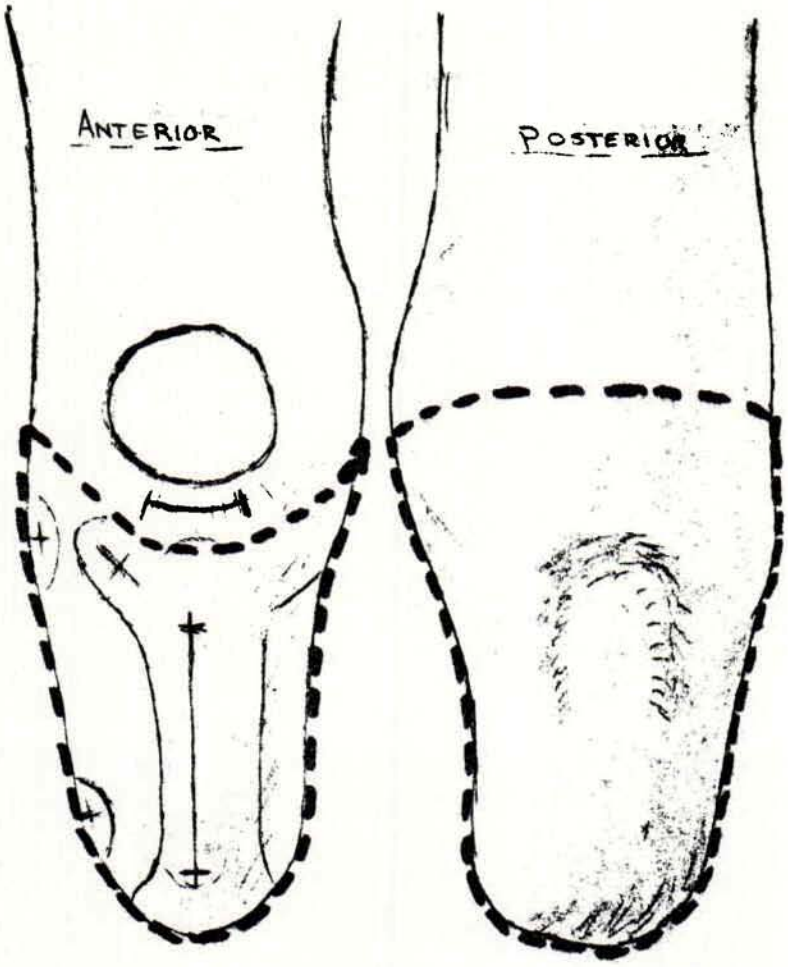

Fig. 2. Outline of the first (distal) wrap.

modification of the "two-part" procedure.

The casting is made over one cotton cast sock and one layer of nylon stockinet. The markings are made on the nylon stockinet which has been pulled on over the cotton cast sock, only to facilitate removal of the cast. The technique uses first a circular wrap of elastic plaster bandage (Figs. 1 and 2) to enclose the distal end, stopping just below the patellar tendon, but going high enough on the medial and lateral sides to cover the condyles.

This first wrap is molded into the popliteal and medial flare areas with one hand while the lateral side is molded into the pretibial area with the other hand (Fig. 3). Once this wrap has hardened sufficiently to prevent distortion, a second circular wrap follows (Fig. 4), to enclose the remainder of the residual limb. It is molded about the patellar tendon in the usual fashion (Fig. 5).

