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Flexible Below Knee Socket With Supracondylar Suspension

by James Breakey*, B.P.T.
with an Introduction by James Foort**, M.A.Sc.

Semi-flexible plastic laminate sockets have been used in the prostheses of fifty BK amputees during the past two years at the Manitoba Rehabilitation Hospital in Winnipeg. These sockets were designed to permit more intimate fit of the socket against bony prominences without damage to the skin, and to permit adjustment of pressure between stump and socket by the insertion of liners between the flexible socket and the supporting structure. We had noticed that no amputee ever complained about discomfort against bony prominences, and seldom complained of discomfort at the end of the stump while standing in the sock during suspension casting of the stump. Also, experience with air cushion sockets indicated the merit of flexibility in the socket against soft tissue areas of the stump which are compressed by the socket during weight bearing. It has frequently been proposed that bony structures now protected from pressure by relief pockets in the sockets might better be used to increase further support and stabilizing areas between stump and socket.

The present system used in conjunction with the semi-flexible sockets includes a supporting receptacle, a wedge-disc alignment unit pylon and a SACH foot. Cosmesis is obtained either with a custom made plastic laminate shell (semi-flexible), or a sponge polyurethane cover which is prefabricated in standard sizes. Many of these prostheses have been suspended from the medial femoral condyle, and a few with additional suspension from the top edge of the patella.

The receptacle supports the flexible socket so that weight bearing and stabilizing forces are resisted, and stability of the supracondylar

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suspension hook is ensured. The receptacle can also be fashioned so that extra relief space external to the flexible socket is provided over any vulnerable area. Further, since the socket can be pulled out of the receptacle, just as the kemblo liner was removable, adjustments can be made to socket fit by bonding in liners without spoiling the inner surface of the socket. When entry into the socket is difficult, because of inward projection of the supracondylar hook, the socket can be donned and inserted into the receptacle with the stump in place as a means of protecting the stump during its insertion into the prosthesis.

The socket referred to here might well be described as a two-piece socket, as a socket with flexible liner, or as a flexible socket with supporting receptacle. In any event, as far as the stump is concerned, the socket is rigid in areas of support and stabilization, semi-flexible in distal areas, over bony areas, and in any other areas which might require it, and is in total contact. It will be referred to as a flexible plastic laminate socket supported by a plastic laminate receptacle.

The outline that follows indicates the method used to fit and fabricate the flexible socket, and the preparation of the supporting receptacle. All procedures omitted are those which are common knowledge and which are not changed with reference to the particular procedures used.

FITTING THE AMPUTEE

Data Recorded

1. Antero-posterior stump knee width at the mid-patellar tendon level—knee relaxed.
2. Medio-lateral stump knee width at the tibial plateau level.
3. Distance between extreme outer edges of the tensed hamstring tendons.
4. Supracondylar measurement from above the adductor magnus tendon insertion medially to the tensor fascia lata laterally.

Fig. 1
Finger Positions During Cast Taking (Medial View).

5. Supracondylar height measured from the mid-point of the medial knee joint line to a point superior to the adductor tubercle of the medial femoral condyle (Insertion of adductor magnus tendon).

MAKING THE IMPRESSION

The Northwestern University's suspension casting technique is used to make the stump impression. The plaster is wrapped as described in the report, *"A Pylon Prothesis System for Shank (B/K) Amputee"* by J. Foort (1).

Fig. 2
Finger Positions During Cast Taking (Posterior View).

1. Define the patellar tendon by impressing the thumb tips on either side of it.
2. Exert light counter-pressure across the back of the stump with the fingers of the hand, which is on the lateral side of the stump.
3. The fingers on the medially placed hand are used to define the contour of the medial femoral condyle (Fig. I). The index and middle fingers are placed anterior to the adductor magnus tendon and the 4th and 5th digits are placed posterior to it. The 5th digit superimposes the medial hamstring tendons (Fig. 2).

Plaster Stump Model Modification

The model is modified in the same manner as described in *"A Pylon Prosthesis System for Shank (B/K) Amputees,"* with the following additional features:

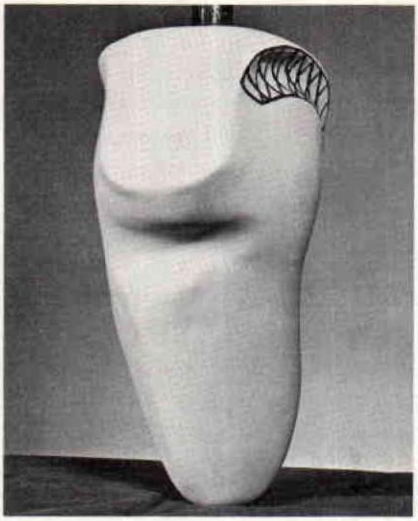

Fig. 3
Antero-medial View of Supracondylar Shelf.

1. The finger indentations outlining the contour of the medial femoral condyle and the condylar height measurement serve as guide in defining the condylar indentation in the plaster model.

The medial supracondylar shelf is approximately ¾" wide from top to bottom. It is approximately ½" deep at most. It is contoured from the medial epicondylar surface of the femur to encompass the adductor tubercle area toward the femoral shaft to blend with these areas. On reaching the deepest point of the shelf, this smooth radii gradually reverses its direction following the shape of the soft tissue of the thigh (Fig. 3). The suspension hook should be at approximately the superior patella level, so that there is a tissue cushion between the hook and the bony surface of the femoral condyle. The medial patellar area and the medial hamstrings area are fitted intimately; however, the shelf is flared and contoured in order to prevent interference with their movement or to produce any discomfort (Fig. 4).

2. The model is reduced to ¼″ greater than the supracondylar measurement to allow

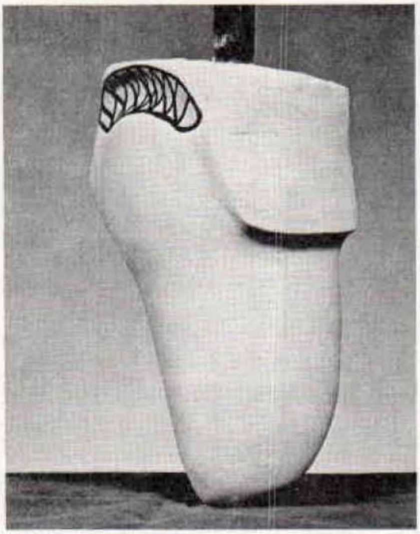

Fig. 4
Posterior-medial View of Supracondylar Shelf.

for wearing a wool stump sock. The lateral aspect of the model is trimmed down in a flaring fashion above the lateral femoral condyle until the desired distance is obtained.

Laminating the Flexible Socket

The vacuum draw technique is always used. The resin combination consists of 75% flexible No. 4134, and 25% rigid No. 4110.

The following procedure is used:

1. Pull a moistened PVA sheet over the plaster cast. A heat gun can be used to aid in removing any wrinkles.
2. Tailor three nylon tricot bags to fit the model.
3. With the vacuum acting on the PVA, put on the first of the tailored tricot bags. Place on three layers of 181 glass cloth in order to give strength

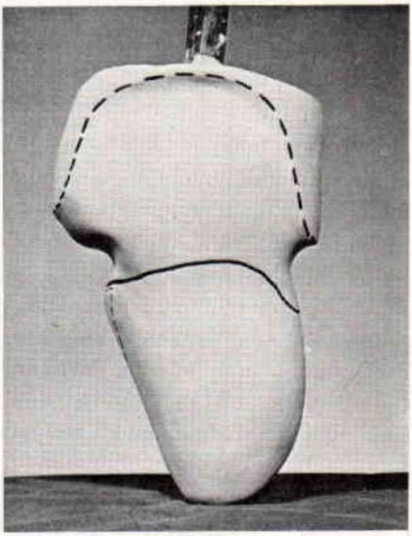

Fig. 5
Medial View of Plaster Model.

to the PTB area, posterior brim area and the medial and

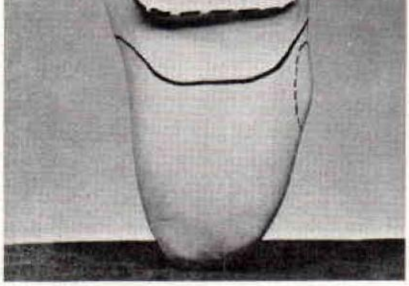

Fig. 6
Posterior View of Plaster Model.

lateral ears of the socket. The glass should include the patellar tendon bar area, but should not exceed the top of the tibial tubercle area. On the medial side it extends from the medial flare region of the tibia inferiorly to the summit of the medial supracondylar shelf superiorly. Posteriorly, it extends 1" below the posterior brim line. Laterally, the glass is so tailored to extend from above the protuberance of the lateral tibial condyle, and from above the head of the fibula to the top of the lateral ear of the socket. The socket must be free from glass in these bony areas to ensure flexibility (Fig. 5, 6, & 7).

4. Put on the other two tricot bags. The seams of the bags are criss-crossed over the inferior aspect of model for strength.

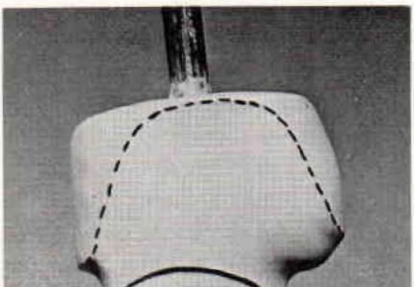

Fig. 7
Lateral View of Plaster Model.

5. Pull a talcum powdered PVA sleeve over model.
6. Add the mixture of flexible and rigid resin and begin

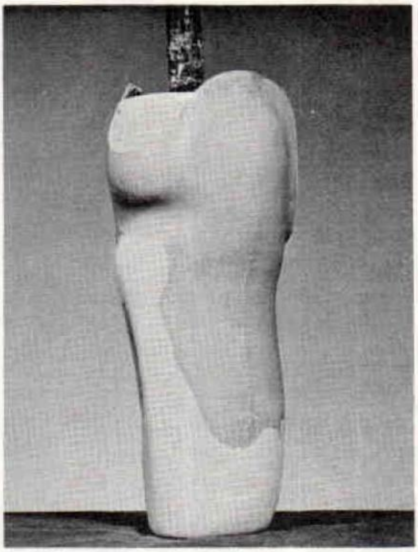

Fig. 8
Medial View of Plaster Build-ups on Socket.

plastic laminating in the usual way. Be sure that any excess resin is removed from the socket, as excess resin reduces the socket flexibility.

Receptacle Construction

The receptacle is custom-built to transmit weight through areas which tolerate weight bearing, and to afford stump stability. Relief areas (spaces) are left between the flexible socket and receptacle in areas which do not tolerate high pressures; mainly, the crest of the tibia and fibular head. The flexible socket is able to distend in these areas of low pressure tolerance, thus cushioning forces against the stump.

