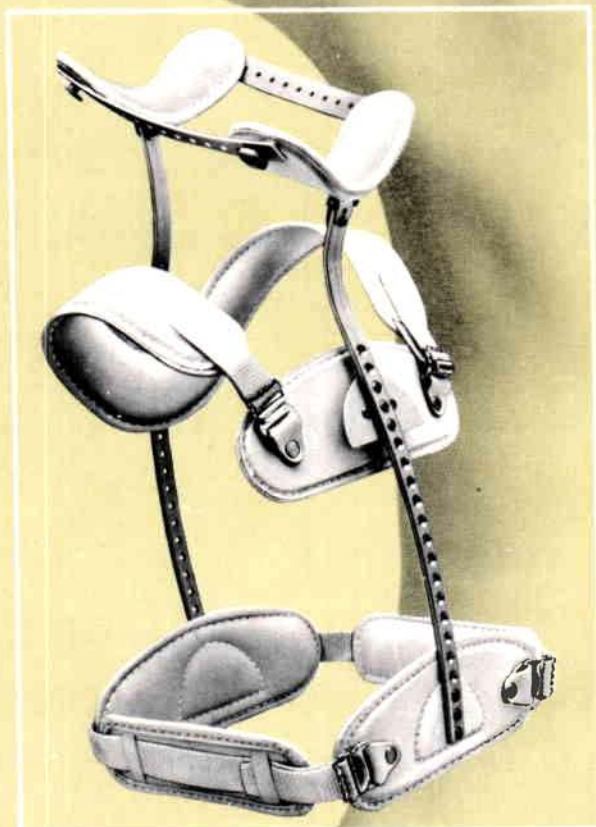


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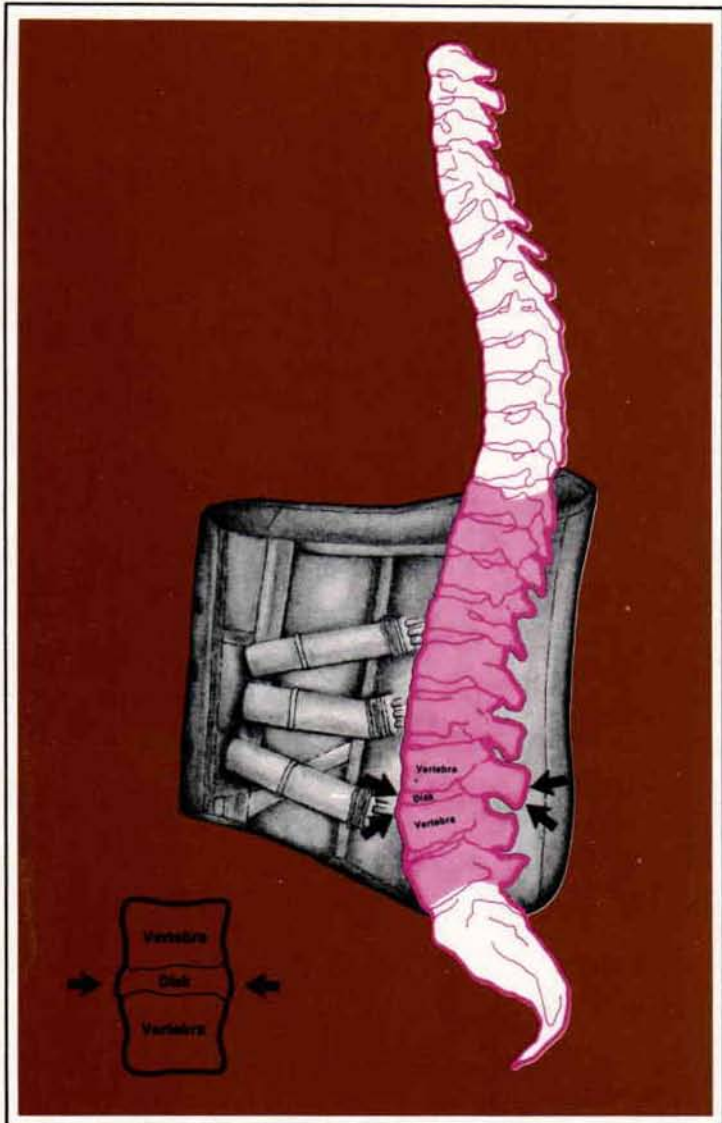
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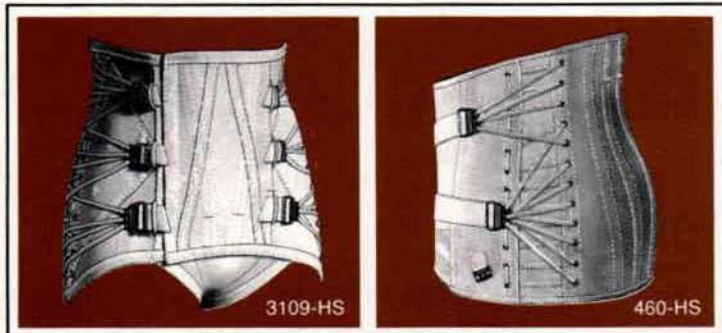
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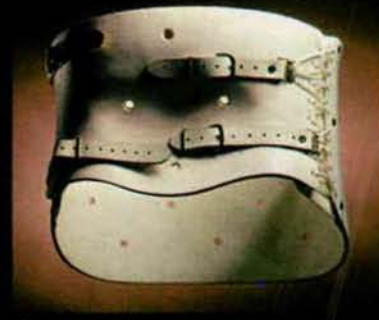
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Orthotics and Prosthetics

Editor

A. Bennett Wilson, Jr.

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1981, June 12-14, AOPA Region II and III Meeting, Host Farms, Pennsylvania.

1981, June 25-27, AOPA Region VI and Midwest Chapter of AAOP Meeting, Holiday Inn of Merriville, Indiana.

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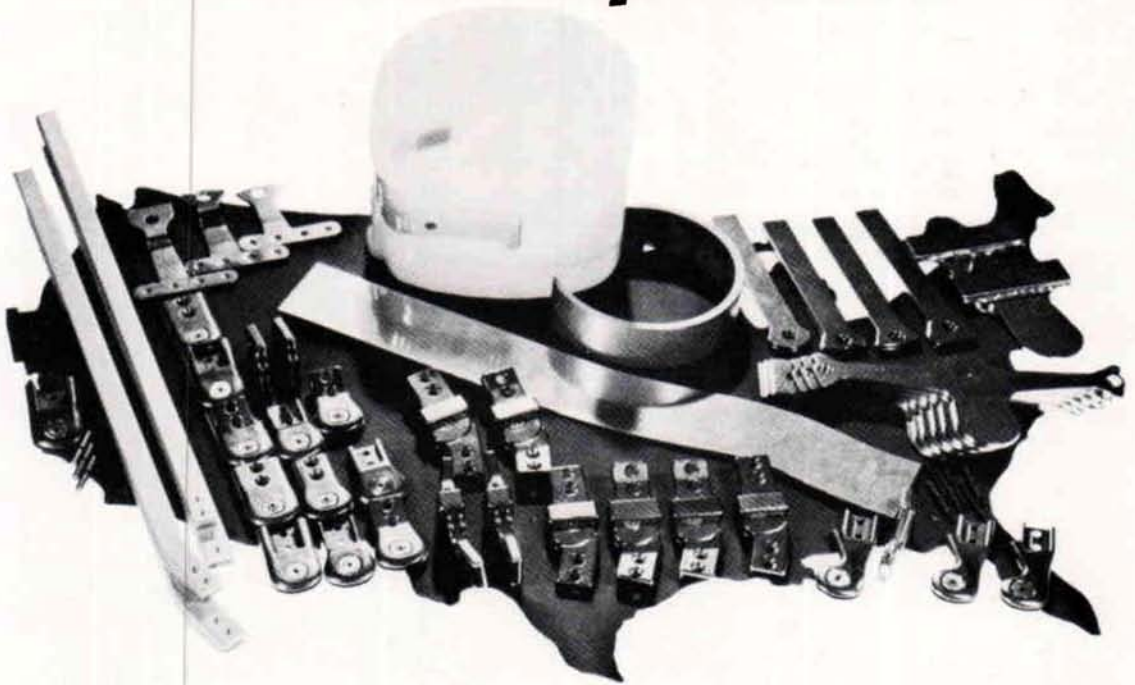
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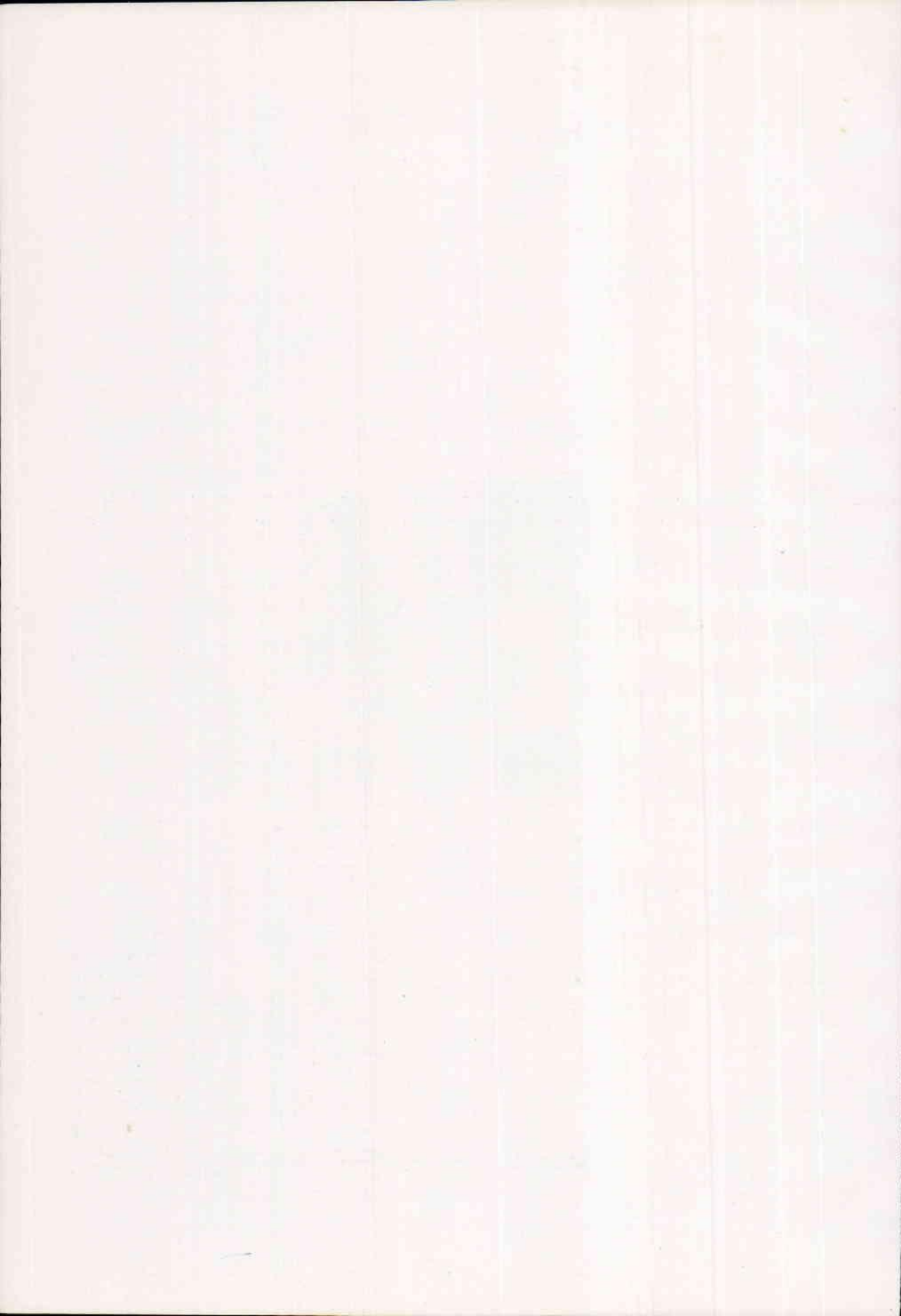
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Syme's Prosthesis—A Brief Review and a New Fabrication Technique

JON LEIMKUEHLER, C.P.O.¹

The traditional Syme's amputation is a disarticulation of the ankle with a transection just above the articular cartilage of the tibia. The heel pad is preserved and secured over the end of the tibia so that the body weight can be borne over the distal end of the stump (Fig. 1). In a similar amputation, Boyd's (1), the calcaneus with the heel pad intact is fused to the distal tibia.