This technique results in a socket which usually fits when one or two nylon socks are used. For the very short residual limb the usual single circular wrap is

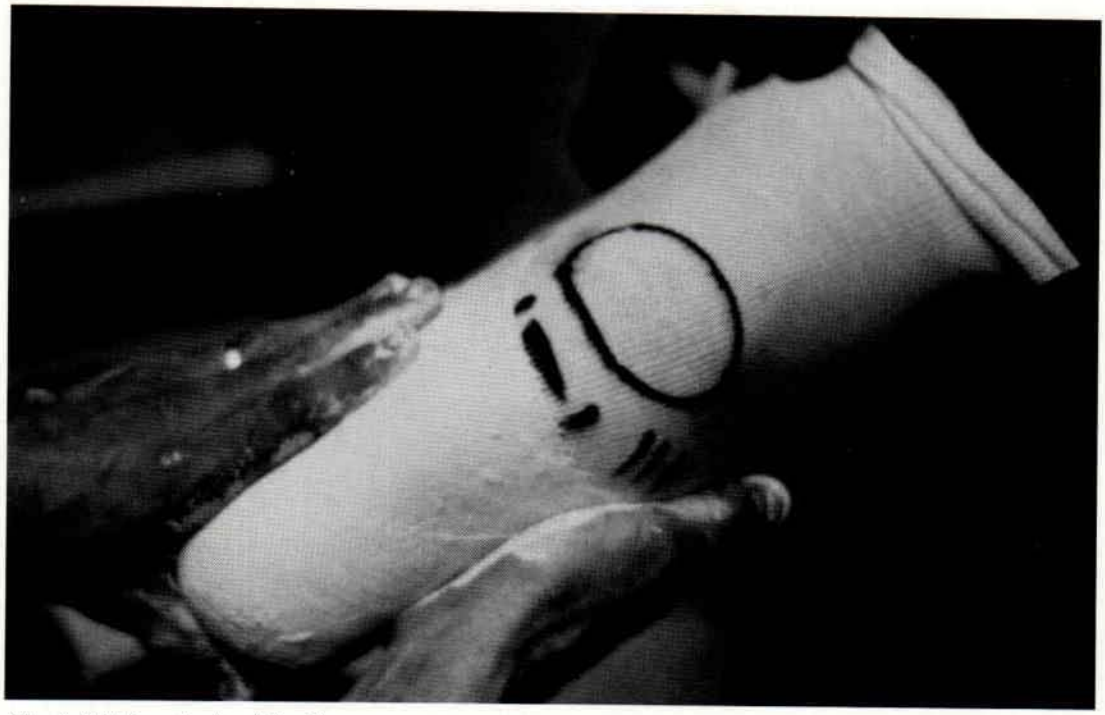

Fig. 3. Molding the first (distal) wrap.