To construct the receptacle, proceed as follows:

1. Remove the PVA bag. Place the socket model in a vise and add approximately 1/4″ plaster extension over the tibia of the plastic socket from the tibial tubercle to the distal end of the tibia. The

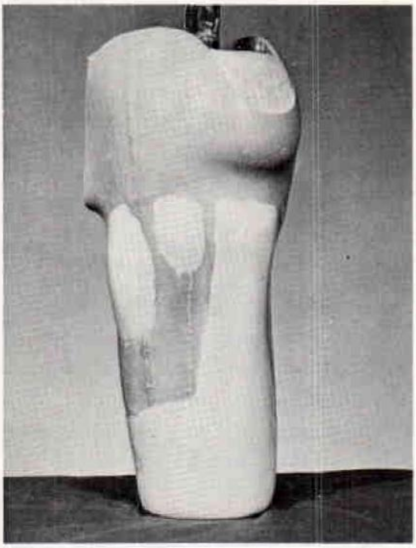

Fig. 9
Lateral View of Plaster Build-ups on Socket.

plaster is to be feathered from its summit to its junction with the socket (Fig. 8).
2. Add the same amount of plaster over the head of fibula and feather it in. If there are any sensitive areas or if flexibility is desired in any other places, spaces can be made by plaster build ups in a similar manner (Fig 9).
3. Place the socket model in a vise and adjust it until, with reference to the floor, there is about five to ten degrees of flexion in the socket and about five degrees of lateral tilt.
4. Add a paper extension which will allow about 1/2 to 1 inch of plaster to be poured into it.
5. When the plaster has set, a 2½-inch circle is scribed with the center as far posterior and lateral as possible.
6. The plaster extending beyond this circle is removed to make the bottom of the socket cup-shaped around the edges.
7. Any excess plaster that has set in areas where contact between socket and receptacle for stump support is desired can be removed by rasp and screen.

NOTE:— It is important that the transition between the plaster build-ups and the flexible socket be smooth and gradual to eliminate areas of high force concentration.

8. Glue 1/8-inch aluminum disc to the bottom of the plaster receptacle and pull on the PVA sleeve.
9. Start the lay-up of fabric with a tailored felt bag made of one-ounce felt.
10. Lay on six squares of 181 glass cloth which slightly overlap the base of the plaster. Six strips wide enough to cover the base, and long enough to reach down the PTB bar level are laid on in a rosette fashion.
11. Complete the layups with two thicknesses of nylon stockinette.
12. Add plastic (90 percent rigid and 10 percent flexible) in the usual manner. After the

plastic has been added, a second disc with a hole for the PVA extension is forced against the base and strapped down with tape to form a flat surface on the outside.

After the resin has cured, plaster is removed from the socket and the socket and plaster are removed from the receptacle. The base of the receptacle is flattened on a disc sander, a ½-inch hole is drilled in the center and a wrench slot is cut on the side. Excess plastic is trimmed and the edges sanded. The socket with supporting receptacle is ready for assembly with the wedge disc alignment unit and sach foot. (Fig. 10).

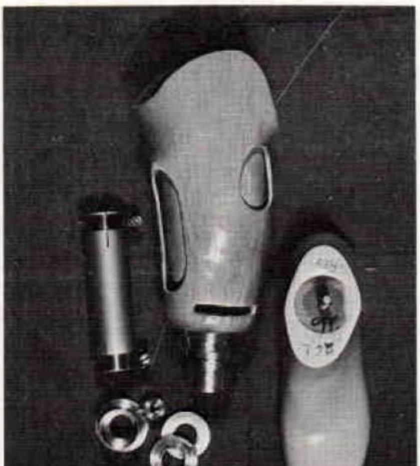

Fig. 10
Components Making Up the Prosthesis.

If small adjustments have to be made, such as allowing a little more relief area or snugging up in an area of the stump, the following can be done:

a. *To relieve an area*—The inside of the receptacle being made of felt can be ground slightly to allow a relief space for the flexible socket to distend or a hole may be cut in the receptacle.

b. *To snug up in an area*—A patch of leather, felt, or rubber can be placed between the socket and receptacle. The flexible socket will bulge inward in that area giving the stump more support.

NOTE:—The relief areas built into the receptacle may be cut out, making the receptacle frame-like.

FABRICATION NOTE: To allow slight adjustability in the medial supracondylar shelf area, patella tendon bar area, or posterior brim region, a layer of one-ounce dacron felt can be included next to the PVA sheet before placing on the first tricot bag in the lay-up procedure. The felt would be tailored and include the same area as the glass cloth.

In cases where greater than normal distal stump weight bearing is desired, it is advisable to include a patch or two of tricot over the distal end of the socket during the lay-up, to reinforce the crossed seams of the tricot bags.

As an alternate to tricot in the socket fabrication, three layers of nylon stockinette can be used if additional flexible resin is added.

Methods of Donning Prosthesis

1. Remove the socket from the receptacle of the prosthesis.

Put it on the stump. Pop the socket back into the receptacle of the prosthesis (Fig. 11).

2. Leave the socket insert in the prosthesis. With the stump flexed to about 90 degrees approach socket with stump almost 30 to 45 degrees internally rotated to the patellar tendon bar of the socket. Insert the stump as deeply as possible into socket, then rotate the prosthesis medially and rotate the stump laterally as the stump is pushed into the socket (Fig. 12).

Fig. 11
Wearing Socket During Donning of Prosthesis.

Advantages of the Supracondylar Suspension

1. Freedom from straps. (But if auxillary suspension is desirable at times, a fork strap with snap fasteners and waist belt suspension can be added).
2. Improved M/L knee stability.
3. Reduced pistoning of the stump in the socket.
4. Improved knee mobility during sitting.
5. Improved cosmetic effect at the knee both in standing and sitting.

CLINICAL EXPERIENCE

Chart 1 illustrates the number of patients fitted with flexible sockets at the Manitoba Rehabilitation Hospital during the past two years and at Kingston General Hospital during the past six months. The chart indicates whether the patient fitted was a new or old amputee; previous prosthesis and socket type; and present socket type.

The majority of the amputees who were previous prosthetic wearers fitted with flexible sockets commented on the following:

1. More comfortable than previous hard or soft sockets.
2. Could wear the prosthesis

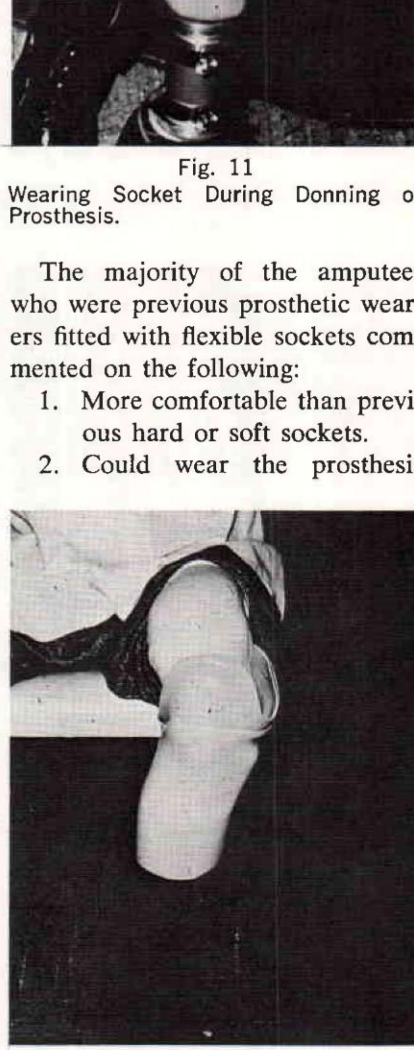

Fig. 12
Donning of Prosthesis.

INFORMATION ON PREVIOUS PROSTHETIC WEARERS

			Present Socket Type***			Previous Prosthesis Type		Previous Socket Type			Previous Socket Material		
	No. of Patients Fitted	Hospital	PTB With Cuff Suspension	PTSC*	PTSPC**	With Side Joints & Thigh Corset	Without	PTB	Plug Fit	Other (Specify)	Hard Plastic	Soft (Kembol Liner)	Other (Specify)
	23	Manitoba Rehabilitation	8	9 Incl. One Bilat. B/K	8 Incl. One Bilat. B/K	4	21 Incl. Two Bilat.	21 Incl. Two Bilat.	4	—	17 Incl. Two Bilat.	4	4 Molded Leather
	7	Kingston General Hospital	1	5	1	4	3	3	3	1 slip	—	5	2 Molded Leather
A Sub-Total	30		9	14	9								

NEW AMPUTEES

			Socket Type		
	No. Fitted	Hospital	PTB With Cuff	PTSC	PTSPC
	27	Man. Hosp.	7	18	2
	8	King. Hosp.	4	3	1
B Sub-Total	35		11	21	3

	Pt's Fitted	PTB Cuff Susp.	PTSC	PTSPC
Total A & B	65	20	35 Incl. One Bilat. B/K	12 Incl. One Bilat. B/K

LEGEND

*PTSC—Patella tendon bearing socket with supracondylar suspension. (Medial femoral condyle)

**PTSPC—PTB socket with supracondylar plus supra patella suspension

***All sockets made of flexible plastic laminate as described in article.

longer daily, before the stump became sore, than with previous prosthesis.

3. Liked this socket type because it had "give" to it.
4. A few commented that they believed the socket was cooler than previous types worn.

Conclusion

A technique has been presented for the fabrication of a flexible socket with a supporting receptacle. A method of obtaining supracondylar suspension has been outlined. Clinical experience has shown the users of this technique significant advantages for continuing to use this method of socket design.

REFERENCES

1. Foort, J., and D. A. Hobson, A pylon prosthesis system for shank (BK) amputees, Prosthetics and Orthotics Research and Development Unit, Manitoba Rehabilitation Hospital, Winnipeg, November, 1965.

The Design of a New Style Ischial Weight-Bearing Brace for Use in the Treatment of Legg-Perthes Disease

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and Michael M. Amrich, C.P.***

Orthopedic Research Laboratories, Harvard Medical School, at the Massachusetts General Hospital, and the Rehabilitation Clinic Liberty Mutual Medical Service Center, Boston, Massachusetts

This work was supported by the Liberty Mutual Insurance Company

Purpose

The principal of protection of the femoral head during avascular necrosis (Legg-Perthes Disease) results from the observation that the natural end stage of this disease, if untreated, is flattened, enlarged femoral head. The late osteo-arthritic changes that these patients frequently develop are probably the result of a loss of congruity between the femoral head and acetabulum. While in the process of healing, the bone in the femoral head is porotic and not able to take the usual stresses of weight-bearing. Furthermore, this disease affects children in a period of relatively rapid growth. The synovial effusion that accompanies the disease usually causes some subluxation of the femoral head, removing it from the acetabulum, allowing the

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head to grow in an incongruous fashion. Concomitant x-rays and photographs taken of cadaver specimens demonstrate that the articular surface of the femoral head is well-covered by the acetabulum in all positions.[1] The advantage of abduction is not better coverage but rather allowing the seating of the femoral head more securely within the acetabulum in the presence of effusion, permitting its growth to be moulded by the socket.

Muscular forces about the hip contribute a much greater share of the load borne by the joint than does body weight. Inman [2] was probably the first to suggest that the abductor muscle group contributed the major share. He theorized that the forces acting through the hip joint approximate two and a half times body weight. More recently Paul,[3] calculating the intra-articular force by analyzing displacement of legs in gait films, and Rydell,[4] by measuring pressures transmitted through a specially instrumented femoral head prosthesis, clearly substantiated that hip intra-articular pressures are far in excess of body weight. Their figures, in fact, tend to suggest that Inman's values were on the low side.