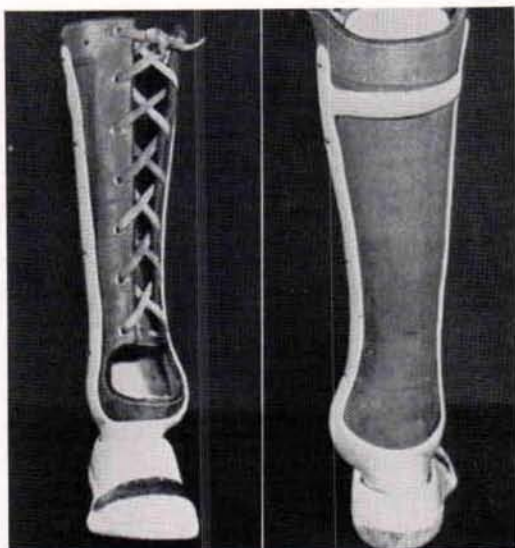
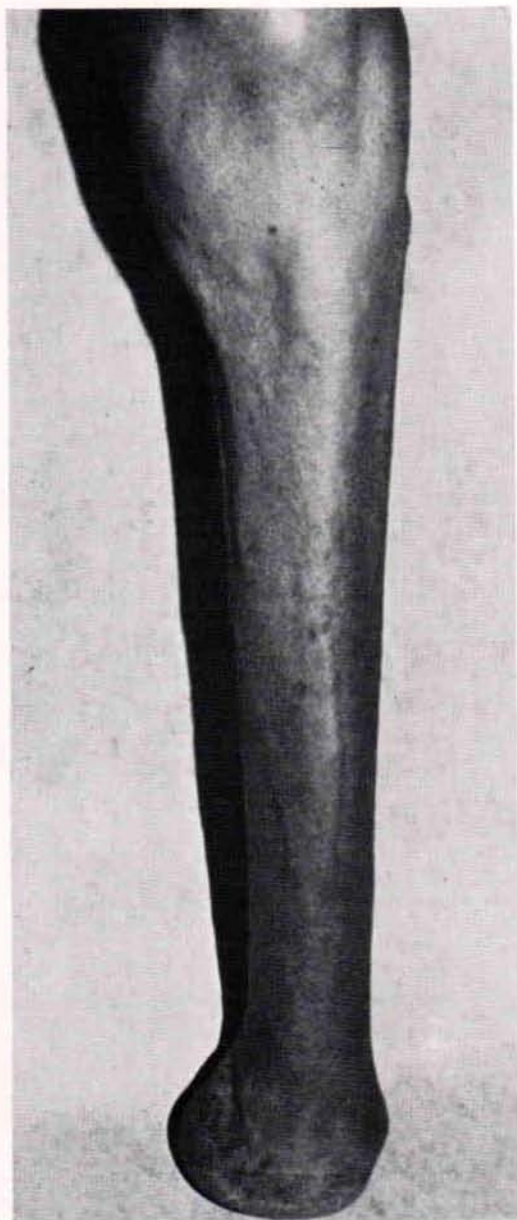
Syme's amputation was first described in 1843 by Sir James Syme of Edinburgh, Scotland (10,11). The procedure seems to have been accepted in many parts of the world but gradually fell into disrepute largely, some believe, because the original procedures were modified or forgotten as the years went by. The bulky prostheses (Fig. 2) required when metals, leather, and wood were the only suitable available materials did not provide much encouragement to surgeons to amputate in the region of the ankle. However, Syme's amputation did survive in Canada (5) where McLaurin, Hampton, and Foort (2,3,4,12) used polyester-and-nylon laminates in the design and fabrication of the Canadian-type Syme prosthesis (Fig. 3) in 1952 which resulted in lighter, stronger, and more cosmetic prostheses. Many modifications to the original design have been introduced through the years (7,8,9) but the basic principle remains.

The purpose of this paper is to discuss briefly these designs, and to explain a technique I have worked out for a good Syme's prosthesis.

Whether Syme's or Boyd's procedure is used, proper technique by the surgeon is critical to provide a stable heel pad and thus comfortable accommodation of the forces encountered over the distal end of the stump during standing and walking. The residual limbs resulting from each procedure are similar in appearance, both having a bulbous end that provides good weightbearing where a comfortable self-suspending prosthesis can be applied.

These types of amputation when carried out properly provide more function and comfort than a below-knee amputation. They allow the amputee to get from one point to another without a prosthesis. Fewer adjustments are needed to maintain a comfortable, well fitting prosthesis. I feel that the Syme's level of amputation is preferable over any other level. The only real shortcoming is the large ankle area which, for some women, presents a cosmetic problem.

Early Syme prostheses were made of a steel frame with a leather socket, (Fig. 2). This, of course, was quite heavy and bulky when they were strong enough to withstand the high forces generated during walking and running.



The original Canadian design (Fig. 3) used a posterior opening to permit insertion of the bulbous stump and the SACH-type foot was built around the socket. The Veterans Administration adopted immediately the Canadian con-

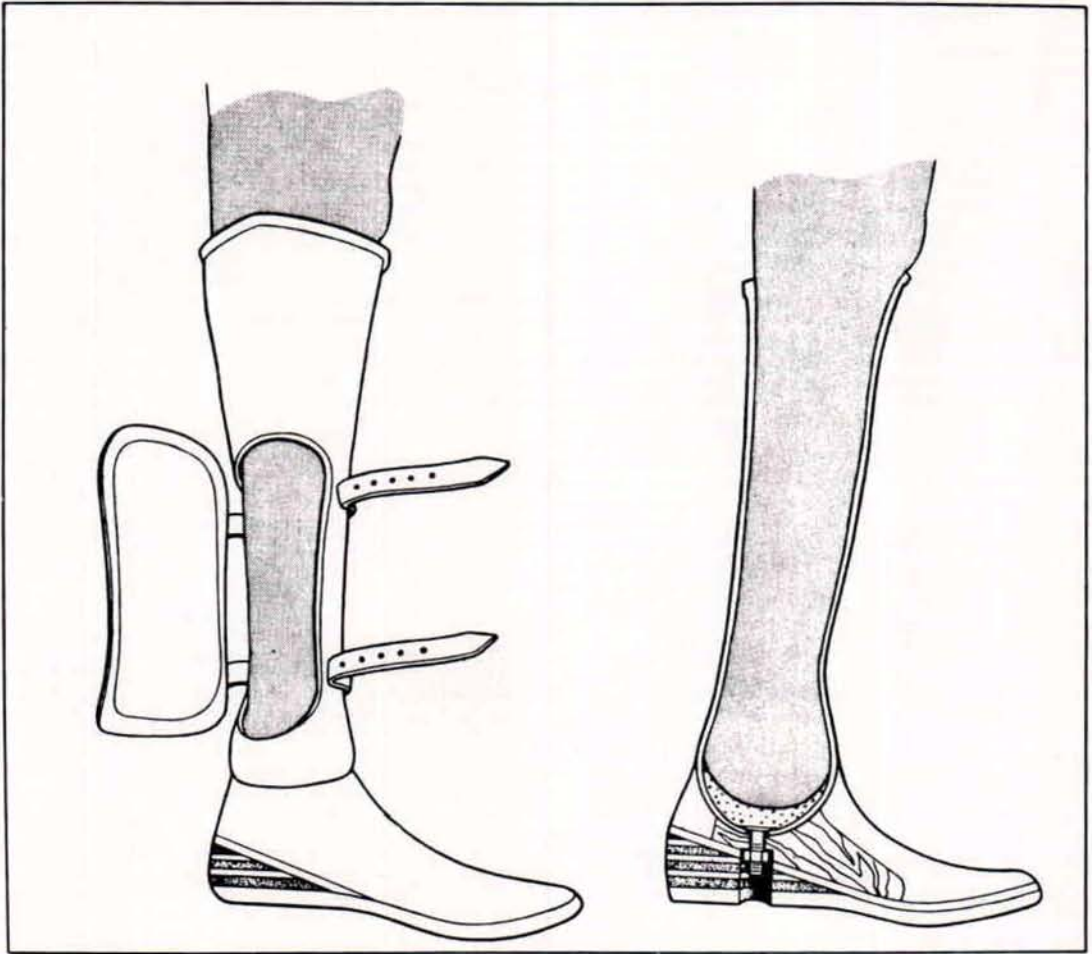


Fig. 4. The Canadian-type Syme prosthesis modified by VAPC to provide a medial opening.

cept and improved the strength and durability by developing a technique to provide a medial window (Fig. 4) (6). Manufacturers of the SACH foot later provided feet designed especially for Syme's prostheses.

A design that is tubular with no opening is, of course, stronger for a given weight, and designs were developed that eliminated this opening, but some cosmesis was lost. For smaller, bulbous ends, one design incorporates an expandable inner liner that is built up to fill in the small volume about the ankle to make it the same circumference as

that of the bulbous distal end, and thus provide suspension (Fig. 5) (9).

This system has the inner socket laminated with 385 Elastomer, a Dow Corning product, over the distal area to allow expansion for the large end to pass through. The proximal part of the socket and outer shell is laminated with polyester resin.

A partial medial insert (Fig. 6) (8) can also be used to provide suspension for a solid tubular socket.

These designs are useful and are well described in the literature. However,

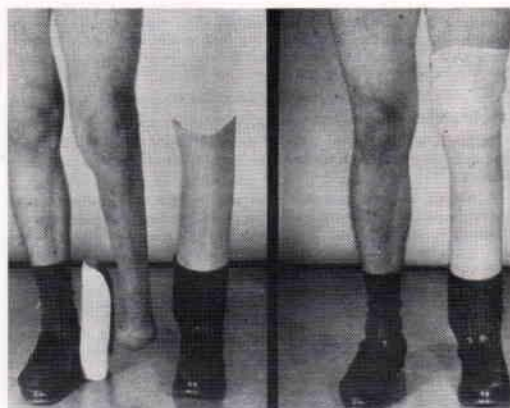


Fig. 5. Syme prosthesis using an expandable inner liner to provide suspension and avoid the need for a window in the socket. This type of socket is used mostly when the tibial condyles have been trimmed during surgery to provide a less bulbous stump.

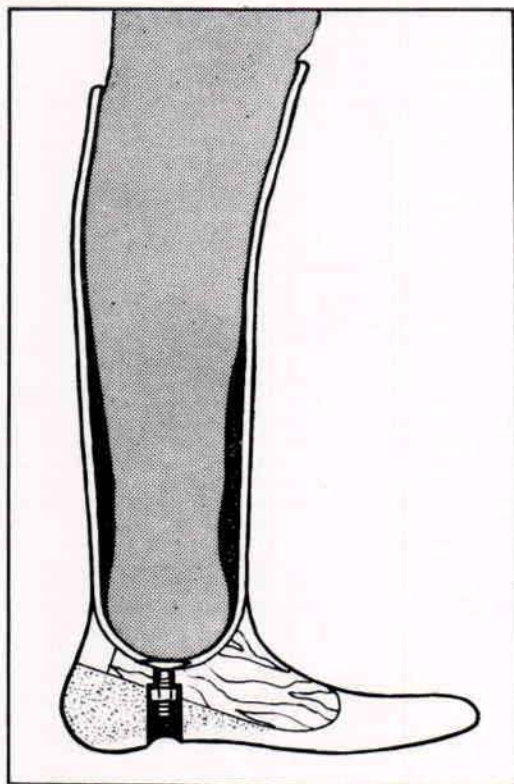


Fig. 6. Syme prosthesis that uses a medial partial insert to provide suspension yet avoid the need for a window to permit insertion. This type of socket is used mostly when the tibial condyles have been trimmed during surgery to provide a less bulbous stump.

they are more bulky than is desirable and a large bulbous end cannot be easily accommodated with these designs.

To create an acceptable Syme prosthesis, we must have the following:

- Properly fitting socket with easy access for adjustment
- Durable, strong socket-and-foot combination
- Light weight
- Ability to adjust alignment and length during fabrication
- Thin and cosmetic ankle area

The technique described below results in a medial-opening Syme prosthesis that fulfills the above requirements to a great extent.

Procedure

Begin by measuring the amount of limb-length discrepancy present with shoes off. Apply two cast socks on the stump to extend above the knee. While the patient is in a supine position on a table, outline the tibia, head of the fibula, and any other bony prominences. Apply 4-inch-wide plaster splints over the anterior half of the stump, and form a bead with the plaster along the edges.

Wrap one plaster splint around the stump; apply plaster at the ankle and again at the calf to hold the anterior section in place (Fig. 7).

Have the patient roll over onto his abdomen, and apply Vaseline or Murphy oil soap (in paste form) in a thin even coat to the entire posterior surface of the leg and $\frac{3}{4}$ inch over onto the anterior plaster.

Apply 4-inch-wide plaster splints to the posterior portion of the leg overlapping the anterior section by about $\frac{1}{2}$ inch. When the plaster has set, make keying marks over the edge of the plaster (Fig. 8) and remove the posterior section. Peel off the wrapped splints, and, with

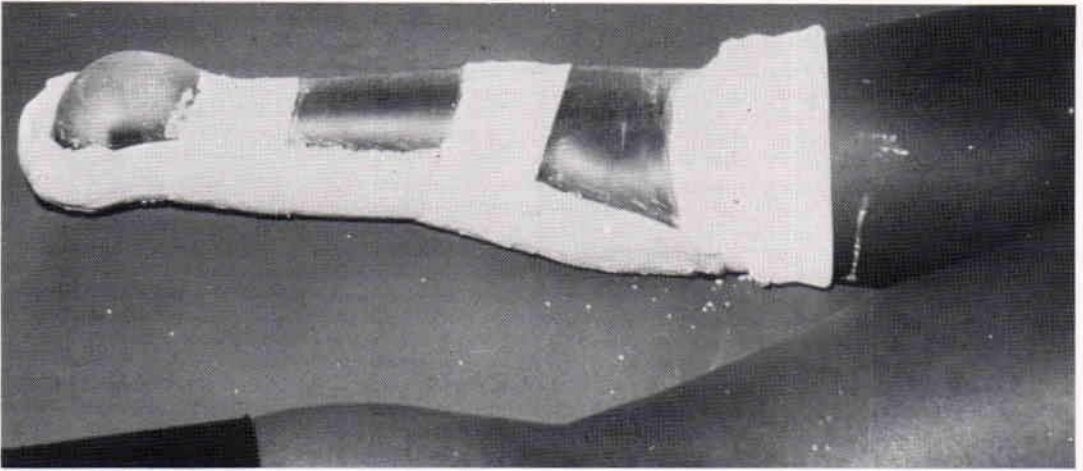


Fig. 7. Posterior view of the anterior portion of the cast in place.