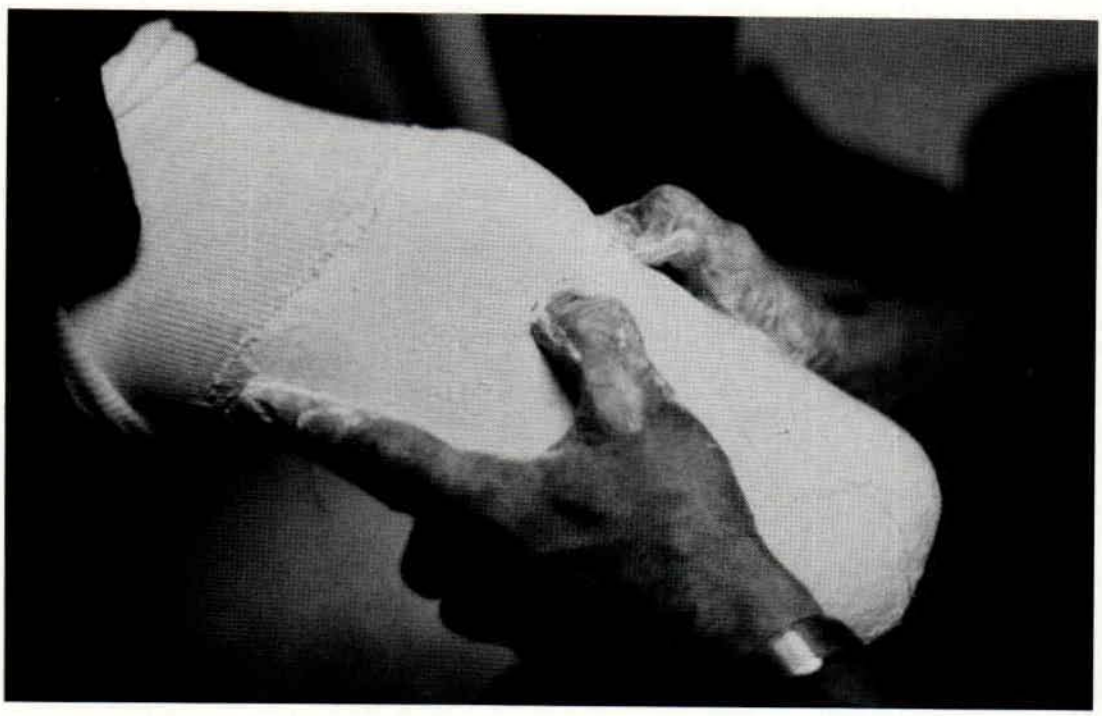

Fig. 4. Molding the second (proximal) wrap.

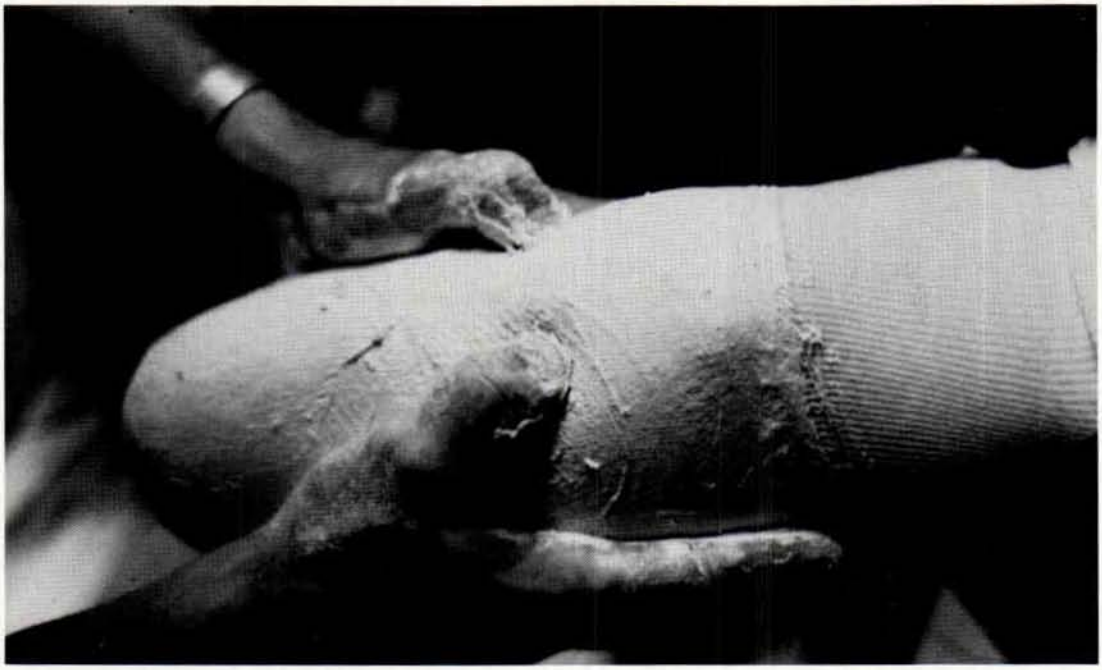

Fig. 5. Molding the second (proximal) wrap.

used. For the PTS prosthesis, the above procedure is followed by a proximal panel of non-elastic splints as in the standard two-part procedure.

The theory involving this technique is that when the cast is formed closely about the area of the medial tibia flare, a minimum amount of modification of the positive model is needed. It is important, then, that the first wrap be allowed to harden completely before application of the second wrap.