The multiplicity of methods now in use in the treatment of Legg-Perthes Disease bespeaks the lack of any truly satisfactory means. Strict bed rest, while removing body weight from the hip, still allows muscular contractions as the patient moves around in bed. The Snyder Sling again gives the patient something to fix against. Furthermore, it is an extremely easy device for a child to overcome. He merely needs to flex the opposite knee in order to get the affected side foot on the ground for full-bearing.

The classical patten-bottom brace, developed empirically, consists of a full-ring Thomas splint, thigh and calf straps, and a rubber patten at the bottom of the brace. The foot is elevated above the patten by building the other shoe up from two and a half to three and a half inches with a lift. Weight is borne through the ring of the splint, from the ischium directly to the patten, bypassing the hip joint. In order to keep the foot within the brace and out of equinus a strap goes from the heel of the shoe to the top of the patten. The circumferential supports as well as the strap gave the child many points upon which to fix the leg in order to contract the muscles about his hip.

It has been our clinical observation that the old style patten-bottom brace was inadequate because it did nothing to eliminate the muscular forces about the hip (Fig. 1). The good results probably derive

NORMAL HIP

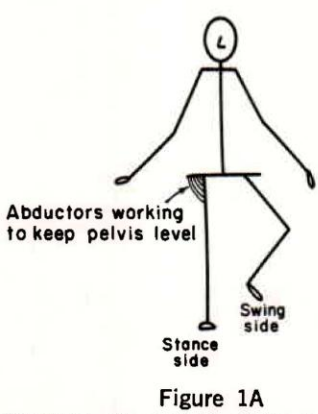


Figure 1A
Diagram of normal abductor muscle function. The stance side abductors contract to maintain the pelvis level.

OLD STYLE BRACE

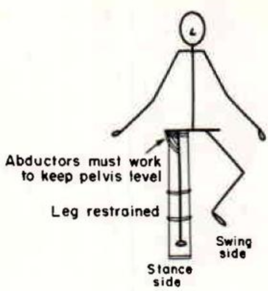


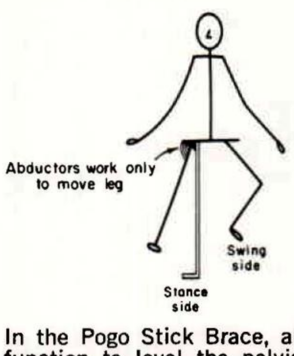
Figure 1B
In the "old style" patten-bottom brace the abductors can still function normally as the leg is restrained.

from the encumbrance of the child with the apparatus. It is clear that to prevent muscular forces acting about the hip joint either the abductor mucles must be fixed in length or the affected leg be completely free.

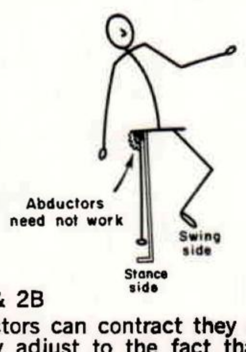
We have approached the problem of redesigning this brace from an experimental point of view. An attempt was made to record direct inter-articular pressures from the hip joint of a chimpanzee which had been taught to walk upright and fitted with braces. However, it became apparent that the chimpanzee's gait pattern was so different from man's that valid conclusions applicable to the human situation could not be drawn.[5] We have thus been forced to rely on EMG recordings of muscle activity during gait to substantiate our design changes.

Our first major change was an attempt to support the opposite pelvis so that the affected-side abductor would not be triggered into firing. It is the slight drop of the pelvis on the opposite side which stretches the muscle and triggers its contraction. Substituting a laminated plastic quadrilateral socket for the Thomas ring for better support, we were able to successfully support the pelvis with a second quadrilateral socket held by a strap cinched over the shoulder. We found, however, that the tension on the strap and the pressures applied to the ischial tuberosity by the support socket were really so great that only very small children could tolerate it. We also did away with the strap from the heel of the shoe to

POGO STICK BRACE



POGO STICK BRACE



Figures 2A & 2B
In the Pogo Stick Brace, although the abductors can contract they can no longer function to level the pelvis. Patients rapidly adjust to the fact that contracting their abductors is no advantage in braced gait. The abductors quickly become silent after their effectiveness has been lost. Balance is achieved by shifting the body weight over the braced side.

the patten and replaced it with a dorsiflexion spring brace, eliminating this point of possible leg fixation.

We then changed our principal attack to focus on attempting to keep the affected leg completely free (Fig. 2). If the leg is free there can be no way to stabilize it and fire the abductors. We accomplished this with a single medial upright, eliminating the calf or thigh straps and adding an extremely loose calf ring (Fig. 3). The superior brim of the lateral wall of the quadrilateral socket was extended to the iliac crest, and an oblong cut-out made distal to the greater trochanter (Fig. 4).

Balanced on the end of a single medial upright without anything to fix the leg on made it difficult to forcefully contract the abductors. EMG studies bore this out. We found, however, that putting pants on over the brace provided the male patients with a means of stabilizing the leg (Fig. 5). It was thus necessary to insist on extremely wide legged pants ("bell bottom trousers") in order to prevent the leg from being fixed. The efficacy of this model has been borne out both in adult tests where the adult volunteer has felt a sense of freeness of his leg which disappeared when the leg was fixed to the upright with straps (Fig. 6).

This brace was first made for a juvenile patient in March of 1964. Since that time 24 children ranging in age from 4 to 12 (Figs. 7 and 8) have been provided with the device. Although it is much too early to draw any conclusions relative to the treatment of Legg-Perthes Disease on the basis of our experience so far, the study is continually expanding. Plans to utilize the brace for adults with hip fractures are also under consideration.

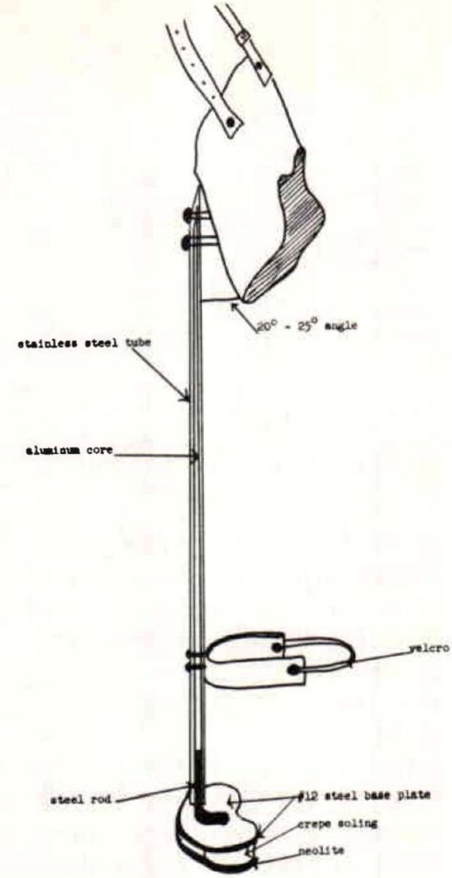


Figure 3
Diagram of the Pogo Stick Brace. Note the large loop to allow free leg motion and the abduction of the socket.

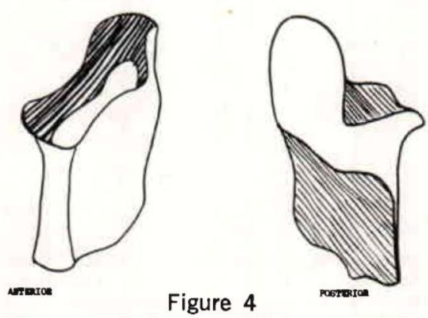


Figure 4
Diagram of the quadrilateral socket. Note the lateral wall cut-out.

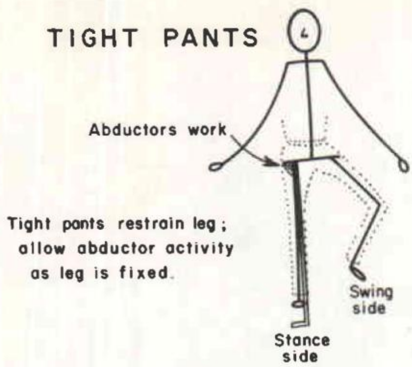


Figure 5
Tight pants over the Pogo Stick Brace act to restrain the leg abolishing the muscle silencing action of the brace.

Since the brace was first introduced there have been a few attempts to imitate it. We have been impressed that the imitators have not fully grasped the significance of the free-hanging leg and have concentrated only on the cut-out lateral wall of the socket and a single upright. We hope that this communication will clarify these important points for all. The following information is provided as a step-by-step procedure for measurement, fabrication, and fitting of the brace.

BRACE FABRICATION AND FITTING

Measurements

Normal brace tracings, lengths, widths, and circumferences are taken of the affected extremity.

Additional Measurements

a) Anterior - posterior measurement taken from the adductor longus tendon to the ischial tuberosity.

b) Medial-lateral measurement taken from the adductor longus tendon to the greater trochanter.

c) Mid-calf height for band of spring toe pickup splint.

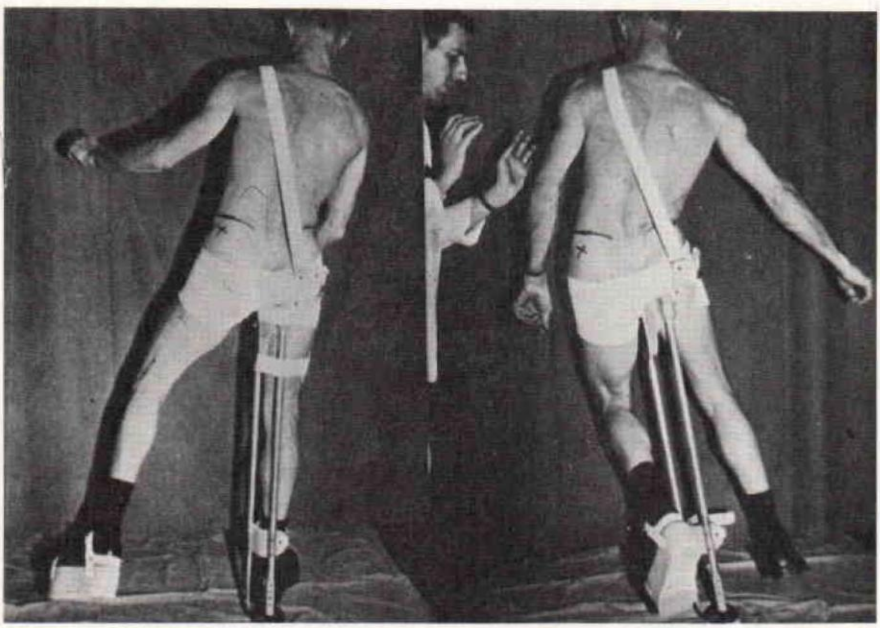
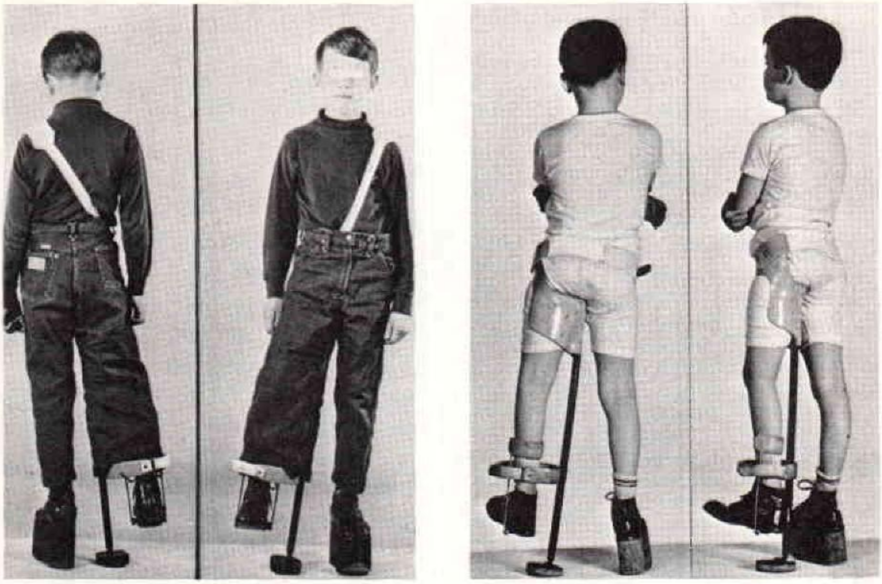


Figure 6

With a strap around the upper leg, it is relatively easy to balance on the brace.