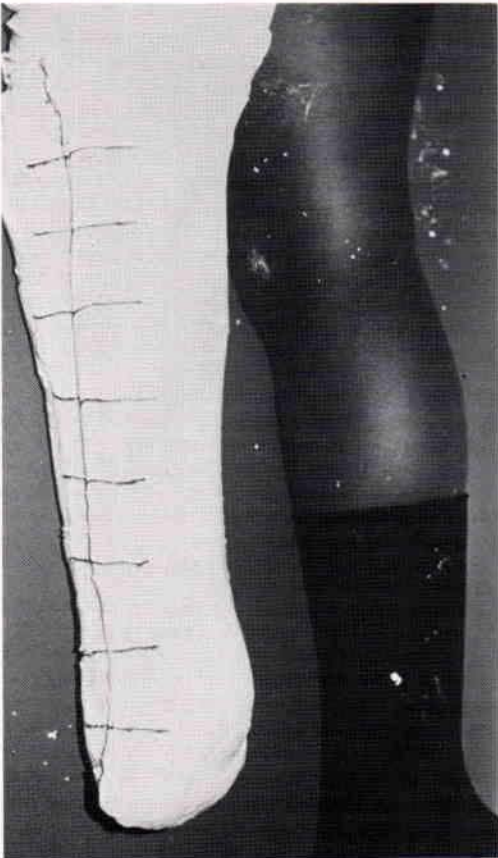


Fig. 8. Completed cast. Note the key marks.

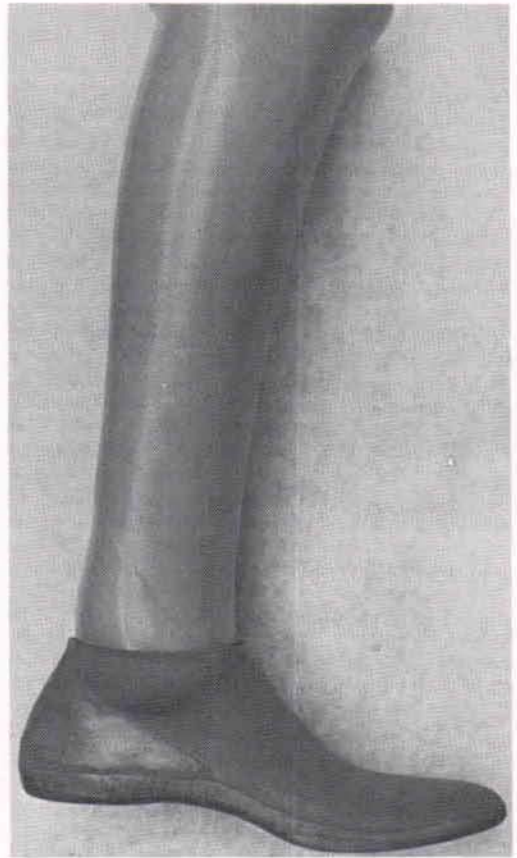


Fig. 9. Syme prosthesis using Kingsley-Syme-SACH foot.

bandage scissors, cut the outer cast sock to make removal of the anterior portion easier.

Secure the two halves with plaster splints and pour the positive model in the usual manner.

Cast Modifications

Do *not* provide for a patellar tendon bar in the cast. For a good endbearing Syme's amputation stump, weight does not need to be carried on the bar, which can present a possible source of irritation and discomfort.

Flare the popliteal area slightly. Position it $\frac{1}{2}$ inch lower than the tibial plateau to permit more knee flexion.

Build up bony areas for relief in the usual manner.

For medial opening, measure circumference of the bulbous distal end, move proximally and mark the cast at the point where the same circumference is found.

Measure M-L dimension at the distal end, move proximally and mark on cast the level where the same measurement is encountered.

Using these marks as a guide, outline roughly an opening on the medial distal area of the cast. Build up plaster to form a straight line along the outline from the calf to the bulbous distal end. This build-up will provide a gap along the sides of the medial opening to allow the bulbous end to enter the socket easier.

Checking The Fit

Make a check socket out of UVEX, polypropylene, or any other suitable material that can be thermoformed.

When fitting the check socket, keep the medial opening as small as possible and still allow easy entry into the socket. The smaller the opening, the stronger the socket will be. Check for good end-

bearing and proper fit for the rest of the socket. Be sure that more than 90 degrees of knee flexion can be obtained without forcing the stump up out of the socket. In general, the proximal trim lines are slightly lower than for a PTB prosthesis.

Correct the cast as needed and smooth it for lamination.

Socket Fabrication

Laminate the socket to be thin and strong. Listed below is the layup I use for an average size individual. For a large heavy person or for a socket that requires an unusually large medial opening, extra layers of fiberglass cloth and roving need to be added.

Standard Lay-Up For SYME Prosthesis:

- One-ounce dacron sleeve
- One fiberglass reinforced stockinet
- One full fiberglass cloth wrapped from proximal end to and over the distal end.
- One fiberglass reinforced stockinet
- One thick cord of roving from proximal anterior, over distal end, to proximal posterior end of cast. Cord of roving around door cut out, $\frac{1}{4}$ inch behind trimline. One fiberglass mat at distal end when using Kingsley foot for Syme prosthesis.
- One fiberglass reinforced stockinet
- Two pieces of fiberglass cloth wrapped at ankle and over distal end. One fiberglass mat at distal end when using Kingsley Syme's foot.
- Two fiberglass reinforced stockinets

Method When Using A Kingsley Syme's Foot (Fig. 9)

Build up distal end of cast to provide room for half-rounded Syme's nut adapter. Place buildup in position so that

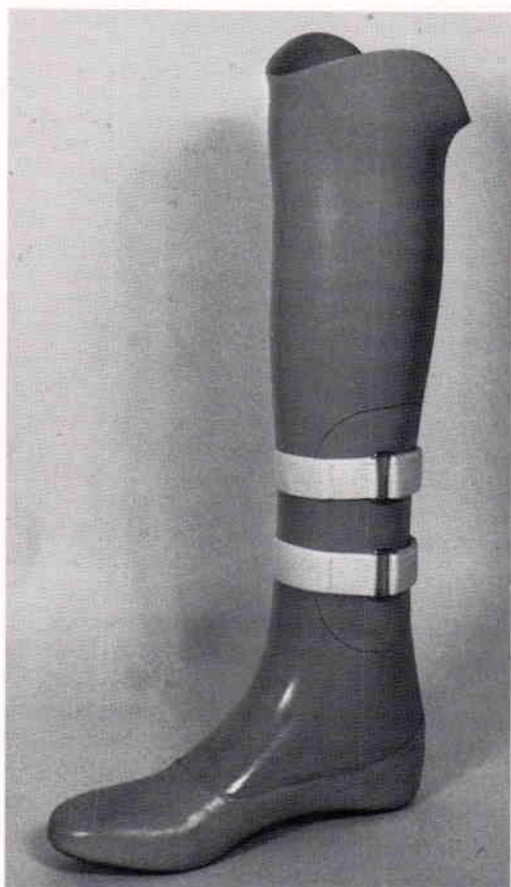


Fig. 10. Syme prosthesis using Otto Bock 1P5 Syme-SACH foot.

stump is aligned in slight flexion and adduction.

After the socket is completed, bolt the foot to the socket using a wood spacer inside the foot to maintain proper length and alignment. This spacer should be shaped like a small oval doughnut. When aligning the prosthesis, the wood spacer can be sanded or shimmed to provide proper alignment. Finish the socket as described later.

Using a strong filler (i.e. Cab-O-Sil or Solka Flock, etc.) thicken polyester resin and gunk the finished socket into the Kingsley Syme's foot maintaining alignment and length.

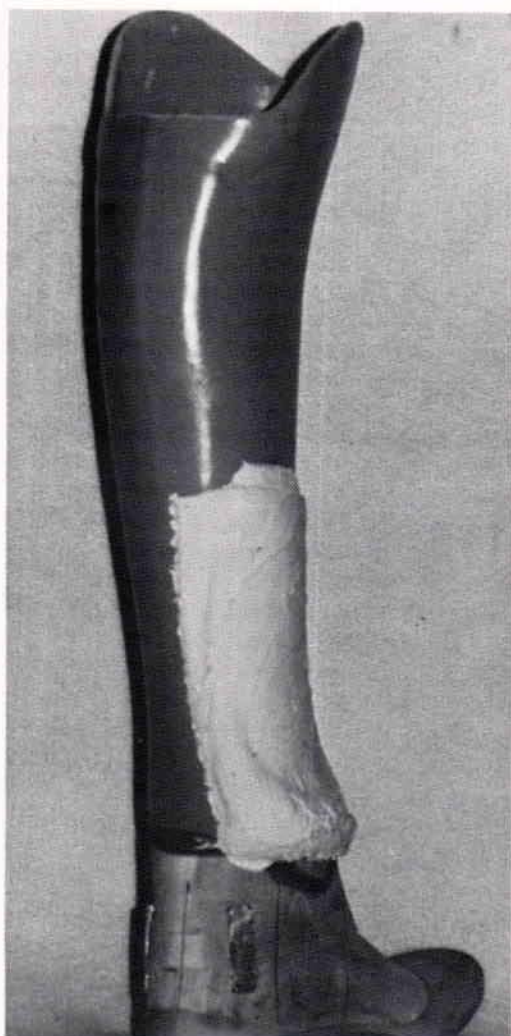


Fig. 11. Unfinished prosthesis with plaster splints formed in and over medial opening.

Method for Using Otto Bock 1P5 Syme's Foot (Fig. 10)

Set the socket in wood to the apex of distal end and level the socket in slight flexion and adduction angles.

Level the top of the foot.

Put foot on heel block of proper height and align socket of foot.

Keep foot as far laterally as possible in relation to the distal end of the socket

and still maintain a reasonable cosmetic appearance.

Position the socket in the A-P plane to provide an acceptable appearance from heel to socket and instep to socket.

Adjust height to exact length discrepancy measurement.

Using white glue (Elmer's) spot glue the socket to the foot temporarily.

Reinforce glue joint with #2 Scotch fasteners. The temporary glue joint can be broken by hitting the foot with a mallet. Wedging by sanding or addition of wood can be used to adjust alignment.

To finish, break apart the foot and socket and permanently fasten with glue while maintaining alignment. Reinforce glue seam with dovetails if desired.

When the lamination is completed, apply masking tape over the rubber part of the foot, and stretch standard PVA bag over the foot and socket. Be sure to extend lamination onto foot covering entire wood area.

Fitting the Prosthesis

Check the fit of the socket and height. Use an Ace bandage over medial opening to obtain suspension. Make all necessary changes for fit and alignment and try prosthesis on the patient again to be sure that optimum fit and alignment have been achieved.

Making Medial Opening Door and Finishing the Prosthesis

Put a smooth plastic bag over prosthetic socks on patient's stump.

Cover the shoe on the prosthesis for protection against plaster.

Have patient don prosthesis and stand up.

Apply 4-inch-wide plaster splints over medial opening overlapping onto socket. Contour and form tightly against the stump (Fig. 11).

Remove splint for later use. This medial door opening cover will suspend the prosthesis.



Fig. 12. Finished prosthesis when Velcro straps are used to hold medial door in place.

Roughen surface of socket except for $\frac{1}{2}$ inch on border around medial opening. This $\frac{1}{2}$ inch will be where the door overlaps onto the socket.

Reapply splint over medial opening and pour distal portion of socket with plaster and insert a pipe. Remove splint and smooth plaster at opening. Seal plaster and $\frac{1}{2}$ inch edge of socket with clear lacquer or some other suitable parting agent.

Layup for finish lamination as follows:

- Dacron felt or Dynalon over medial opening, extending $\frac{1}{2}$ inch onto socket.
- Four or more glass-tricot or some other reinforced stockinet over entire socket (and foot when using Bock foot 1P5).



Fig. 13. Finished prosthesis when an elastic anklet is used to hold medial door in place.

- Use only polyester resin for final lamination. Acrylic resin will adhere to the socket and the door over the medial opening and cannot be removed.

Using a sharp knife and a heat gun, cut out door $\frac{3}{8}$ inch from edge of medial opening.

To hold door in place use:

- Dacron webbing and Velcro straps (Fig. 12)
- Or a small elastic anklet (Fig. 13)
- Or a strong tape (i.e. filament tape)

Summary

The method discussed here is for a prosthesis for Syme's amputation with a large bulbous end. It utilizes a split casting procedure. Cast modifications do not have a PTB bar, but have a lower posterior flare and as small of a medial opening as possible. The medial door is made in the final lamination and provides an accurate fit and acceptable cosmetic appearance. It is important to be able to adjust length and alignment. Either the Otto Bock 1P5 foot or the Kingsley Syme's foot can be used.