V.L. Rice, C.P.

Orthotics and Prosthetics, Vol. 33, No. 4, pp. 55-57, December 1979

NEW PUBLICATIONS

Materials and Orthopaedic Surgery, Dana C. Mears, FRCS(C), The Williams and Wilkins Co., 762 pp., 900 illus., $75.00

"Materials and Orthopaedic Surgery" is considered to be successor to "Metals and Engineering in Bone and Joint Surgery" which was authored by Patrick Laing, Charles O. Bechtol, and Albert B. Ferguson, Jr. and published in 1959.

However, this book, twenty years later, contains so much basic information useful in understanding the musculoskeletal system and methods employed in the use of implantable materials in correction of deficiencies that, in this reviewer's opinion, it is a completely new text worthy of the attention of orthotists, bioengineers, and rehabilitation engineers, as well as the surgeons and engineers for which it was mostly intended.

A beautifully written history of implant surgery is followed by a comprehensive chapter on the structure, properties, and mechanical behavior of nonbiological materials. After a section on the dissolution of implantable materials the structure, properties, and mechanical behavior of human tissues of the musculoskeletal system are described.

To complete the information needed before surgical techniques are considered there are chapters on the effect of pressure on tissues and cells and the biological response to implanted materials.

The remaining two-thirds of the book is devoted essentially to surgical techniques, but includes clear descriptions of the mechanical devices and the tools required for the various procedures considered to be practical at this time.

A chapter concerned with the future concludes this excellent contribution to the surgical and bioengineering literature.

Every orthotist and every engineer involved in orthotics research and development should read this book.

A. BENNETT WILSON, JR.

Bulletin of Prosthetics Research
(BPR 10-31, Spring 1979)

The Office of Technology Transfer of the Veterans Administration announces the availability of the Spring 1979 issue of the Bulletin of Prosthetics Research (BPR 10-31). This issue contains 490 pages, 116 illustrations and is available from the Government Printing Office, Washington, D.C. 20401 for $4.50 postpaid for delivery in the United States.

Featured in this issue:

Of especial interest in this issue is the five-year, ten-issue, cumulative index.

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An Announcement

The Board of the Professional Association of Prosthetists-Orthotists of Belgium has decided to publish a bi-annual review of orthopaedic developments under the name of "ORTHO-SCOP."

All articles will be published in both French and Dutch.

The columns of the review "ORTHO-SCOP" are open to all persons of good standing in the orthopaedic as well as in the paramedical field.

Advertisements of firms in the same fields will be accepted equally.

The price of a yearly subscription will be 250 Belgian Francs.

We congratulate our Belgian colleagues for this initiative and wish them complete success.

All correspondence for the review "ORTHO-SCOP" is to be addressed to Mr. A.D. DAXHELET, Mont Saint Martin, 11, 4000-LIEGE—BELGIUM.

Orthotics and Prosthetics, Vol. 33, No. 4, p. 58, December 1979

Letters To The Editor

Dear Mr. Wilson:

We have received several inquiries about the ice-water quenching of polypropylene since our article was published (March 1979). Interest has been primarily centered on the problem of excessive internal contraction of the material after removal from the model. In one case, the contractions were so severe that the orthoses had to be refabricated.

The initial work that we conducted with the quenched prolypropylene was circumferential in nature, i.e., K.O. and B/K prosthesis. The contraction of the plastic only increases the intimacy of the fit. Later research on A.F.O. (after the article was submitted) lead us to believe that the technique had to be modified to reduce this contraction to a minimum. We have found, both in research and in the Prosthetic-Orthotic Center at Northwestern, that with a maximum of one minute in the ice water (1° - 4°C.), the desired properties of toughness and transparency are maintained without the excessive contraction of the plastic.

I hope that you can pass on this information to the readers of "Orthotics and Prosthetics" as quickly as possible to reduce further problems with the technique.