With the strap removed, and the leg free, it is no longer possible.



Figures 7A & 7B
Patient fitted with a Pogo Stick Brace on the right. Note the bell-bottom pants in Figure 7A.

d) Top of shoe height for ankle retainer band position. Normal shoe extension height must be added to this for proper attachment of brace.

e) Shoulder loop suspension length is taken from the anterior perineum level over the opposite shoulder and back to the greater trochanter.

f) Ischium to bottom of shoe plus height of shoe extension for brace length.

Casting

a) Small children may be casted by hand moulding technique. Brims and/or brim stands can be used, if sizing can accommodate thigh circumference.

b) Procedure:

1. Patient stands with normal foot on 4″ block and affected extremity abducted 25°-30°. Assistance may be necessary for balance.

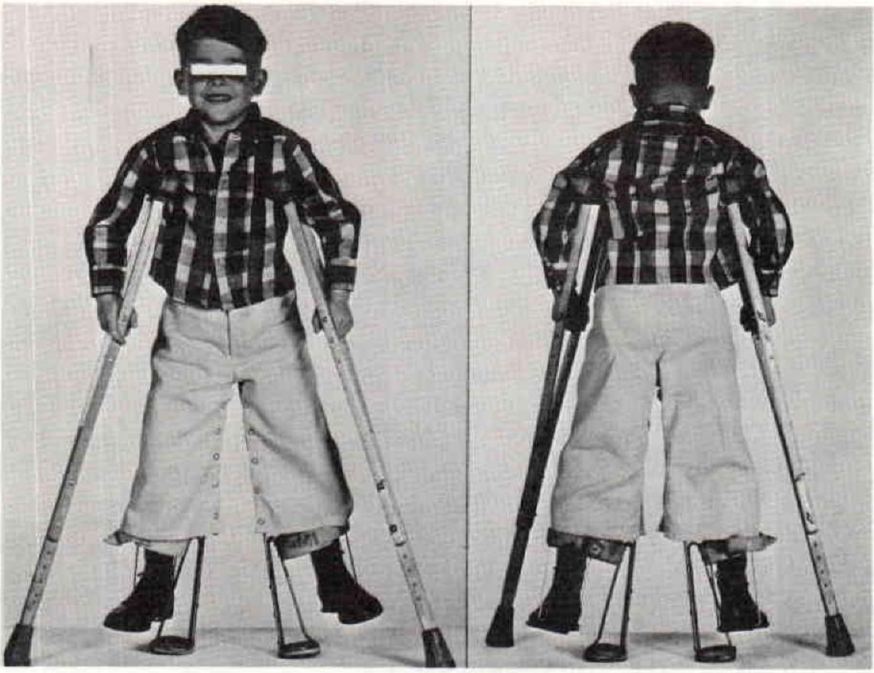
2. Cast sock is applied to include the complete pelvic area of the affected side. For small children it is better to fashion a pair of briefs from 8″-10″ stockinette.

3. Indelible markings are made on the sock at the greater trochanter, ischial tuberosity, crest of the ilium and distal brim line.

4. Using 4″-6″ elastic or fast setting plaster of Paris bandage, wrap extremity laterally up to iliac crest, and distally from the ramus about 8″. If a casting brim is used, the plaster wrap must be carried above the brim to the iliac crest.

5. If hand casting, thumb and flat of hand are used respectively to shape the scarpas to ischial tuberosity level. Right hand is used for right casts with opposite hand used to mould cast into the iliac fossa area.

6. The negative cast is closed on the end, and extensions are made anteriorly, medially, and posteriorly in preparation for vacuum lamination.



Figures 8A & 8B
Patient with bilateral Legg-Perthes Disease fitted with Pogo Stick Braces bilaterally.

FIG. 8B

Cast Modifications

a) Cast is altered in usual manner according to measurements.

b) AP shaping to measurements is critical. Ischial seat must be altered to accommodate the degrees of abduction and should be perpendicular to the floor in stance position.

c) Superior lateral modification of cast is done by making cast concave in iliac fossa area.

d) Cast is prepared for vacuum lamination.

Lamination

a) Material set-up:

1. One layer of ½ ounce dacron felt.

2. Four 2″ strips of fiberglas reinforcement around complete upper portion of brim. Add several layers of 4″ width fiberglas to medial wall of lay-up.

3. Three or four layers of nylon stockinette.

b) 90% rigid-10% flexible resin mixture. 600-800 grams will be needed for child-size brims. Epoxy resin is suitable for heavy weight use.

Trim Line of Brim

a) Medial Wall—Extends about 6″-8″ distally for attachment to medial upright.

b) Anterior Wall—Trimmed similarly to AK socket with adequate flare to maintain ischial tuberosity on seat.

c) Posterior Wall — Trimmed 1½″-2″ below ischial seat and flared into medial wall.

d) Lateral Wall—Proximal trim line is distal to iliac crest and anterior superior iliac spine and blended into anterior and posterior superior brim. Lateral wall is removed in inverted U shape from level of greater trochanter distally and blended into the anterior and posterior walls.

Components and Assembly of Brace

a) Brim with abduction cut-out

b) Medial support:

1. Stainless steel tube (T304, ¾″ OD, .035-20GA wall.

2. Aluminum tube (⅝″ OD-⅜″ ID).

a) Fits into steel tube for added strength .

3. Tube and insert extend from superior medial wall distally to base plate attachment.

a) Tube and insert are flattened at proximal attachment to brim to avoid bulk.

b) Brim is temporarily attached with two #8 copper belt rivets at 5° flexion and 25° abduction angle. Wooden wedge is used to maintain angle.

4. Steel rod attachment to base plate (⅜″ x 10″):

a) Distally a 1½″ right angle bend is welded or silver soldered to steel base plate—medial to mid-line.

b) Upper part inserted into tube assembly and attached with four SS screws 8/32″ x 7/16″ ½″ apart for height adjustment.

5. Steel base plate #12 gauge spring steel:

a) Cut about 2½″ x 4″ and corners rounded.

b) After attachment to steel rod, leather is glued and riveted for base of soling.

c) ½″ crepe soling is glued to leather.

1. Crepe is sanded medially to tilt plate an additional 5°.

d) Neolite or some hard wearing sole is glued to crepe.

6.) Ankle band retainer 2″ x 10-12″ #16 gauge spring steel):

1. Bend in J shape:

a) Posterior part of band approximately 2½″.

b) Medial part of band approximately 3″.

c) Anterior part of band approximately 6″.

2. Laterally, a loose velcro closure about 12″ long is made through a rectangular bar.

3. Band is dipped in plastisol or leather covered.

4. Retainer is attached with two steel rivets at pre-measured height about 8″-10″ from floor.

Brim is permanently attached to medial upright at correct angle.

a) Epoxy filler is used for firm attachment.

b) Buckles are riveted to brim for shoulder loop.

1. Anterior attachment at mid-brim level of seat and lateral attachment midway between superior trim line and greater trochanter.

2. Foam rubber shoulder pad should be made for loop.

Spring Wire Pickup Splint

a) Standard type used to maintain foot in moderate dorsiflexion. Since non-weight bearing, tension of spring may have to be lessened to avoid heel riding out of shoe.

Normal Shoe Extension

a) Recommend 3½″-4″ buildup of lightweight material.

b) Bottom of extension sanded on medial aspect to place foot into

c) ¼″ crepe soling and hard rubber sole are glued to extension. slight eversion.

d) Extension can be stained and water-proofed.

Wearing Apparel

a) Loose clothing should be worn over brace.

1. For female patients, a dress or skirt would be better to avoid restriction of movement of the involved extremity.

2. For male patients, trousers must be altered in an exaggerated bell-bottom fashion. The outside seam of the trouser leg is opened from top to bottom. An appropriate triangular shaped piece of material is then sewn to this seam to allow free motion of the extremity. Trousers or slacks should not extend below the ankle band.

Fitting, Checkout, and Ambulation

a) Application of brace:

1. Protective sock or stockinette must be worn.

2. Brace is applied by putting foot through brim and pulling brim up to perineal level.

3. Shoe with spring splint is put on and positioned into retainer band with loose velcro closure.

4. Normal shoe and shoulder loop suspension are put on.

b) Check-points:

1. In stance position, check for level iliac crests. Also check for height of affected shoe from floor. Should be about same height as shoe extension.

2. Location of greater trochanter—should allow free abduction of extremity.

3. Retention of foot in retainer band.

a) Loose velcro closure so that foot is free and only light contact is made with velcro.

4. Shoulder loop suspension should be snug to support brace and maintain ischial tuberosity on seat.

Initial Ambulation

a) Patient should use two crutches for balance.

1. Children will usually regain balance with brace in about two weeks and discard crutches.

b) Patient should ambulate with broad base and concentrate on abducted gait with brace.

c) Bilateral brace wearers should use two crutches at all times, however, some children may develop good balance and discard crutches indoors.

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Brace-to-Body Dynamics

John Glancy, C.O.*

For over twenty years the results of the studies done on human locomotion at the Biomechanics Laboratory, University of California at Berkeley, have been available to the orthotics profession. Perhaps the fact that these studies were oriented toward prosthetics is the explanation as to why their findings have not been applied more aggressively to orthotic problems. Traditionally, orthotics and prosthetics have been practiced as separate professions, and although the two have become more closely associated in recent years, it appears that orthotics may still be in the grip of past traditions.

While there is no question that intensive orthotic research is the ultimate to sound future progress, it is questionable as to whether orthotics is making as imaginative a use of current biomechanical information as it might in the present. What follows is a suggested method of analyzing the interactions which take place between a brace and the human body, i.e., the effects which a mechanical system (a brace) has upon a biomechanical system (the human body) and vice versa. For the lack of a better term these interactions will be referred to as—**brace-to-body dynamics.** The proposed method permits control of brace-to-body dynamics, by 'programming' the control of motion. 'Programmed' motion control being here defined as 'planned' or 'allowed' motion within a given brace system versus static control of every movable segment that a brace system may encompass.