Footnotes

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Hip Abduction Splint for Use At Night For Scissor Leg of Cerebral Palsy Patients

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One of the spastic leg positions in cerebral palsy is known as the scissor leg which is the result of continued hypertonus on the hip adduction muscles. The scissor leg is a serious disturbance for both children and parents. It contributes to disturbances in the development of physical functions such as rolling over and crawling. It can cause spastic hip dislocation or subluxation of the hip joint. Also, the compression provided by the scissor leg is a cause of torsio testis or urinary disturbance. Furthermore, it encourages the occurrence of dermatitis in the genital area.

In Tottori Kenritsu Seishi Gakuen (1751 Kamifukuhara, Yonago, Tottori, 683, Japan), thirty-seven patients (15 boys and 22 girls) between 4 and 16 years of age (average 10.9) were selected for study with the proviso that they were able to walk or stand using supporting instruments or braces. The roentgenograms of both hip joints were observed. Almost all of the center-edge (CE) angles on hip joints measured below the normal range, and 78.4 percent of them had dislocation or subluxation (Fig. 1).

For these patients, we used the hip action brace for the relaxation of hip adduction muscles during the day.

For use at night, we prescribed the conventional hip abduction brace or

the abduction board, but these devices interfered with change of position and were unclean because of nocturnal enuresia. Because the brace had many straps and parts, putting it on and taking it off were carried out with considerable difficulty.

To overcome these problems, we designed the splint shown in Figures 2 and 3 for use during the night.

Hip Abduction Splint for Use At Night

The Hip Abduction Splint for use at night has an arch-shaped pelvic band and thigh suspender made of Subortholen sheet, 3/16-inch thick. The outer side of the pelvic band is bent forward and surrounds the pelvis. A Velcro strap around the pelvis holds it in place. The thigh suspender (Fig. 4) is three-fourths of a cylinder, the opening being in the anterior-lateral section. A stainless steel turnbuckle between the thigh cuffs makes it possible to control the angle of hip abduction. Rivets are used to fasten the turnbuckle to the thigh cuff, and the thigh cuff to the pelvic band. All edges of the splint are flared toward the outside, eliminating the need for leather or sponge rubber liners. In the fabrication procedure, we measured only the circumference at the iliac crest and the thigh for each child on the drawing paper and,

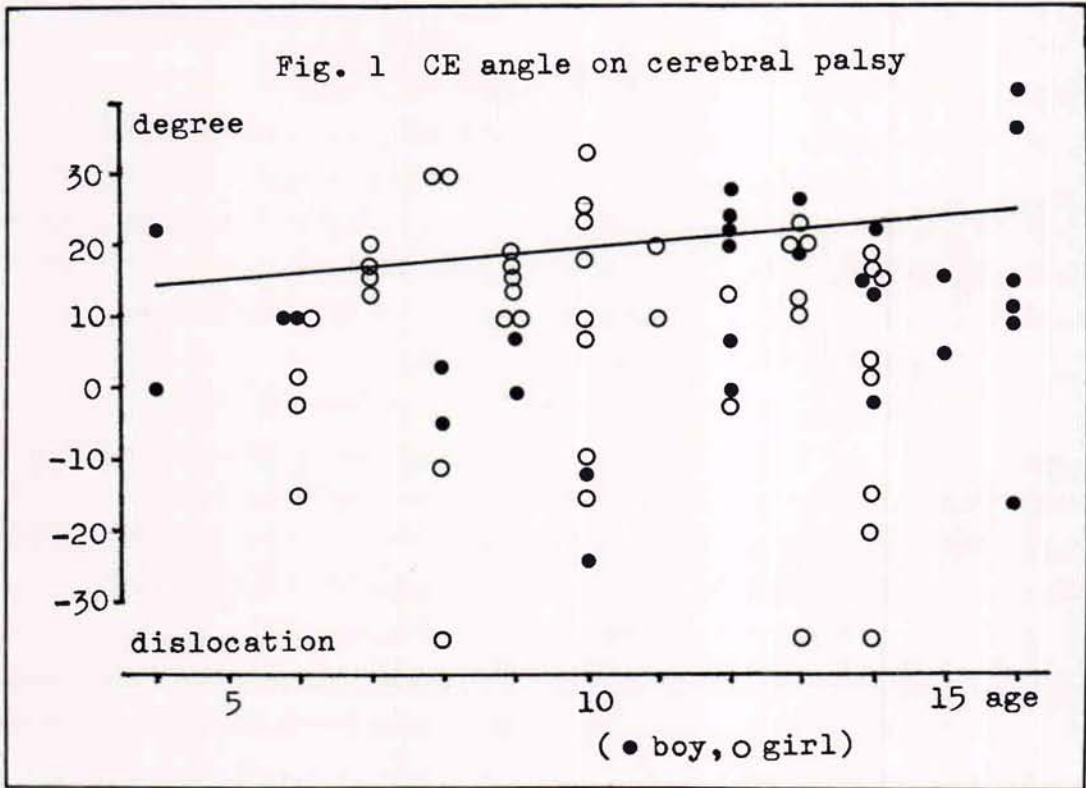


Fig. 1. Center-edge (CE) angle of cerebral palsy patients.



Fig. 2. Anterior view of Hip Abduction Splint for use at Night.



Fig. 3. Posterior view of the Night Splint. The stainless turnbuckle makes it possible to control the angle of the hip joint.

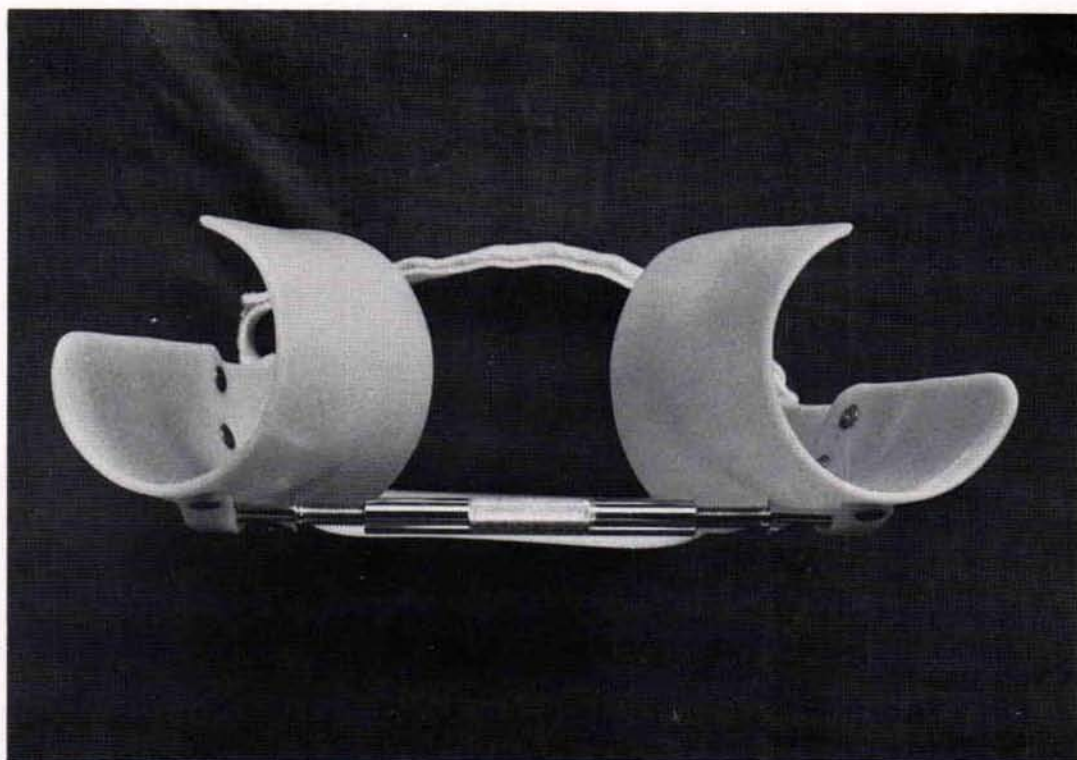


Fig. 4. View of bottom side of the Night Splint.

thus, eliminated the need for casting. For the purpose of fitting the thigh, the thigh cuff is heated by use of a heat gun and modified in shape and size as needed. The total weight is about one pound; far lighter than the common brace. Although this splint is not likely to fall off, it may do so in some patients. In the one case we experienced where it was difficult to hold the brace in place during changes of position, we were able to solve the problem by using Velcro straps on the thigh cuffs.

Clinical Experience

Seven children referred to in Table 1 were treated with the new splints for 16 months. The average CE angle of these

cases who had the scissor legs was 10 degrees, except for the case with complete dislocation. Cases 4 and 5 had sometimes complained of pain in both hip joints. Cases 1, 2, and 3 were bothered with the results of nocturnal enuresis, and all the cases had dermatitis or pigmentation in their genital area. The follow-up period was so short that we could not find any improvement of the CE angle or sphericity of the hip joint by roentgenogram, but the change of position in bed was considered to be smooth and the genital area was kept clean. As the contractures of the adductors were improving steadily, it was easier to passively abduct the hip joints. As shown in Figures 5, 6, and 7, the centralization

Table 1 Cases treated with the splint

No.	Name	Sex	Age	Type of CP	CE angle	
					rt	lt
1	T.K.	m	4	spastic	22	2
2	M.M.	f	7	spastic	lux.	-10
3	K.T.	m	7	spastic		
4	Y.R.	f	8	spastic	15	15
5	K.N.	m	12	spastic	17	20
6	Y.K.	f	14	spastic	lux.	20
7	S.A.	m	15	spastic	2	20
8	K.N.	m	16	mixed	13	-15
					Ave. 10	
					(degree)	

of the hip was good with this splint. Furthermore, their parents and nurses were pleased because it was easy for them to clean the orthosis and to put it on and take it off.

Summary

The methods of treatment for scissor leg should be selected according to the grade of the hip centralization. The

grades consisted of (1) normal hip joint, (2) subluxation, and (3) luxation.

The cases treated with the surgical therapy, for example, the obturator nerve resection and the adductor muscle release operation, it was difficult to determine the indication, and the results were not consistent. Therefore, we treated them by using the abduction brace first.



Fig. 5. Anterior view of Night Splint on the body.

Observing the scissor leg of the CP patients, we found the following features; one, the tonus of the adduction muscles were always superior to that of abductor, mainly medial gluteal muscle, and the force abduction with the excess power only increased the tonus of adductor but with no other effect; two, the muscle relaxed relatively during sleep and the relaxation was increased by the ability to freely change position in bed.

Because the power of the abductors with the common brace was too strong, the reflex tonus of the adductor increased and the changes of position were disturbed. The common braces became dirty as a result of nocturnal enuresis and sweat and caused contact dermatitis.

To overcome these problems we designed the Hip Abduction Splint for use at night.

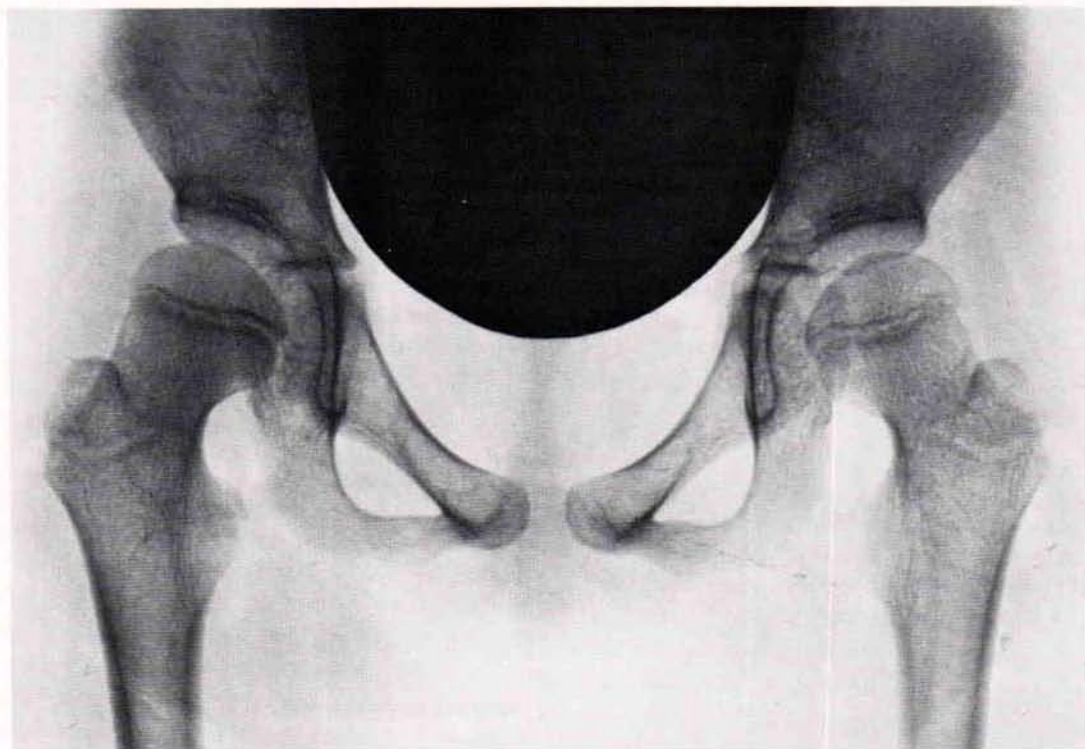


Fig. 6. Roetgenogram of the hip joint without splint.