Thank you for your assistance now and in the past.

Sincerely yours,
Terry J. Supan, C.P.O.
Chief Research Prosthetist-Orthotist

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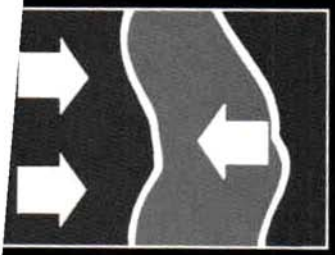

support to the heavier figure type. Truform's new 446-HS support features three pull straps and four semi-rigid steels.

The new garment is constructed of the finest quality preshrunk white cotton duck with snap bottom closure, and a cupped front which has elastic releases top and bottom to provide support

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THE KINGSLEY LADIES HI-STYLE FOOT WITH NATURAL TOES presents a truly stylish 3½" heel. The natural molded toe allows the choice of open or closed high-heel, high-fashion shoes. The Hi-Style is designed to fit most regular width shoes.

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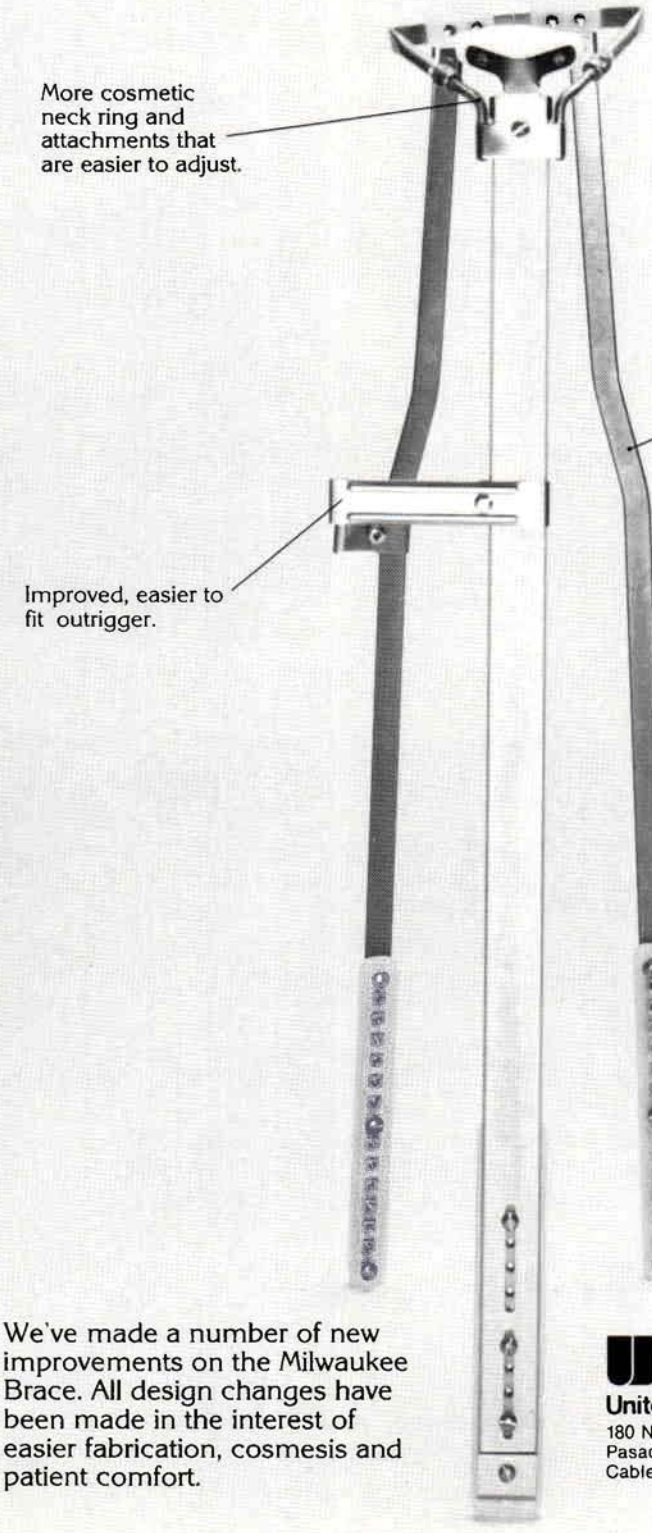
New Milwaukee Brace