With the armamentarium presently available to the orthotist, much can be done in several areas to improve brace-to-body dynamics, and in so doing improve the patient's functional performance. The adult patient can be braced more satisfactorily than a child, as the

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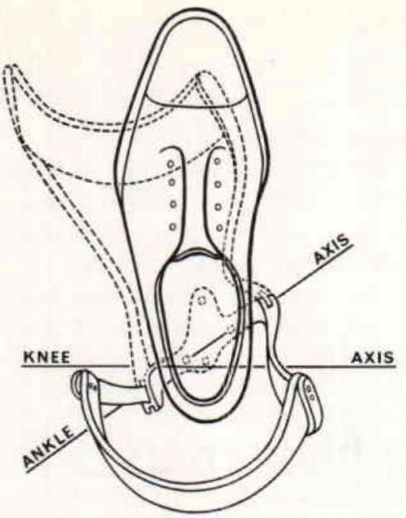


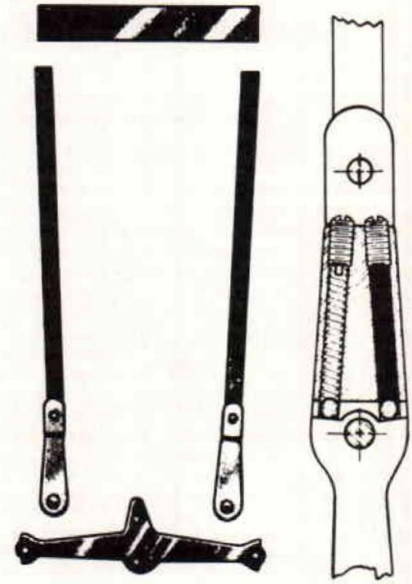
Fig. 1A
BK brace for an adult with accommodation for external tibial torsion and anatomical alignment of the foot to the knee and ankle axes. Brace with posterior calf band is illustrated to give a clearer view.

maximum degree of his external tibial torsion is fixed; therefore some accommodation can be built into the brace (Figure 1). However, a brace is not presently available which can provide necessary motion controls, and yet accommodate the normal development of external tibial torsion in the child who must wear a brace during his growing years.

Two examples of the 'programmed' brace-to-body dynamics analysis technique are presented to demonstrate its functional application. The rationale for the designs is based on two primary premises: 1.) The complex sequence of motions which enable man to walk in an upright position are dictated by the laws of motion. Man's obedience is not an act of will—however, his locomotor system must practice absolute obedience. 2.) A brace has but one function—that is, to control body motion. Its design is therefore subject to the same laws of motion as the body it serves.

The following is a design of a BK brace for a hemiplegia patient with the common pathological condition of a varus foot due to a spastic tibialis anterior (the only dorsiflexor functioning). The patient's plantar flexors are not spastic. The knee is unstable due to weak quadriceps.

Each component of the design is listed, followed by the rationale for its use.



DOUBLE UPRIGHT BK BRACE
Spring Dorsiflexion and / or Plantar Flexion
(Note replacement of one spring with solid rod.)
FIG. 2

1. Bilateral Pope double spring-action ankle joints and uprights. The anterior springs are to be replaced with steel rods, thereby converting the joints to rigid (slightly less than 90°) anterior stops. The posterior portion should permit 15° of plantar flexion against the spring's resistance. (Figure 2.)

RATIONALE:

The anterior stops check the forward progress of the tibia in the sagittal plane as it rotates over the foot. Its forward rotation is checked at 2° to 3° forward of a 90″ relationship to the fixed foot. This setting will maintain the knee in its normal, slightly fixed position during mid-stance. This setting also prevents any tendency for the anterior metal band (see #2) to cause genu recurvatum. The posterior setting of the ankle joints permits the normal range of plantar flexion to occur between heel-strike and foot-flat. The springs resist the force of gravity as well as the resultant force from the floor, thereby mechanically producing the function normally required of the pretibial muscles. Thus a mechanical supplement or substitute, for the function of the pretibials during this period is possible. As to which is the actuality, supplement or substitute, would seem to depend upon the severity of the spasticity present.

The result is either a partial or a total by-pass of the pretibial muscles. Stimuli to regional proprioceptors are kept to a minimum, if not eliminated, thereby reducing further excitation to the spastic tibialis anterior. The fact that the normally inactive plantar flexors have not been interfered with throughout this period, is most significant. The posterior springs also hold the foot in 2° to 3° of dorsiflexion throughout the swing phase. The force of the springs eliminates the need for the pretibials to sustain a position of dorsiflexion, so important to maintaining clearance between the foot and floor during swing phase.

2. The metal band is to be attached anterior to the uprights instead of the usual posterior calf band.

RATIONALE:

The purpose of the band is to stabilize the knee, from mid-stance to toe-off, by supplementing the weak quadriceps muscles. This band and the anterior stops in the ankle joints work in unison to check the tibia's forward progress beyond the mid-stance period. As the tibia presses against the band a counter force builds which prevents flexion of the knee. During the mid-stance period the gastrocnemius muscle is kept in an eccentric contraction by preventing the heel from raising while simultaneously extending the knee. By mechanically producing what is normal position, at its normal time, in the overall sequence of motions within the stance phase, further protection against the occurrence of genu recurvatum is provided.

3. The ankle joints are to be set in 22° of external rotation. The Lehneis-New York University Measuring Board is used to determine the amount of tibial torsion and toe-out the patient presents.

RATIONALE:

The mechanical ankle axis of the brace will then be congruent to the patient's anatomical ankle axis, i.e., 22° of external tibial torsion. This will ensure against any impingement of the normal transverse rotary motions of the tibia, caused by the wearing of the brace. This setting prevents the brace from introducing abnormal torque forces to the ankle and foot, with all that

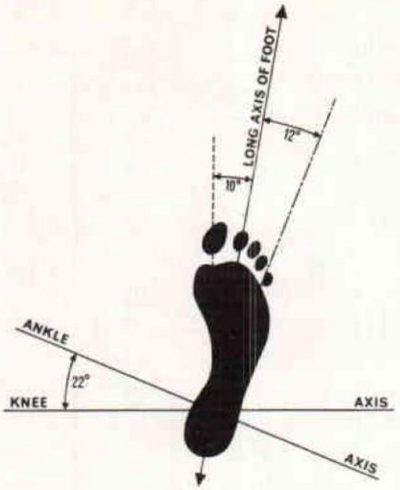


Fig. 3A
Transverse plane—(right foot—viewed from above)
Example of the anatomical alignment of the long axis of the foot (toe-out) to the knee and ankle axes.

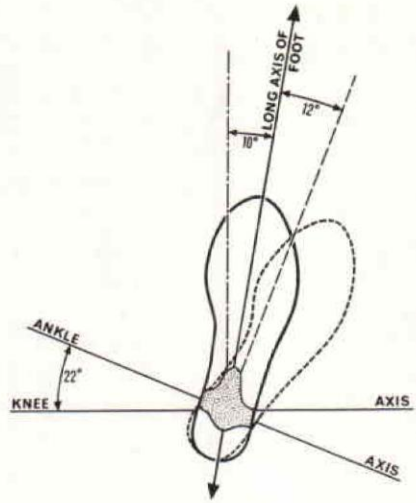


Fig. 3B
Transverse plane (left foot — viewed from below)
Duplicating nature's alignment — brace attachment set at 12° toe-in to ankle axis and 10° toe-out to knee axis. The dotted outline indicates the position in which the shoe, would be, in relation to the knee axis, were the 22° of tibial torsion put into the brace with the attachment fixed to the shoe in the patient's 10° of toe-out.

such torque forces imply to propriceptors in both regions.

4. The brace attachment (whether it be a solid stirrup or a receptacle for a split stirrup) is to be set at 22° of **toe-in** on the shoe.

RATIONALE:

This setting of the brace attachment to the shoe will duplicate the patient's anatomical relationship of the long axis of the foot (toe-out) to both his knee and ankle axes. (Figure 3A.)

The uprights are bent in a manner which places the ankle joint axis in a fixed 22° of external rotation. With the ankle joints thus aligned, were the brace attachments fixed to the shoe at the patient's anatomical toe-out of 10°, the result, when assembled, would be a shoe setting of 32° of toe-out to the patient's knee joint, as viewed in the transverse plane. (Figure 3B.)

In order to match nature's alignment, the following procedure is used:

PATIENT

A. 22° external tibial torsion

B. —10° toe-out.

—

12° (equals degree of toe-in to ankle axis)

BRACE AND SHOE

A. Brace must duplicate the full 22°.

B. Brace attachment is set in 12° of toe-in on the shoe

When the shoe is attached to the brace it will be in proper alignment, i.e., 10° of toe-out to the knee and 12° of toe-in to the ankle, as viewed in the transverse plane.

5. A rigid metal strip is inserted between the welt and the sole, throughout the length of the shoe.

Before insertion, its distal end is to be preshaped to set the forefoot in approximately 15°-20° of flexion as in the toe-off position.

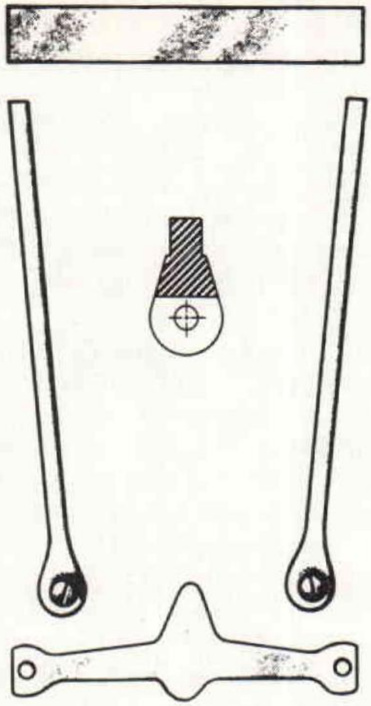
RATIONALE:

The purpose is threefold: 1) To utilize the entire length of the shoe as a more efficient resistance arm; 2) To reinforce the shoe; 3) to by-pass the spastic tibialis anterior muscle by mechanically placing the forefoot in the toe-off position, thereby alleviating its need to be active at this time in the walking cycle. The posterior springs, at toe-off, provide some push-off force to start the leg into its forward acceleration during the swing phase.

6. A 3/16" to 1/4" 'rocker' bar is to be attached to the bottom of the sole of the shoe. The apex of the rounded rocker bar is to be placed immediately proximal to the metatarsal heads.

RATIONALE:

The rocker bar acts in conjunction with the anterior metal band and the anterior stops in the ankle joints. As the tibia's forward progress is checked at the mid-stance position by the anterior stops, a counter force is produced by the anterior metal band which prevents the knee from buckling. At this time in the walking cycle, the body weight is just beginning to rotate, in the transverse plane, forward of the lateral mid-line, having received its impetus from the push-off of the opposite limb. This same impetus is also rotating the body forward, in the sagittal plane and serves to 'trip' the body over the rocker bar, raising the heel and automatically placing the braced leg in the pre-set toe-off position. Thus the action



DOUBLE UPRIGHT BK BRACE
Limited Motion
FIG. 4

of raising the heel and the placement of the foot in the toe-off position are produced mechanically, without using the musculature which would normally be required to accomplish these movements.