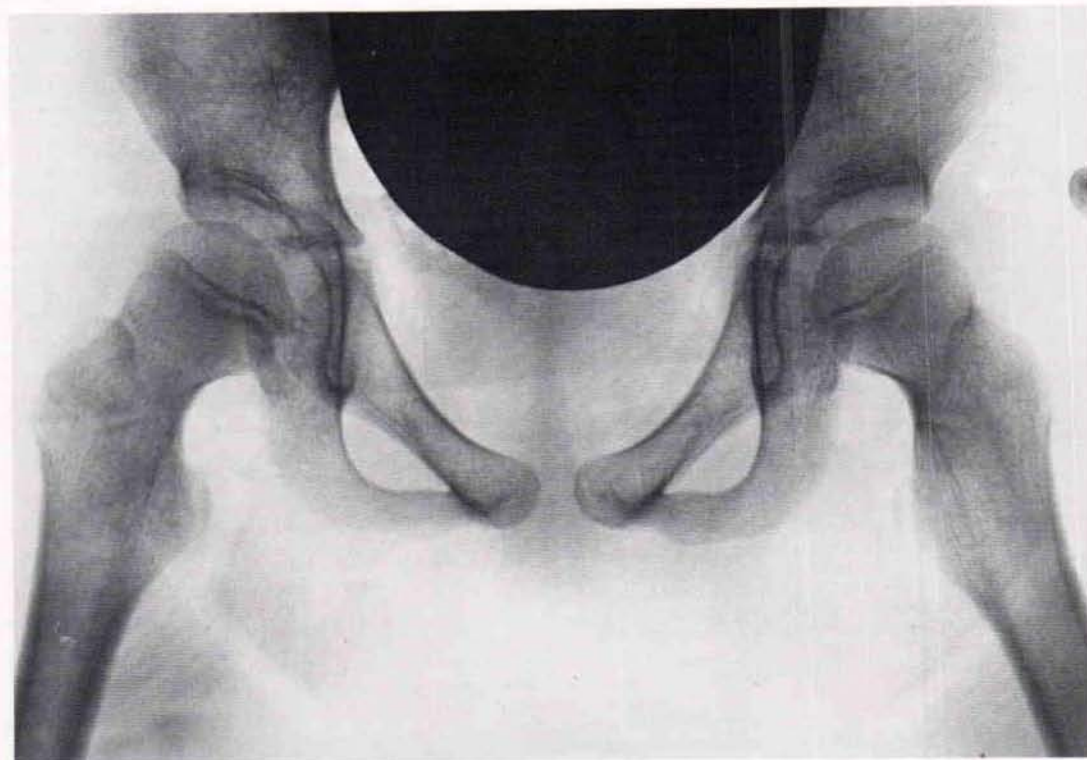


Fig. 7. Roentgenogram of the hip joint with the splint in place. Note that the centralization of the hip is improved.

The advantages of the new splints:

- (1) simple structure
- (2) easy doning and doffing
- (3) excellent durability
- (4) light weight
- (5) easy to keep clean

The disadvantages are:

- (1) correction of rotation not possible
- (2) less strength than the muscle power of the older patients

When we could not find improvement of the contracture of the adductors or of the abduction angle with this splint, we felt that surgical treatment was indicated.

Conclusion

We reported that we designed and used the new Hip Abduction Night Splint which is superior to the braces commonly used. This splint had many

advantages for rehabilitation of the children with cerebral palsy.

Footnotes

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THE CONNECTION¹

A. BENNETT WILSON, JR.

The functions provided by the connection between an amputee and his artificial leg are primarily: transfer of weight-bearing loads to the ground through the distal portion of the prosthesis; the transmission of power from the body to the prosthesis for actuation and control of the prosthesis; and the provision of suspension of the prosthesis when it is not in contact with the floor or ground.

The only successful way of providing these functions to date is by means of a tubular, cup-like receptacle, known as "the socket", that encases the amputation stump. Sometimes all or part of the suspension function is provided by straps over other parts of the body.

No single factor is more important in lower-limb prosthetics than the relationship between the amputation stump and the socket. Proper fit has yet to be defined quantitatively. But the most sophisticated mechanical components are of little use when the artificial leg is attached to the patient so loosely that control is inefficient. Conversely, when, in an effort to provide stability, the socket fits so tightly as to restrict blood flow in the stump, the prosthesis must soon be abandoned.

The most significant contributions of the American and Canadian research programs in limb prosthetics (Wilson 1970) are considered by many to be socket designs, methods of socket fitting and fabrication, and principles of pros-

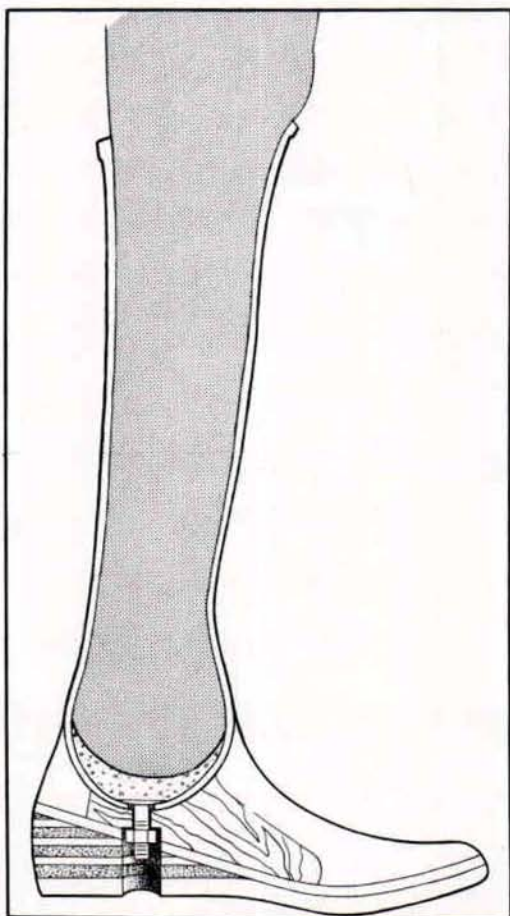


Fig. 1. Cross-section of plastic Canadian-type prosthesis for Syme's amputation.

thesis alignment. The outstanding examples are Canadian-type Plastic Syme's prosthesis (Fig. 1) and its variants, the patellar-tendon-bearing (PTB)

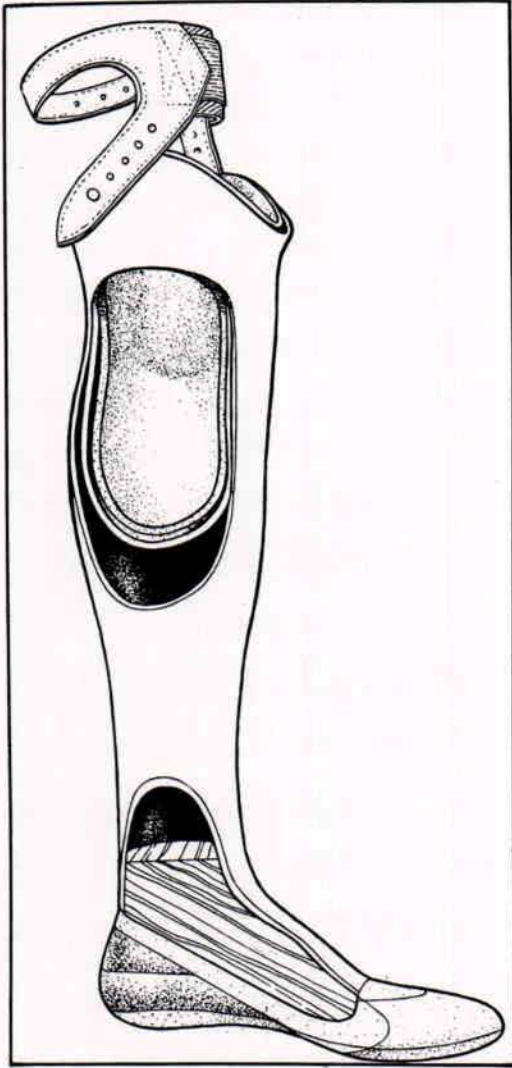


Fig. 2. Cross-section of standard patellar-tendon-bearing (PTB) prosthesis developed at the University of California, Berkeley and San Francisco.

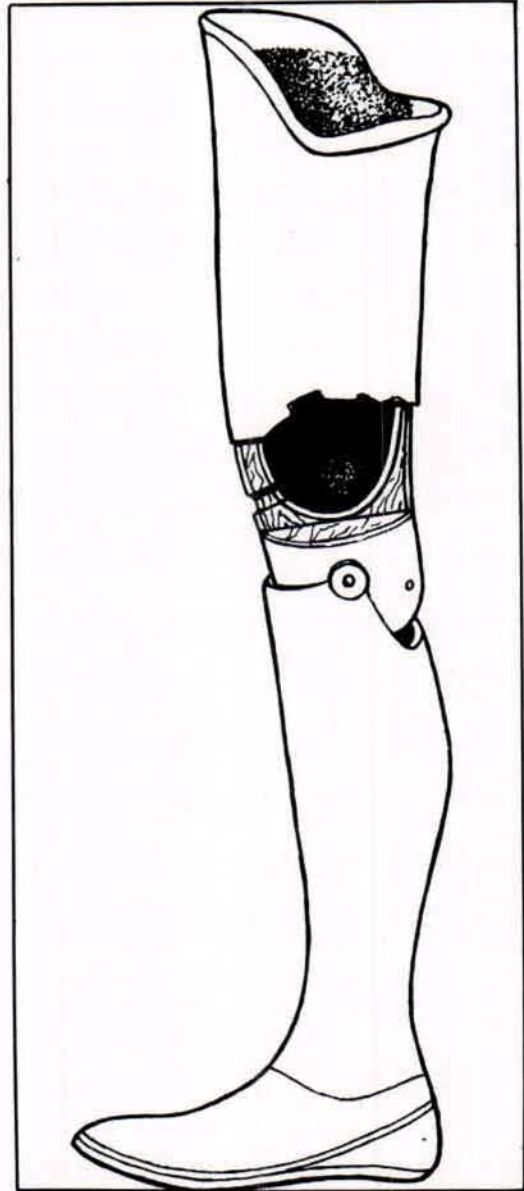


Fig. 3. Total-contact, quadrilateral socket for above-knee amputations developed at the University of California, Berkeley and San Francisco.

below-knee prosthesis (Fig. 2) and its variants, the quadrilateral sockets (Fig. 3) with and without suction, with and without total contact for above-knee amputees, and the Canadian-type hip-disarticulation (Fig. 4) and hemipelvectomy prostheses (Wilson 1968, 1969, 1970).

The instructions set forth in manuals used in educational programs, when followed closely by skilled prosthetists, result in adequate prostheses for patients

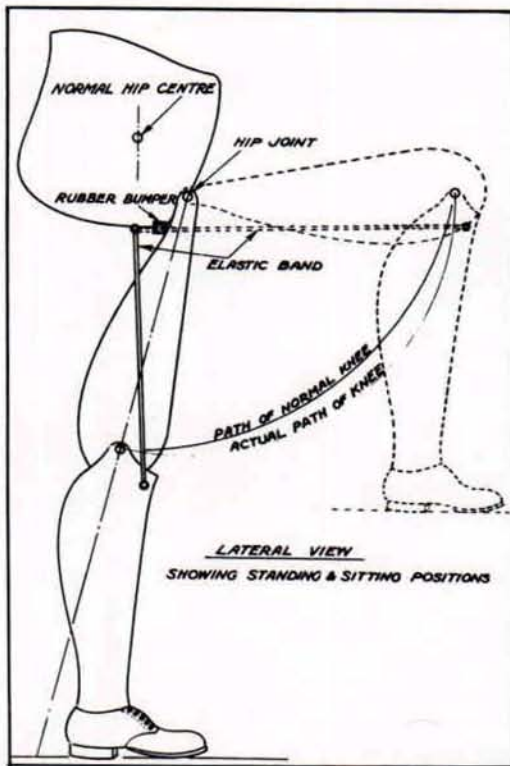


Fig. 4. Schematic of the Canadian-type hip-disarticulation prosthesis.

without other complicating factors. However, complicating factors which tax even the most competent prosthetists are often present, and if, for no other reasons, methods for providing sockets that meet more adequately the demands of all amputees are needed.

Socket Design

To provide better criteria for socket designs, it seems obvious that we need to know a good deal more about the mechanisms of edema and the circulation of body fluids than we do at present. One reason we lack knowledge in these areas is that we do not have the means to measure efficiently the pressures between the stump and the socket, or the methods of measuring effectively the results of the application of pressure.

These problems have been recognized for many years, and some efforts, though with little useful results, have been made in determining the distribution of forces over the amputation stump (Appoldt 1969, 1970). Pressure transducers that have been used to date have been either unreliable or used improperly, and up to this point few ideas have been set forth in reference to practical ways to measure the effects of pressure on the soft tissues of an amputation stump (CPRD 1972).

Several independent developments have taken place through the years that, if combined, might lead to relatively inexpensive studies that might in turn lead to improved connections between patient and prosthesis.