We've made a number of new improvements on the Milwaukee Brace. All design changes have been made in the interest of easier fabrication, cosmesis and patient comfort.

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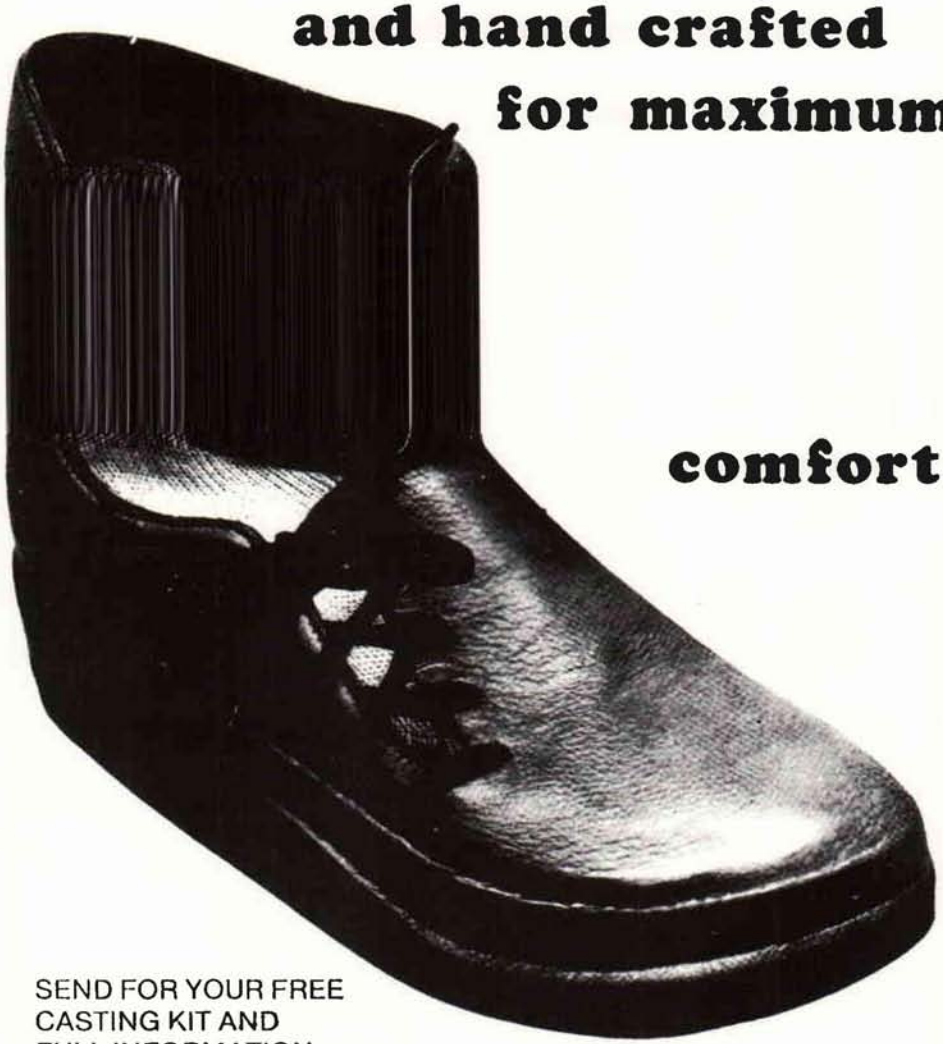

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