7. A cushion heel is used to replace the hard rubber heel.

RATIONALE:

The cushion heel's function is to reduce the sudden jolt (exceeding the body weight by 15-20 percent), which the limb receives at heel-strike, thereby reducing excitation to whatever spasticity may be present.

The design of a BK brace for a cerebral palsy patient who presents the common problem of a spastic gastrocnemius and accompanying knee flexion, would consist of the following available components:

1. Bilateral limited motion ankle joints and uprights. The anterior portion of the joints are to be rigid stops set slightly less than 90°, the same as the previous design. The posterior portion is to permit 15° of plantar flexion. (Figure 4.)

RATIONALE:

In the normal sequence of events during stance phase, the gastrocnemius is not involved in achieving foot-flat, i.e., the 15° of plantar flexion. Any attempt to prevent foot-flat from occurring, will force the gastrocnemius and all other plantar flexor muscles to go into an isotonic contracture following heel-strike, to overcome the resistance of placing the foot in the normal position to receive the weight of the body. In those cases where a plantar flexion stop is used and the calcaneous is successfully prevented from raising in the shoe when the gastrocnemius is spastic—the result is a force which will act to flex the knee. Again, the contradiction of the use of a plantar flexion stop to prevent equinus becomes evident. Posterior springs are not used because the patient possesses the full compliment of functional pretibials (though weakened due to constant overpowering by their spastic antagonist).

2. Anterior metal band.

RATIONALE:

Again, this band and the anterior stops in the ankle joints work in unison to check the tibia's forward progress beyond the mid-stance position. The previous rationale for the use of this band is still valid, although this patient has functional quardiceps. It should be noted that because of the tendency of a spastic muscle to lose its normal length, it seems practical to permit the gastrocnemius to perform the eccentric contraction which occurs between the foot-flat and mid-stance positions. (Figure 5.)

3. The ankle joints are to be set in external rotation equal to the external tibial torsion which the patient presents.

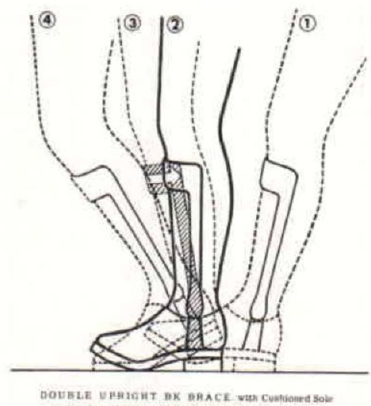
RATIONALE:

The previous rationale is still valid. However, as previously mentioned, no brace is presently available which will accommodate to the gradual 'developmental' increase of external tibial torsion in the growing child. The restriction of this aspect of growth which present-day braces impose, hopefully will be alleviated before too long.

a. Foot is plantar flexing toward the foot-flat position following heel-strike. Note the impact absorption through the compressed posterior portion of the cushion heel.

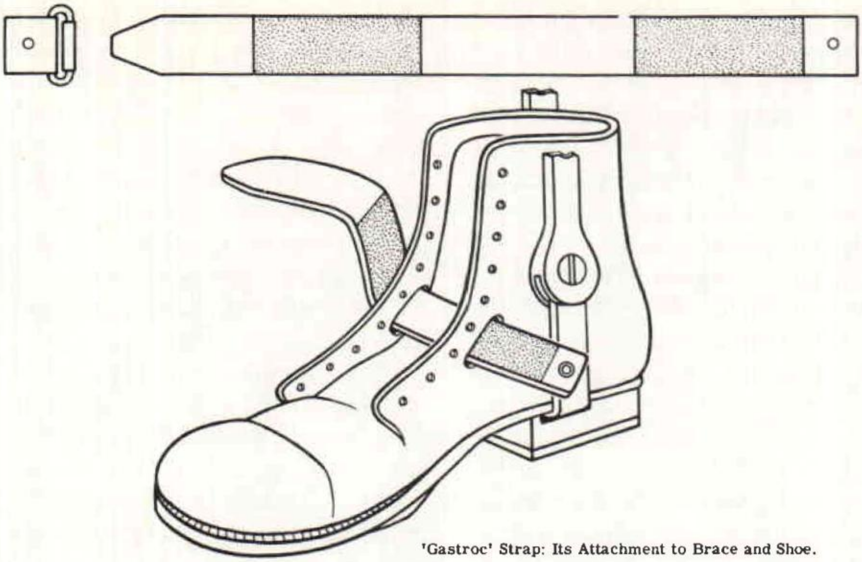
b. Mid-stance position: The limb in swing phase, along with the

A SCHEMATIC ILLUSTRATION OF "PROGRAMED" BRACE-TO-BODY DYNAMICS



DOUBLE UPRIGHT BK BRACE with Cushioned Sole and heel and "Rocker" Bar and Rigid Metal Sole Plate

FIG. 5



'Gastroc' Strap: Its Attachment to Brace and Shoe.

FIG. 6

body, has rotated in the transverse plane to the lateral midline. Note the stability of the knee at this period when the magnitude of downward vertical force is high. The preset toe-off positioning of the metal sole plate is evident.

c. Just before heel-rise: The body's center of gravity has now rotated in the transverse plane forward of the lateral midline. Note the stabilizing of the knee by the counter pressure of the anterior metal band. 2°-3° of forward motion allowed to the tibia by the anterior stops in the ankle joints permits normal knee flexion during this period.

d. The forward rotation of the body has 'tripped' over the rocker bar and placed the foot in the toe-off position in preparation for push-off.

4. The brace is to be fixed to the shoe to match the patient's anatomical requirements, as per the previously described procedure.

RATIONALE:

The previous rationale still applies and also relates to the remarks added to #3 immediately above, as the toe-out relationship would appear to be subject to change also.

5. A rigid metal plate is inserted between the welt and the sole, throughout the length of the shoe. Its distal end is to be preshaped as in the toe-off position of 15° of forefoot flexion.

RATIONALE:

The purpose remains threefold. The first two reasons presented in the previous rationale still apply. However, the reasons for placing the forefoot in a pre-set toe-off position are somewhat different: 1) Since normal heel-rise following the mid-stance position is prevented by the combined blockage of the anterior band and the anterior stops in the ankle joints, it appears reasonable to expect the patient's functioning pretibials will attempt to raise the heel. 2) The rigid plate stiffens the flexible sole of the shoe and resists both muscular and resultant forces. Therefore, the forced inactivity of the plantar flexors is not challenged by excessive activity of the pretibials at an unnatural time in a normal walking cycle. 3) The pre-set toe-off contouring of the shoe limits the efforts of the pretibials to a push-off force only, as the 'rocker bar' (see #6) serves as a mechanical substitute for their toe-off positioning activities.

6. A rocker bar is added to the sole of the shoe in the same placement as for the hemiplegic patient.

RATIONALE:

The same as the previous #6.

7. The hard rubber heel is replaced with a cushion heel.

RATIONALE:

The same as the previous #6. When additional 'shock absorption' is desirable, a ⅜" cushion sole is applied throughout the length of the shoe, and the cushion heel and rocker bar are added to it. When a cushioned sole is used, an equal thickness must be placed on the other shoe. When reduction of unwanted stimuli to the skin of the sole and heel, which is related to contact with the floor is desired, a ⅛" to $\frac{3}{16}$" cushion inner-sole may be placed inside the shoe. Whenever a cushion inner-sole is used a size larger shoe is necessary to ensure patient comfort.

8. A gastroc' restraining strap.

RATIONALE:

This velcro strap is pivotably attached on the solid, or split stirrup, below the ankle joint. It passes over the instep, through two slots cut below the eyelets on either side of the tongue, and passing through a metal loop (also pivotably attached on the opposite side, below the ankle joint) to fasten onto itself, either side of the instep (Figure 6). A $\frac{3}{16}$" x ¼" felt pad is cemented to the inner-sole of the tongue to prevent the velcro strap from cutting into the instep. A size wider shoe will allow room for the tongue pad.

The patient's foot is placed in the shoe while the brace is attached. The knee is flexed and the heel is checked to be sure it is in contact with the bottom of the shoe. The velcro strap is then passed through the metal loop attached below the ankle joint. A firm downward pressure is applied to the instep with one hand while the slack is drawn out of the strap. When the foot is firmly set against the bottom of the shoe, the velcro strap is fixed to itself on the metal loop side of the tongue. The shoe is then laced and tied and the loose end of the velcro strap is drawn over the laced instep and fixed to itself at the originating end of the strap.

The purpose of this strap is to insure that the gastrocnemius muscle cannot go into isotonic contracture as the tibia moves forward over the foot in the sagittal plane. The combined effect of this strap and the anterior metal band attached to the uprights force the gastrocnemius to stretch, thus limiting its action to an eccentric, or more clearly descriptive, an isometric contraction—the tibia's forward progress having been checked well short of its normal maximum range.

Although the preceding examples are confined to two specific biomechanical dysfunctions, the functional analysis approach is suggested as a means of analyzing orthotic problems in general, regardless of etiology, as they relate to walking. The technique appears to hold promise as a means of realizing the full potential of current knowledge, and in so doing, help to identify the areas in which future orthotic research would be most fruitful. It is hoped that the publishing of the preceding ideas will serve to excite the interest of those who are dedicated to improving the well-being of the handicapped.

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The 1970 NATIONAL ASSEMBLY of the