One of the deterrents to studying the effect of changes in socket shape on the amputation stump has been the cost of making individually tailored sockets, and fitting and aligning them with other components to provide prostheses suitable for experimental purposes.

The dilatancy technique for taking impressions of amputation stumps has been refined in recent years, especially by Germans et al. at the Medical Physics Institute in Holland, and Hagglund in Sweden. This technique offers a very inexpensive way of obtaining casts and models of stumps, for the production of experimental sockets (CAL 1947, Koster 1972), Hagglund 197) (Fig. 5).

The work of Snelson & Mooney (1972) has shown that for practical purposes not only can the time required for lamination be eliminated, but a transparent socket as well can be had quite inexpensively by vacuum-forming techniques (Fig. 6). A transparent socket clearly offers the opportunity not only for visual observation, but also an opportunity for the investigators to ensure that the pressure transducers are always in the same location and that the socket is

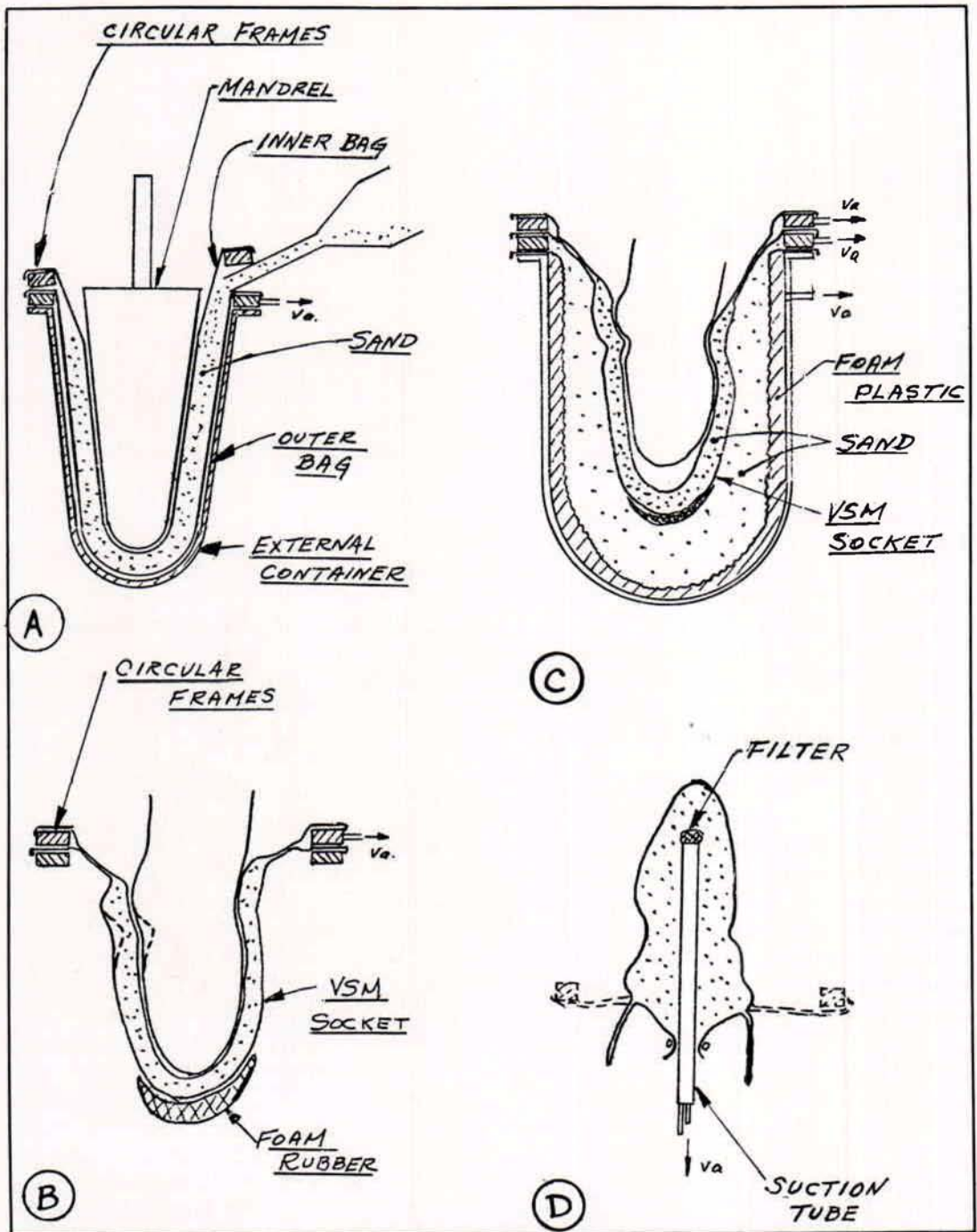


Fig. 5. Steps in dilatency casting of stump and production of a positive model.



Fig. 6. Vacuum forming a transparent socket for a below-knee prosthesis.

in the same relationship with the stump during each trial (Fig. 7).

Lightweight, inexpensive, endoskeletal components for lower-limb prostheses that permit all adjustments required for proper alignment are now available commercially (Wilson 1968, 1969), so that, coupled with dilatancy-casting and vacuum-forming of sockets, a feasible means of providing many experimental socket shapes for the same group of subjects is readily available.

A few years ago the pressure transducers considered useful for measuring pressure between the stump and the socket cost more than \$300 per unit, and the area covered was less than 1.28 cm². There is some question about the size of the area that will provide a useful measure, but certainly 1.28 cm² is too small to be practical or desirable, even when the pain threshold is not exceeded.

An approach not yet tried scientifically is the measurement of forces over components of a segmented socket. It would seem that this is a more logical approach than measuring pressures over pinpoint-size areas.

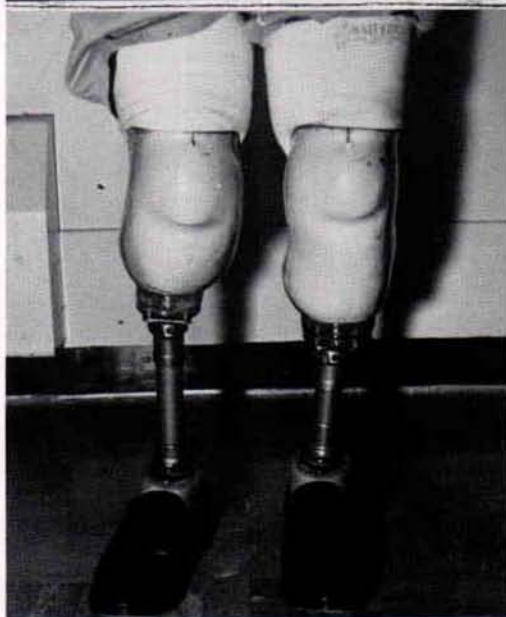


Fig. 7. Transparent sockets fitted to a bilateral below-knee amputee for extensive checkout.

Visual observation through a transparent wall of a socket will of course help in observing the outward effects of pressure on the soft tissues of the stump, but it would seem that one of the most logical methods available to measure and record these effects is the Thermograph

camera (Brand 1969, 1970). A complete record of skin temperatures can be made very rapidly by use of thermography without danger or discomfort to the patient. Brand, in working with leprosy patients, has pointed the way for use of this technique.

Another development that has been suggested over the years, and one that is gradually being learned about, is the use of inflated pads on the inner surface of the socket to provide an adjustable range of pressure. Newer materials and more awareness of the way inflated units work, coupled with the suggestions given above, should make this approach more attractive as time goes on.

New sheet plastics that have better properties seem to be introduced rather constantly. Yet polypropylene, polyethylene, and other materials have not been tried thoroughly, although they are used in orthoses routinely in some institutions. Their combination of flexibility and tensile strength seems to have much to offer when studying the advantages that might be provided by socket walls that have a stiffness gradient—one that becomes more flexible in the proximal direction (Murphy 1960).

Surgery

It has been stated many times that surgical procedures have a great effect on the stump and the consequent fitting of the socket. This of course is true especially in reference to invaginated scars and obviously poorly placed incisions. Not so clear are the advantages of myoplasty, myodesis, and osteoplasty (Burgess 1969, Dederich 1970, Loon 1962, Swanson 1966, Weiss 1971). We all have our clinical impressions, but to date no one has carried out a scientific evaluation of these techniques. This is most unfortunate because the means of doing this are available.

Not so easy to assess is the idea of "skeletal attachment", or the connection of the prosthesis directly to the long bone of the amputation stump. This idea is not new, but if it would be made practical, the connection problem for the majority of amputees would be solved, and the engineers could devote more time to the design of other mechanisms and components.

The problem can be divided into two parts: attachment to the bone, and the exit through the skin and the superficial soft tissues.

The first reference to skeletal attachment came from Germany (Cutler 1945, Murphy 1960) in 1945 but little work seems to have been carried out since then in any place but the United States. Esslinger (1970), influenced by Stone's work with the human eye, showed that certain Silicone compounds were compatible with both osseous and soft tissues, and he had some success with percutaneous plastic strips staying in place along the backs of dogs, but did not collect sufficient data to make follow-up studies of his techniques attractive. Hall* used Dacron velour in treating a horse with some success. Mooney (1971) has been experimenting with ceramic structures and vitreous carbon as the percutaneous materials.

In all of the experiments, encouraging results have been obtained. It is, of course, difficult to find human subjects for these kinds of experiments, and animal studies leave much to be desired. Nevertheless, research in skeletal attachment of external prostheses is encouraging and should be supported.

Summary

The need for improved designs for sockets for artificial legs is stated, and suggestions for research that will lead

to more functional connections between the patient and the prosthesis are set forth.

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A Modular, Prefabricated Orthosis for Treatment of Elbow Flexion Contractures¹

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M. H. BOBLITZ²

R. W. ROSENBERGER, C.P.²

A simple and adjustable orthosis has been designed and several prototypes have been built to aid in increasing the limited range of extension available in disability involving flexion contracture at the elbow. The present prototype, positioned 5 degrees larger than the angle of maximum passive extension, applies a small extension moment to the arm, slowly lengthens the musculature, and leads to a gradual decrease of the contracture. When used in conjunction with therapy it helps maintain the benefits achieved by daily stretching exercises.

Key design features include modularity with discrete, easy to fit and adjustable components that are compatible with anatomical constraints—without left or right sided parts—simplicity, cosmesis, and low cost.

As a result of research and development in upper-limb orthotics in the past two decades, restoration of useful function in upper extremity motor impairment has been much improved. Efforts at such institutions as the Texas Institute for Rehabilitation and Research, the Rehabilitation Institute of Chicago have resulted in the development of the modular concept with emphasis on lightweight finger prehension orthoses. However,

despite the many available functional devices an acceptable orthosis for the prevention of upper limb deformity due to elbow contracture has not yet been achieved. Flexion contracture at the elbow in particular is disabling in itself and is a difficult problem to correct (6). In certain spinal cord injuries this contracture may lead to reduced patient mobility by preventing reach to the propulsion handrim of the wheelchair.

This paper presents the design and the application of a simple adjustable orthosis designed to prevent and help correct contractures at the elbow. The prototype has been fabricated in three sizes for application by clinicians. Clinical trials are now underway.

Methods of treatment of elbow flexion contractures may be surgical or they may be non-operative. Surgery involving tenotomy to lengthening the biceps tendon has been successful in improving arm function in paralytic diseases other than spinal cord injury (5). Another surgical technique, using percutaneous electrodes, has also been successful. Mooney (4) implanted electrodes to stimulate the extensor muscle group and reduce the muscle imbalance that caused the flexion contracture at the joint.

Among the non-operative methods, serial or wedge casting of the patient's arm in forced extension has been used with success. However, the weight and bulk of the cast, the pressure sensitivity and inaccessibility of the skin are real shortcomings of this method. Traction is another non-invasive treatment that has been tried (7). Unfortunately, traction requires stationary positioning of the patient in a bed or chair which in spinal cord injury cases, may encourage formation of pressure sores and thus is seldom used.

Orthotic devices to correct elbow flexion contractures have been described as well. Goller and Enders (2) have used a dynamic plastic elbow-extension orthosis on five patients with moderate success for an average of 15 degrees reduction in flexion contractures. More recently Green and McCoy (3) have described a turnbuckle orthosis which accomplished in 12 patients an average reduction in deformity of 37 degrees in an average treatment period of 20 weeks. This custom-fitted orthosis has been tried in existing short term contractures of traumatic fracture origin where little or no impairment of skin sensation was present.

Expected Benefits

The orthosis at the University of Virginia Rehabilitation Engineering Center was developed with the expectation that this modular system will make the correction and prevention of an elbow flexion deformity easier to be resolved by the therapist. It is hoped that the availability of three sizes in stock components will make possible the application and fitting of the orthosis by the therapist immediately upon need in the hospital setting.

It is assumed that this orthotic system will be worn by the patient during non-therapy sessions and, thus, maintain the increased elbow extension achieved in



Fig. 1. Elbow extension orthosis used by a C5-6 tetraplegic individual.

therapy. The orthosis is expected to benefit any disability involving a flexion contracture at the elbow with particular emphasis on C4-6 quadriplegia, brain injury, burns, and some forms of rheumatic diseases.