AMERICAN ORTHOTIC AND PROSTHETIC ASSOCIATION

will be held

SEPTEMBER 30 to OCTOBER 3, 1970

at the

PORTLAND HILTON HOTEL

PORTLAND, OREGON

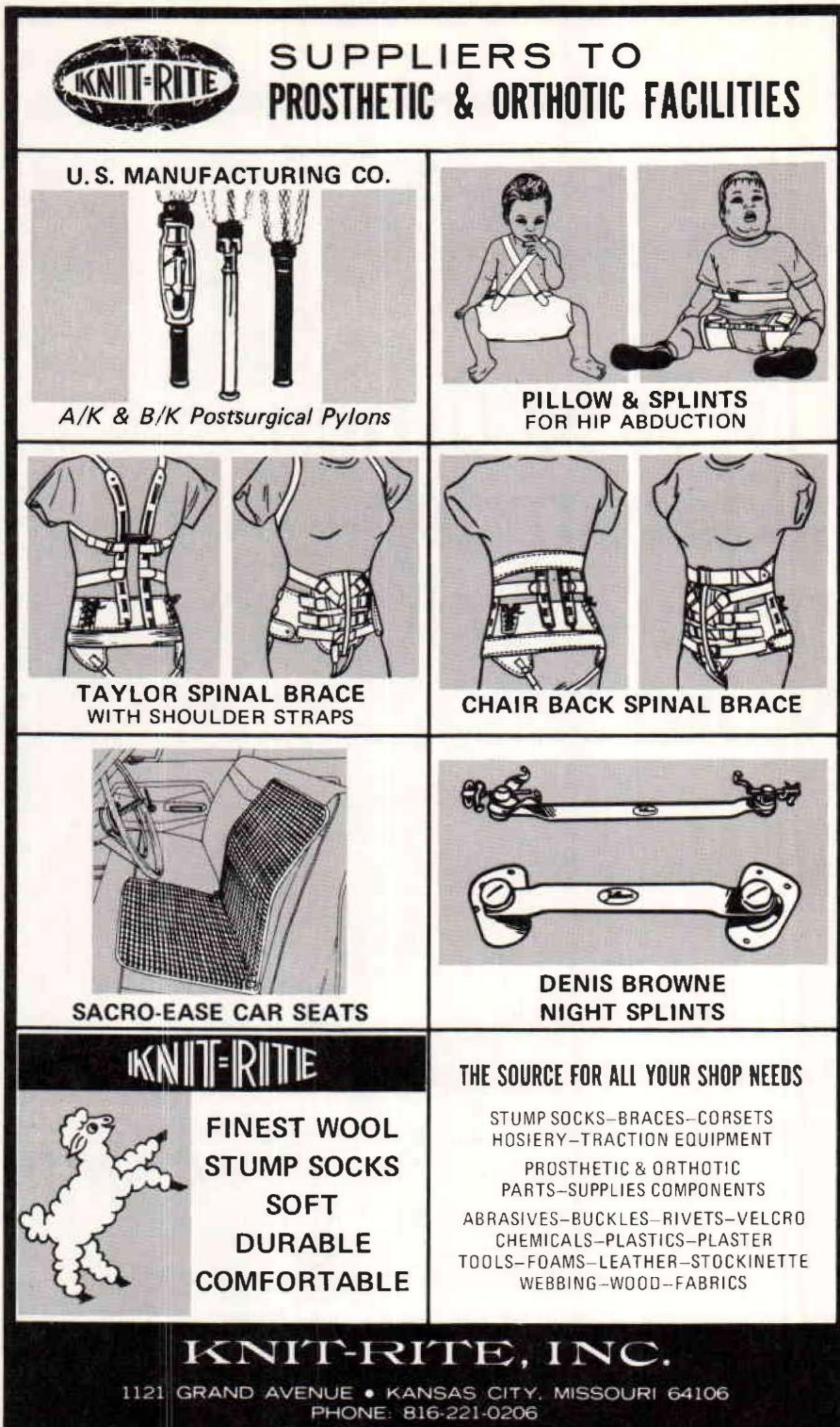
For Program Details and Registration Information
write to

The American Orthotic and Prosthetic Association

1440 N Street, N.W.

Washington, D. C. 20005

The Assembly is open to all who are interested in the
rehabilitation of the orthopedically disabled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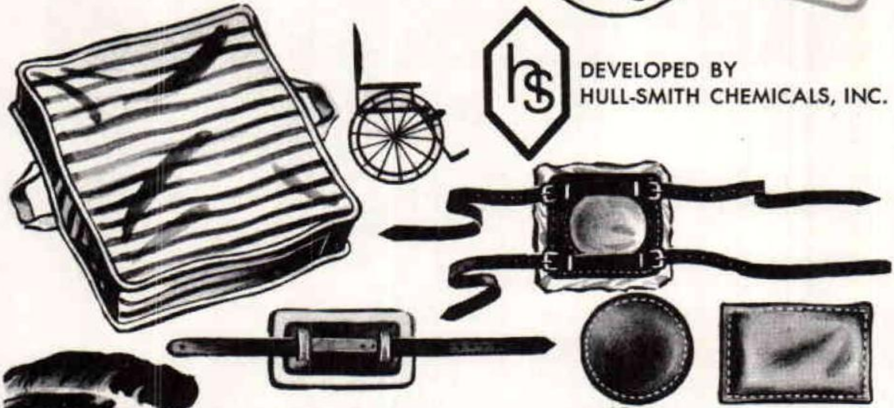


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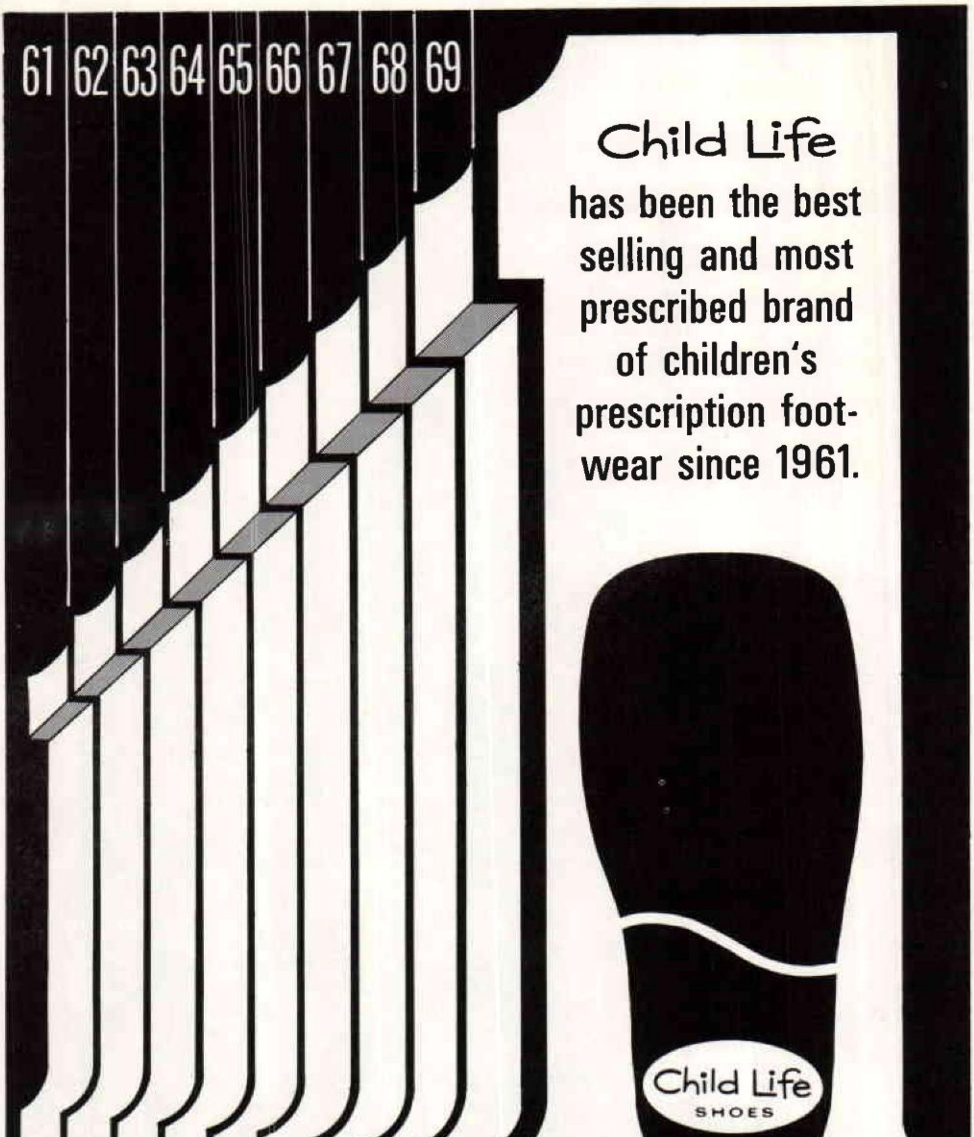
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1970 NATIONAL ASSEMBLY PROGRAM

Saturday, September 26

National Office Staff arrives

Sunday, September 27

Set up on-site assembly office
Final run-through of physical arrangements and program
Hotel Staff Orientation of Convention Bureau help.

Monday, September 28

8:00 A.M.	Assembly Office opens.
9:00 A.M.	ABC Board of Directors

Tuesday, September 29

8:00 A.M.	Assembly Office opens.
9:00 A.M.	AOPA Board of Directors
12:00 Noon	Begin Exhibit Set-up
6:00 P.M.	Reception
	TS Moderators Meeting

Wednesday, September 30

8:00 A.M.	Assembly Office opens.
	Women's Auxiliary Desk opens
8:30 A.M.	The President's Breakfast
10:00 A.M.	Formal Opening of Exhibits
10:30 A.M.	Women's Auxiliary Hospitality Room
10:30 A.M.	Coffee Service
10:30 A.M.	TECHNICAL SESSION "Upper Extrémity Orthotics"
11:00 A.M.	Women's Auxiliary Meeting
12:00 Noon	Joint Executive Council Meeting
1:30 P.M.	TECHNICAL SESSION "New Products"
3:30 P.M.	TECHNICAL SESSION "Plastic Materials in Orthotics and Prosthetics"

Thursday, October 1

8:00 A.M.	Assembly Office opens.
	Women's Auxiliary Desk opens
	Exhibits open
	Coffee Service
8:30 A.M.	TECHNICAL SESSION "Spinal Anatomy"
10:30 A.M.	CONCURRENT TECHNICAL SESSIONS I. "Spinal Bracing" II. "Cosmetic Finishing of Skeletal Systems"
12:30 P.M.	Lunch
2:00 P.M.	Insurance Committee
2:00 P.M.	TECHNICAL SESSION "Legal Liability in Orthotics & Prosthetics"
4:00 P.M.	Exhibits close
	Free Time – Weather permitting, it is planned to have a swim party with beer and soft drinks at the hotel's outside pool and patio.
6:30 P.M.	Barbecue with entertainment and cash bar at the hotel's pool and patio

Friday, October 2

8:00 A.M.	Assembly Office opens.
	Women's Auxiliary Desk opens
	United Airlines Desk opens
	Exhibits open
	Coffee Service begins
8:30 A.M.	CONCURRENT TECHNICAL SESSIONS I. "Hand Splinting" II. "Status of Fitting Symes, Knee and Hip Amputees"
10:30 A.M.	Break
11:00 A.M.	TECHNICAL SESSION "Orthotic and Prosthetic Knee Mechanisms"
12:30 P.M.	ABC LUNCHEON
2:30 P.M.	ABC ANNUAL MEETING
	ABC BOARD OF DIRECTORS MEETING

Saturday, October 3

7:30 A.M.	Suppliers Breakfast
9:00 A.M.	Women's Auxiliary Breakfast
9:00 A.M.	TECHNICAL SESSION "Evaluation Criteria for Immediate Post-Operative and Fracture Bracing Techniques"
11:00 A.M.	Lunch
12:30 P.M.	Begin Exhibit Take-down
12:30 P.M.	TECHNICAL SESSION "Stress and Strain on Skin and Soft Tissues"
2:45 P.M.	AOPA ANNUAL MEETING
6:30 P.M.	CONCLUDING RECEPTION[
7:30 P.M.	CONCLUDING BANQUET

Sunday, October 4

8:30 A.M.	AOPA Board of Directors (new)