Description

The modular orthosis (Fig. 1) consists of a biceps cuff and a forearm cuff, each with Velcro straps, a leaf hinge with a protective sleeve, and two "book-binder" screws. The cuff type can be distinguished by its shape and the number of Velcro straps. The biceps cuff has only one strap while the two straps of the forearm cuff are fastened to each end.

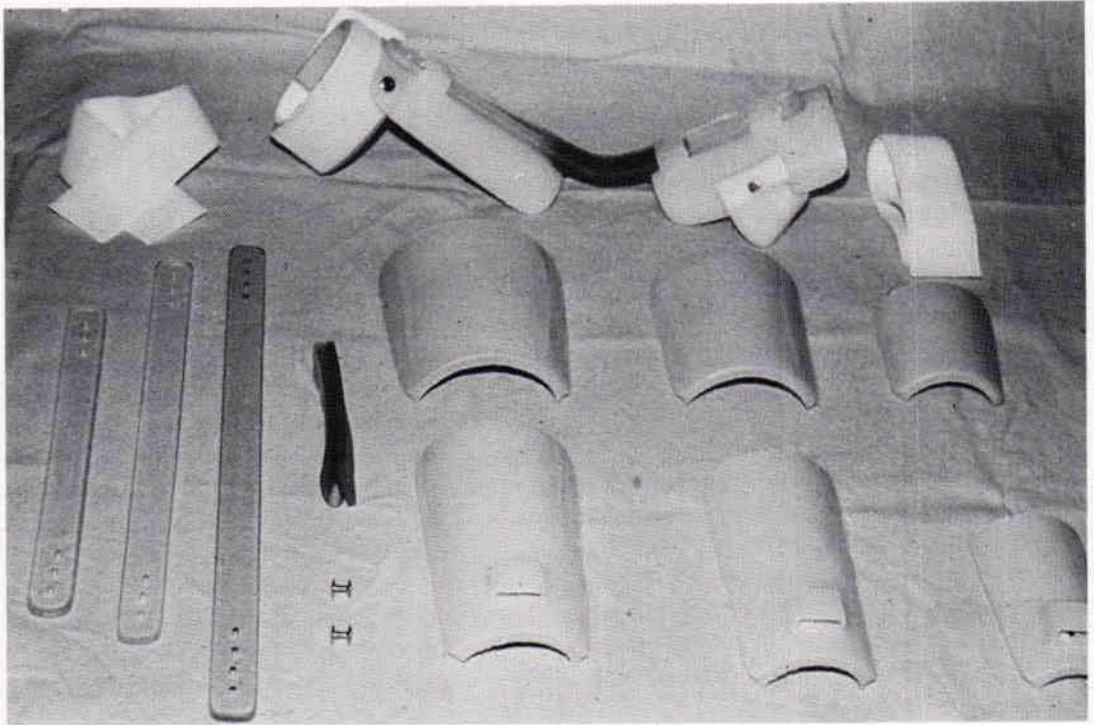


Fig. 2. Three sizes and interchangeable components of the modular adjustable orthosis.

Each cuff type is available in three sizes; small, medium, and large.

The leaf hinge is a thermoplastic material also available in three sizes. The large leaf hinge (46 centimeters long) with four screw holes at each end are made of acrylic and available in two lengths of 38 and 30 centimeters. Figure 2 shows an assembly and the interchangeable three sizes of the components. The "book-binder" screw is a two piece fastener consisting of a slotted threaded screw and its base nut.

Initial designs used the three-point principle for application of correcting forces to the upper limb with the olecranon area as the central point. This principle was abandoned because the pressure applied at the center was such that it could result in skin breakdown.

The current design uses force couples based on the four-point principle acting on the arm segments and produces a constant extension force from the spring action of the plastic hinge. The force application is shown on Figure 3. It can be seen that elbow extension is maintained by application of slight pressure to the arm.

To prevent tissue ischemia, the applied pressure must be less than the capillary pressure of 40 mm Hg. When the angle of the brace is larger than the angle of the arm with the contracture arm the brace must bend when applied. The resulting deflection of the leaf hinge will generate the applied force necessary for the extension moment across the elbow joint. For a brace angle of 5 degrees greater than the contracture angle, the

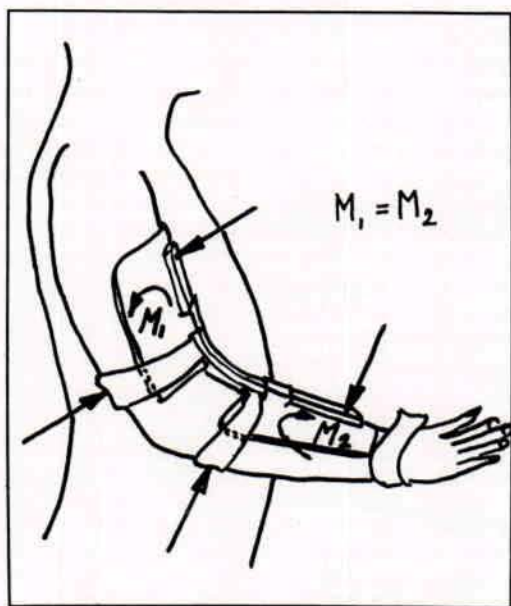


Fig. 3. Four point principle of elbow extension orthosis, showing moments M^1 and M^2 maintaining extension. The orthosis can be adjusted by heating the hinge strap with a heat gun.

applied force, using medium size components, was measured to be 4 lbs. and was calculated to be less than 20 mm Hg of pressure applied to the skin.

Application

Patient Selection

The orthotic system is an adjunct to the patient's therapy treatment of stretching and will assist in the maintenance of the newly acquired range of motion. This orthotic system will be an aid to those patients with flexion contractures at the elbow of 60 degrees or less as defined by the American Academy of Orthopedic Surgeons (1).

Because this system utilizes direct pressure from the cuffs to the underlying skin, the therapist must take precautions to periodically check the skin for pressure sores. It is recommended that the

therapist applies this device for half an hour at the first application and gradually increases the wear time if no problems are apparent.

Patient Measurement and Components Selection

The proper cuff size is determined from four circumferences and length measurements of the fore and upper arm. The measurements are to be made with the elbow flexed at 90 degrees with the wrist rotated to its neutral position as shown in Figure 4. The therapist is then able to choose the small, medium or large cuffs for the orthotic assembly from the conversion chart shown in Table 1.

Hinge length and stiffness selection are determined by the summation of length measurements.

Flexion Contracture Angle Measurements

Measure the flexion contracture angle passively under the effect of gravity. This measurement is used to establish the extension angle of the orthosis. Once this procedure has been accomplished, add approximately 5 degrees to the extension angle to compensate for the leaf hinge flexibility. The result will be the initial extension angle of the orthosis.

Setting The Leaf Hinge Angle

While the elbow is passively extended to the contracture angle, place one end of the leaf hinge on the volar surface of the arm proximally to the radial styloid. The other end of the hinge should be lateral to the antecubital fold of the elbow. Mark the leaf hinge in line with the antecubital fold. Once this has been accomplished, mark the hinge 3 cm proximal and 3 cm distal to the fold line.

Heat the leaf hinge between the marks with a heat gun until the plastic is soft and pliable in this region. Place the

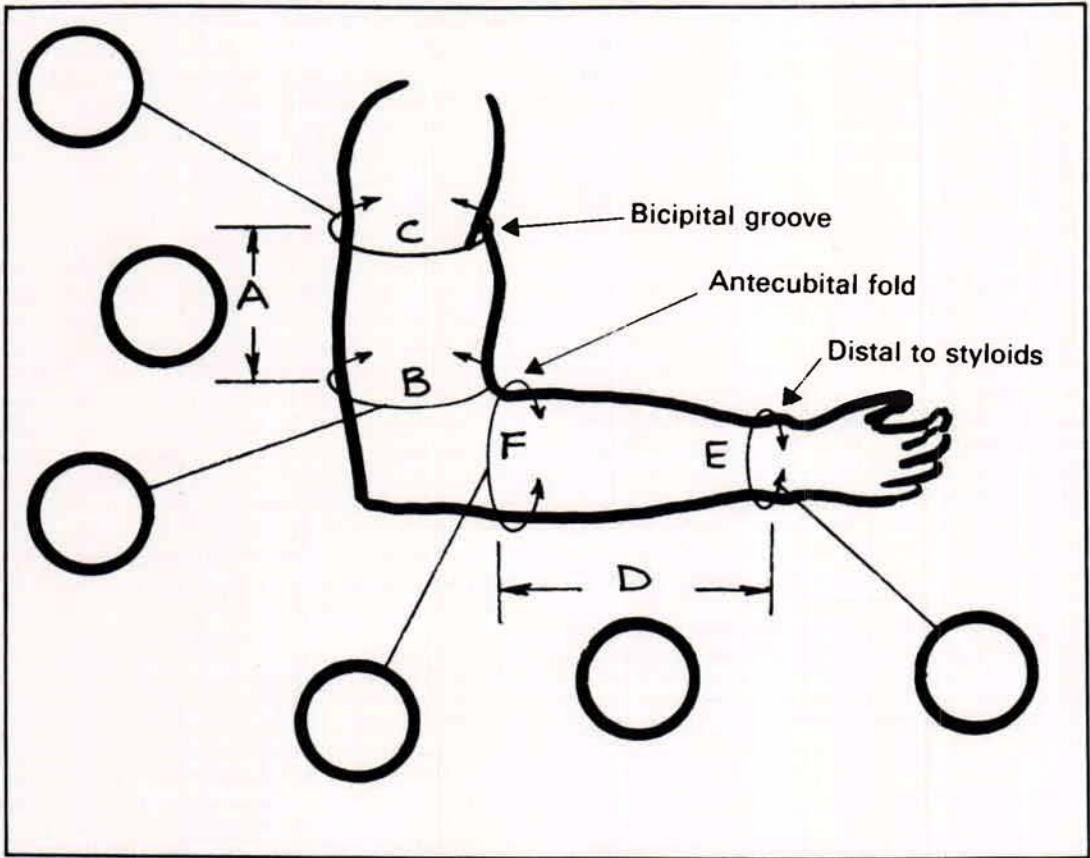


Fig. 4. Measurement Chart. Measure arm dimensions in centimeters. Measurements A and D are lengths, C, B, F and E are circumferences as indicated below. Record values in circles, and refer to Table 1, Conversion Chart.

heated hinge flat on a table surface. While holding the distal (longest) end on the table proceed to lift or bend the other end until the orthotic extension angle is achieved. Hold this angle until the hinge cools (about 3 minutes).

Assembly

First, slide the distal end of the hinge into the forearm cuff tunnel. Next slide the proximal hinge end into the biceps cuff such that the cuff tunnel is near the hinge bend. Position both cuffs on the hinge to fit the contour of the arm. Align

the screw holes in both cuffs with the nearest screw holes in the hinge. Mark the position of the aligned holes on the hinge. Remove the orthosis and fasten the cuffs to the hinge with the book-binder screws.

Fitting and Check Out

Reapply the assembled orthosis to the patient. Test for excessive pressures and cuff misalignments. Make any necessary adjustments. Finally, trim the velcro straps to the patient's need. Again, remove the orthosis and apply the protective sleeve to the hinge.

**TABLE 1:
Conversion Chart**

Cuff Selection

Circumference C	Biceps Cuff
Less than 25 cm	Small
25 to 31 cm	Medium
Greater than 31 cm	Large

Circumference E	Forearm Cuff
Less than 14 cm	Small
14 to 19 cm	Medium
Greater than 19 cm	Large

Leaf Hinge Selection

Length A + D	Leaf Hinge Length
Less than 32 cm	Small
32 to 42 cm	Medium
Greater than 42 cm	Large

Readjustment

Periodic readjustment of the hinge angle is required with changes of the contracture angle of the elbow. It is recommended that the hinge angle be changed with each 5 degree change of elbow contracture. To achieve a change in the hinge angle, remove the protective sleeve from the hinge and reheat the area with a heat gun. It is necessary to disassemble the orthosis to accomplish this task.

Summary

An orthosis has been designed to aid in increasing the limited range of arm extension available in disability involving flexion contracture at the elbow. When used in conjunction with therapy it helps to maintain the benefits of daily stretching exercises.

Important contributions of the orthosis are modularity with interchangeable components in three sizes, simplicity, cosmesis and low cost. Copies of the

prototype have been fabricated for application by clinicians, and clinical trials are now underway.

Footnotes

¹This work was supported by National Institute for Handicapped Research Grant No. 23-P-55690.

²Rehabilitation Engineering Center, University of Virginia, Charlottesville, Virginia 22903.

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An Active Bilateral Above-Knee Amputee— A Case Report

BERT GORALNIK, C.P.¹

ARTHUR SCHEINHAUS²

A bilateral above-knee amputee, A. H., sustained multiple injuries in Vietnam in 1969, at the age of 22, as a result of a booby trap explosion. Following amputation through both lower limbs above the knee, the left stump was 7½ inches in length and the right was 8 inches in length as measured from the public ramus. A. H. was 6'1½" in height prior to amputation and when first seen at the VA Prosthetics Center with his previous limbs he was 5'9". He requested an increase to 6'2" and because he was in excellent physical condition when seen at the VA Prosthetics Center in 1970, this height adjustment was approved since it was felt to be important psychologically.