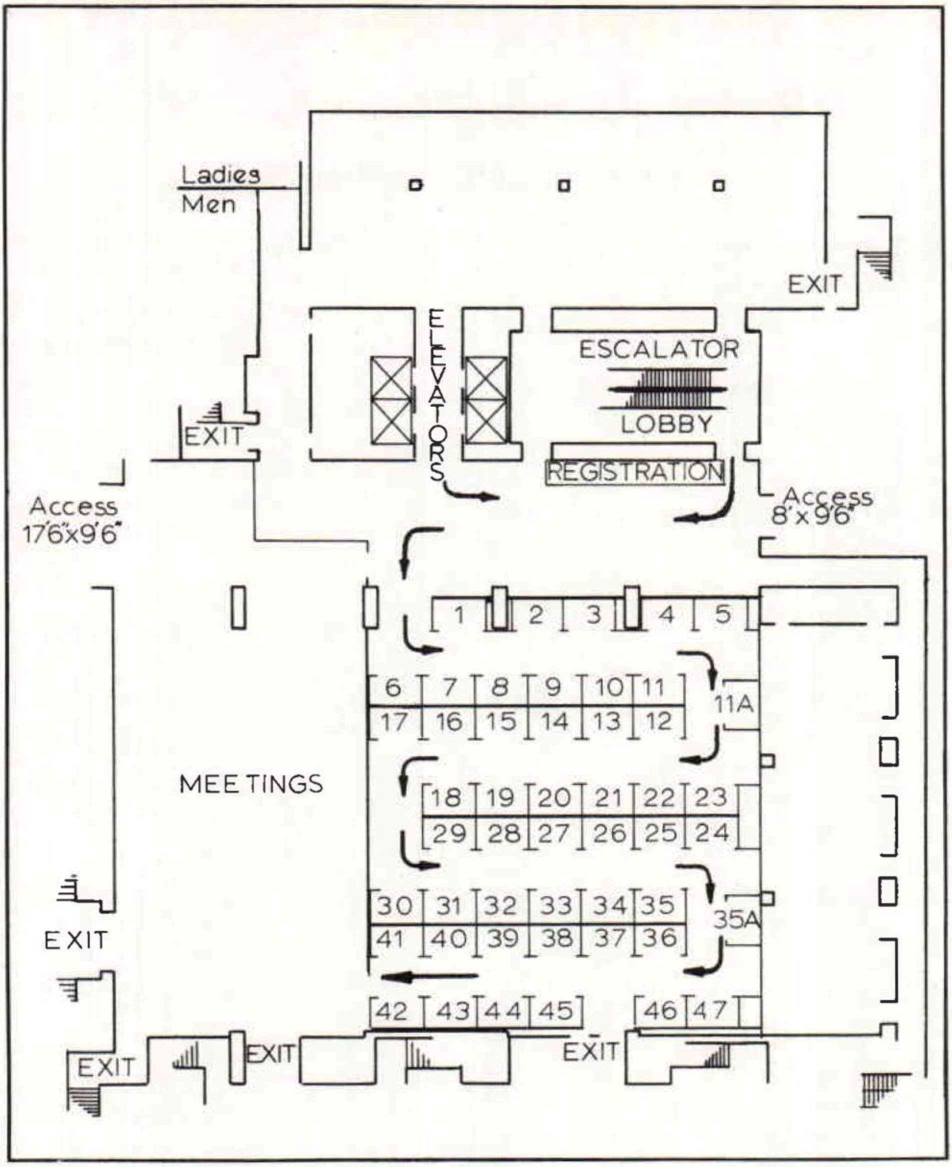


EXHIBIT FLOOR PLAN

Northwestern University Prosthetic-Orthotic Center Announces Courses

Prosthetics 601

Above-Knee Prosthetics for Prosthetists

Three-week course will cover functional anatomy, biomechanics, measurement and lay-out techniques, adjustable leg, transferring with alignment duplication jig, auxiliary suspension, plastic laminate reinforcing, and checkout. Instruction will include fluid-controlled mechanisms; analysis of a variety of fitting problems. Only total contact plastic sockets will be taught in this session. One of the prostheses fitted will be on a hydraulic unit. This course is open to certified prosthetists and to those preparing for certification.

Tuition:

Prosthetists	$300.00 plus
Laboratory Fee	200.00
Total Tuition:	$500.00

Date: October 5-23,1970

Prosthetics 611

Below-Knee Prosthetics for Prosthetists

Three-week course will include functional anatomy and locomotion of the below-knee amputee, measurement and casting techniques, fabrication of plastic sockets; fabrication and fitting of special prostheses including the PTB supracondylar wedge suspension, PTB supracondylar, supra-patellar prosthesis (PTS), and air-cushion sockets; location of knee joints, alignment analysis, application of these to the use of the new below-knee adjustable leg. During practical laboratory sessions students will fit four below-knee amputees. Time will be devoted to seminar discussions of problems encountered by students. The course is open to certified prosthetists or to those preparing for certification.

Tuition:

Prosthetists	$250.00 plus
Laboratory Fee	150.00
Total Tuition:	$400.00

Date: April 12-30, 1971

Prosthetics 621

Advanced Below-Knee Prosthetics for Prosthetists

Five-day laboratory course offering instruction and laboratory practice in the fabrication and fitting techniques of special below-knee prostheses. This will include the patellar tendon bearing supracondylar wedge suspension prosthesis; patellar tendon bearing supracondylar, suprapatellar prosthesis (PTS); air-cushion socket and Polysar socket. This course is open to certified prosthetists and to those preparing for certification.

Pre-requisite: Completion of a B/K course at N.Y.U., U.C.L.A. or N.U.

Tuition:

Prosthetists	$100.00 plus

Laboratory Fee	175.00
Total Tuition:	$275.00

Dates:

Section A February 1-5, 1971
Section B May 24-28, 1971
Section C June 14-18, 1971
Section D July 12-16, 1971
Section E July 19-23, 1971

Prosthetics 661

Upper-Extremity Prosthetics for Prosthetists

Three-week course will include measuring, fabricating, fitting and harnessing the upper-extremity amputee. Functional anatomy will also be covered. The students will make two below-elbow prostheses including a Muenster type; two above-elbow prostheses; and measurement and check socket fitting of shoulder disarticulation amputee will be taught. This course is open to certified prosthetists and to those preparing for certification.

Tuition:

Prosthetists	$250.00 plus
Laboratory Fee	150.00
Total Tuition:	$400.00

Date: February 22-March 12, 1971

Prosthetics 671

Review of Fluid Control Mechanisms for Prosthetists

A seminar in fluid-controlled mechanisms will be offered for qualified prosthetists. Enrollment is limited to those who have successfully completed a course in above-knee prosthetics.

Tuition:

Prosthetists	$100.00

Date: January 11-13, 1971

Orthotics 701

Spinal Orthotics for Orthotists

Two-week laboratory instruction in this course will include practice in the measurement, tracing, fabrication and fitting of spinal orthoses (lumbo-sacral; thoraco-lumbar; anterior hyperextension and cervical appliances) with special instruction in corsetry. Milwaukee Brace construction will not be offered in this course. In addition, lectures in anatomy, kinesiology, pathology and components will be given. This course is open to certified orthotists and to those preparing for certification.

Tuition:

Orthotists	$200.00 plus
Laboratory Fee	100.00
Total Tuition:	$300.00

Date: March 22-April 2, 1971

Orthotics 711

Lower-Extremity Orthotics for Orthotists

Two-week laboratory course will include instruction and practice in measurement, tracing, fabrication and fitting of lower-extremity orthoses (below-knee orthosis; above-knee orthosis) with emphasis on mechanical joint location and tibial torsion. In addition, lectures in anatomy, kinesiology, pathology, components and shoe modifications will be given. This course is open to certified orthotists and to those preparing for certification.

Tuition:

Orthotists	$200.00 plus
Laboratory Fee	100.00
Total Tuition:	$300.00

Date: November 2-13, 1970

Orthotics 721

Upper-Extremity Orthotics for Orthotists

Two-week laboratory course includes instruction and practice in measurement, tracing, fabrication and fitting of short opponens, long opponens, tenodesis and externally powered hand splints. In addition, lectures in anatomy, kinesiology, pathology and components will be offered. This course is open to certified orthotists and to those preparing for certification.

Tuition:

Orthotists	$200.00 plus
Laboratory Fee	100.00
Total Tuition:	$300.00

Date: May 3-14, 1971

Orthotics 741

Basic Plaster and Plastic Orthotic Techniques

Five-day course offers lectures, demonstrations and laboratory instruction in plaster and plastic techniques. Included will be casting of patients, modification of molds, plastic resin lamination and thermoplastic application. The students will fabricate a PTB weight-bearing socket for a B/K orthosis; plastic shoe insert for correction of flexible foot deformities with application as distal attachment for B/K and A/K orthoses; thermoplastic hand-positioning splint. This course is open to certified orthotists and to those preparing for certification.

Tuition:

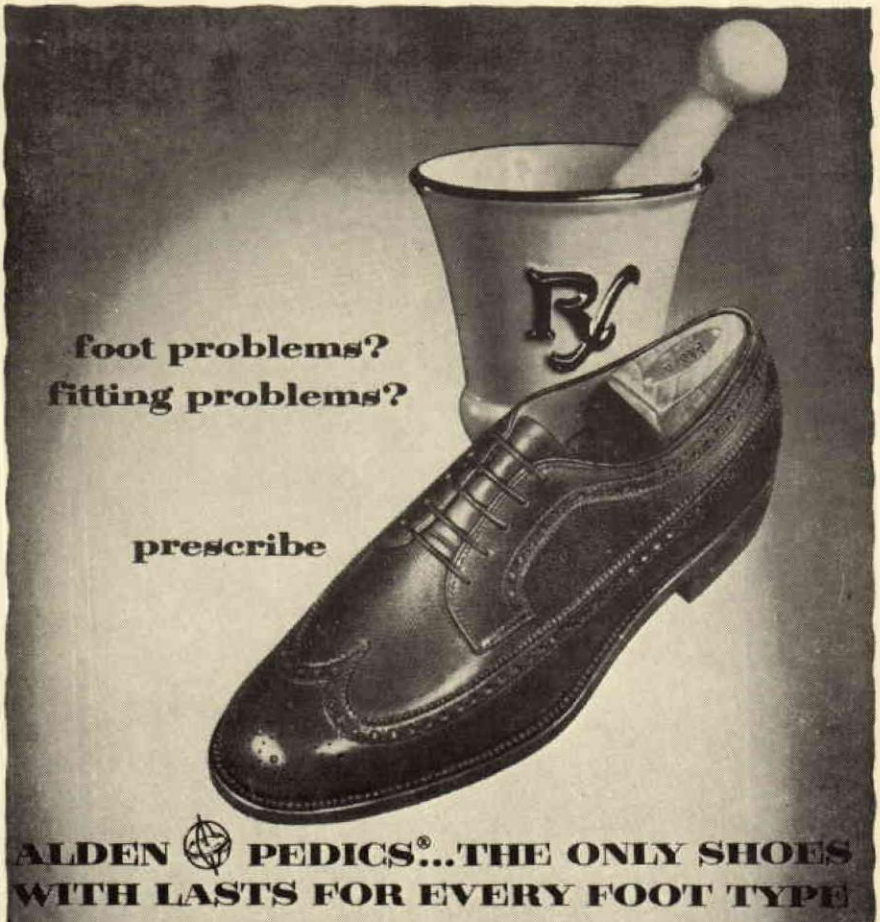
Orthotists	$125.00 plus
Laboratory Fee	100.00
Total Tuition:	$225.00

Dates:

Section A February 1-5, 1971
Section B March 15-19, 1971

Please address inquiries and requests for Application for Admission to:

Charles M. Fryer, M.A., Director
Prosthetic-Orthotic Center
Northwestern University Medical School
401 East Ohio Street
Chicago, Illinois 60611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