In addition to the lower-limb amputations, A. H. had amputations of the left index and middle fingers with good function of the remaining fingers. On the right side, there were additional finger amputations. The right first metacarpal and portions of the right 4th and 5th metacarpals remained. Defects had been covered by full thickness skin grafts to both hands. He was able to grasp crutch handles with both hands although he was not able to fully oppose the first metacarpal residual to the residuals of the fourth and fifth fingers on the right. On the left side he was able to oppose the tip of the thumb to the fourth and fifth fingers and had a good grasp. It was concluded that prosthetic devices for

the hands would only interfere with function, and therefore were not prescribed.

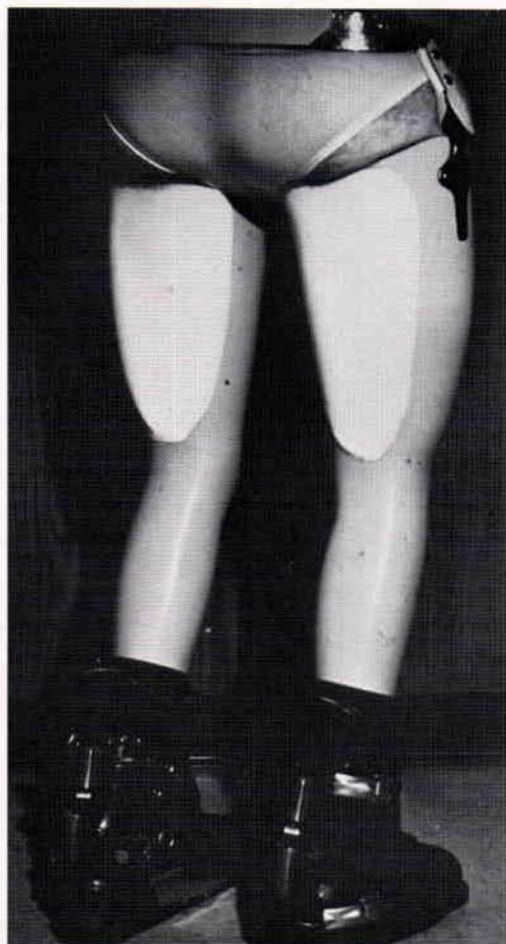


Fig. 1. Above-knee prostheses with rigid knees for skiing rejected by A. H.

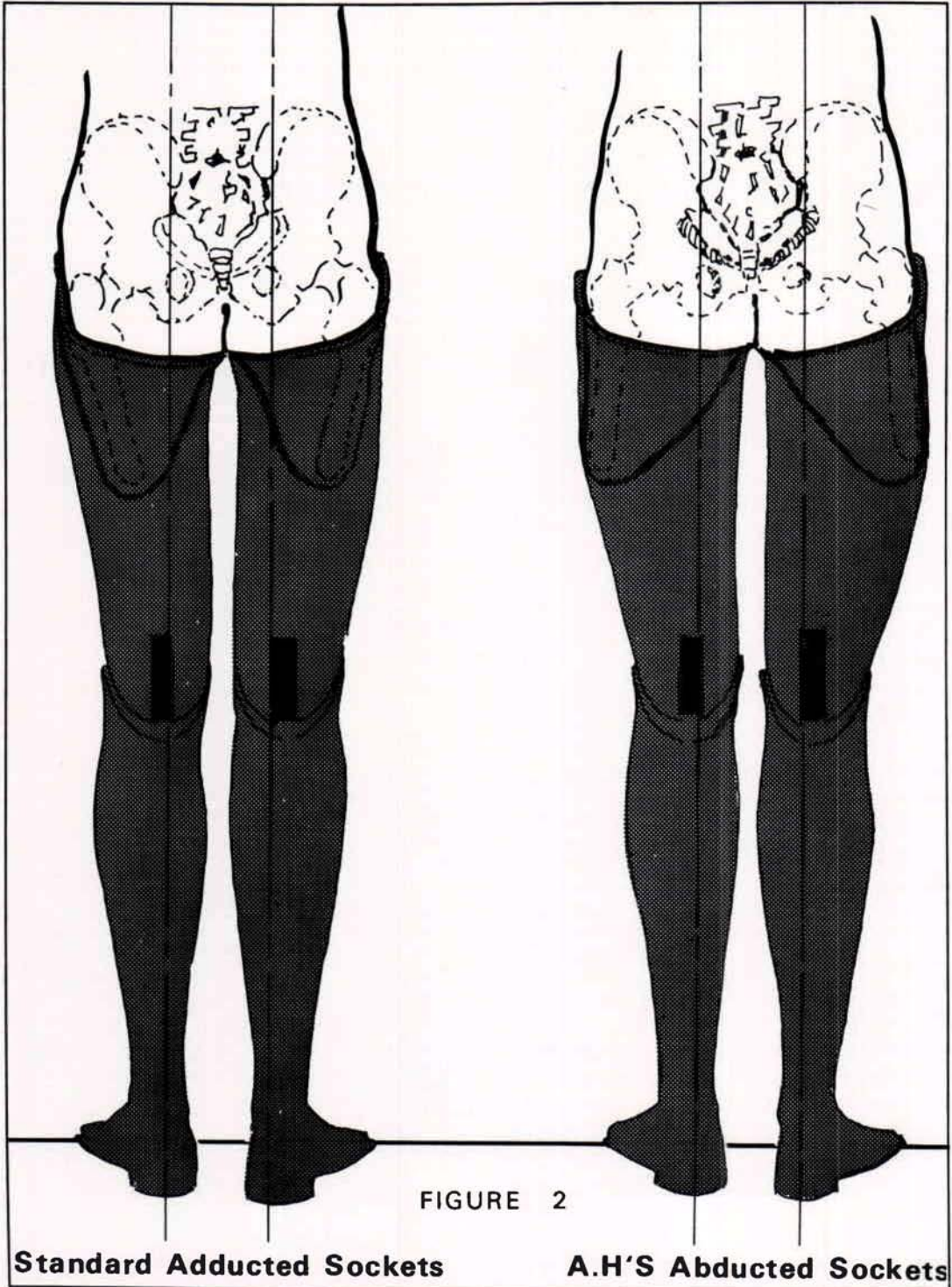


Fig. 2. Comparison of standard practice and A. H.'s skiing prostheses with respect to alignment in the mediolateral plane.



Fig. 3. A. H. in action.

A. H. was strongly motivated. He was fitted with a waist belt, hip joint, partial suction sockets, Mauch S-N-S knees, and single-axis feet. An attempt at fitting him with "total suction" was unsuccessful because of perspiration problems. Following delivery and instruction in the use of S-N-S knees, A. H. walked into the examining room without a cane. He was urged to use one initially, however. He subsequently became active in swimming, boating, horseback riding, and even sky-diving, and then indicated a strong desire to ski. He had been a capable skier prior to amputation, and was anxious to ski again.

Inquiries were made to determine if a similar situation had arisen elsewhere at a prosthetic facility, and it was found that specially designed prostheses had been fabricated by another facility and used by a patient for skiing purposes, but

this had been made, as illustrated in Fig. 1., with solid knees. A. H. rejected this concept as too limiting. Prostheses were then fabricated incorporating S-N-S knees, partial suction sockets, nylon waist bands and hip joints, and single-axis feet. The sockets were set in 20 degrees of abduction and the heel centers were brought directly under the ischial tuberosities (Fig. 2). The abduction alignment allowed the adductor muscles to contract, thus allowing his feet to be brought closer together. This, of course, is contrary to standard alignment principles, but the standard alignment for A. H. was found to be insufficient. When the feet were set up with a four-inch walking base he would have greater side-to-side displacement, but more energy would be required. With the walking base set narrower, A. H. was able to obtain greater control of his prostheses and yet still have the option to widen his base.

A. H. found that he could achieve better control and ski parallel with this arrangement. The S-N-S knees proved to be ideal for this patient, and he has become a very proficient skier employing these components and outrigger skis. He negotiates a standard slalom course at a respectable speed.

Since sky diving was also important to him, his replacement prostheses were fabricated with Pelite liners to lessen the impact on soft tissues at the level of the brims upon contact with the earth.

A. H. does not use crutches or a cane, and he works out extensively with weights. His occupation has changed from being a manager of a Health Spa to that of director of a cardiopulmonary fitness sports training institute in New York.

Since there is such a variety of prosthetic components available now, the Clinic Team should spend the time to make the prescription that meets indi-

vidual needs. If the patient's motivation level and attitude reaches that of someone such as A. H., it is up to us as prosthetists to help meet these individual needs.

Acknowledgement

The authors wish to thank Dr. Gustav Rubin for his assistance in helping to prepare this article.

Footnotes

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Technical Note

An Acrylic Lamination Technique for An Ultralight Below-Knee Prosthesis

The first patient that this type of prosthesis was fabricated for was a 70-year-old male, five feet, ten inches tall, and weighing 158 pounds. Amputation on the left side below the knee was carried out secondary to diabetic gangrene. He also has a longitudinal partial foot amputation on the right, leaving the great toe intact, but weakened for push off.

The first prosthesis was a conventional patellar-tendon-bearing leg. It weighed 5 pounds, one ounce and was delivered to the patient in December, 1976. He was quite active in this prosthesis with a cane and was without problems except for an occasional replacement of the liner because of shrinkage of the residual limb.

The patient's main complaints about the prosthesis were the weight and the resultant high rate of energy consumption while walking. He asked that a lighter prosthesis be provided. The prescription called for a PTB with soft socket, SACH foot, cuff suspension strap, and waistbelt.

Originally, we planned to fabricate the prosthesis of polypropylene, but we were not satisfied that this material is the answer to the ultralight question. Not only do we question the integrity of the material itself, but the additional expense of the oven, plastic welder, and a vacuum system and the lack of success in our hands and others in fabricating a polypropylene PTB led us to seek another solution.

Using materials and equipment available in most prosthetic laboratories, we have devised the procedure described below which makes use of acrylic resin in the lamination process.

Fabrication Procedures

Impression taking, model modification and soft interface fabrication remain the same. A check socket is desirable, since the thin laminations leave little room for error.

Steps in the First Lamination

1. Dry the model in oven for 8 hours at 140 degrees F.
2. Paint model with parting agent.
3. Apply PVA bag.
4. Apply one layer of half-ounce Dacron felt.
5. Apply two layers of Perlon stockinet.
6. Apply four layers of glass stockinet.
7. Apply two layers of Perlon stockinet.
8. Apply PVA bag.
9. Laminate with 80% rigid-20% flexible acrylic resin.

Static Alignment

Use the Bock 1S19 SACH foot with external foam keel. Be sure that the midline of the socket (A-P placement) is over the center of the foot, so as to reduce to a minimum the pressures exerted on the keel.

We also used the Bock 743Z4 adaptor to the BK adjustable leg and a 2R8 SACH foot adaptor instead of the conventional foot plug because this gives further adjustability at the ankle without the need to change the position of the socket.

Transfer Process

1. Put the aligned prosthesis in vertical fabrication jig. Tighten the knee yoke screws in the keel to hold foot in alignment. Fill the socket with plaster to maintain its shape.
2. Remove the BK adjustable leg and smooth the distal end of the socket.
3. Apply a polyvinylchloride (PVC) bag to the socket to prevent foam from adhering to it. Do *NOT* use PVA, because the moisture needed to soften a PVA bag will affect the foam. Use heat to soften the PVC, and seal the distal end of the bag. Cover the bolt hole in the keel with tape.
4. Apply a sleeve to contain the foam.
5. Foam from keel to the proximal trim line.
6. Remove leg from the vertical fabrication jig.
7. Shape shin according to measurements and blend the foam to the proximal trim lines. Leave foam in the patella-tendon indentation and any other undercut areas to facilitate removal of socket from outer shell in later stages.

Final Lamination

1. Separate the sole and the cushion heel from the keel of the SACH foot.
2. Make "knotholes" in foam at distal socket (anterior, posterior, medial, and lateral sides) to allow contact between outer shell and socket.
3. Run a string from the keel to the vacuum source.

4. Apply a PVA bag.
5. Fill "knotholes" with "gunk" and let set in depressions. This will bond to the laminate.
6. Apply six to eight layers of perlon/glass stockinet.
7. Apply a PVA bag.
8. Laminate with acrylic resin.
9. Seal distal lamination on underside of keel so that the lamination is left smooth.

Assembly

1. Remove plaster from socket.
 2. Clean proximal trim lines.
 3. Separate the socket from the outer shell.
 4. Remove foam from shell using prosthetic router. Pulling tools can be used to remove foam from keel.
 5. Bond the socket to the outer shell with Siegelharz gunk. Be sure to bond "knotholes" projections to outer shell to forestall breakage.
 6. Bond the sole of the foot to bottom of keel.
 7. Apply suspension straps.
- The key points in this procedure are:
1. Prevention of breakage through alignment.
 2. Prevention of breakage through the use of "knothole" projections to contact the outer shell.
 3. Use of lightweight acrylic resin.

The finished prosthesis weighed two pounds, five ounces, compared with five pounds, one ounce for the old prosthesis. The components are shown in Figure 1.

This article was originally submitted for publication in April, 1978. I came across my copy in my BK notebook again, whereupon I rewrote parts of the fabrication section since I had discovered in the meantime easier ways to carry out some steps.

Since January 1, 1978, our laboratory has fabricated about 20 ultralight be-

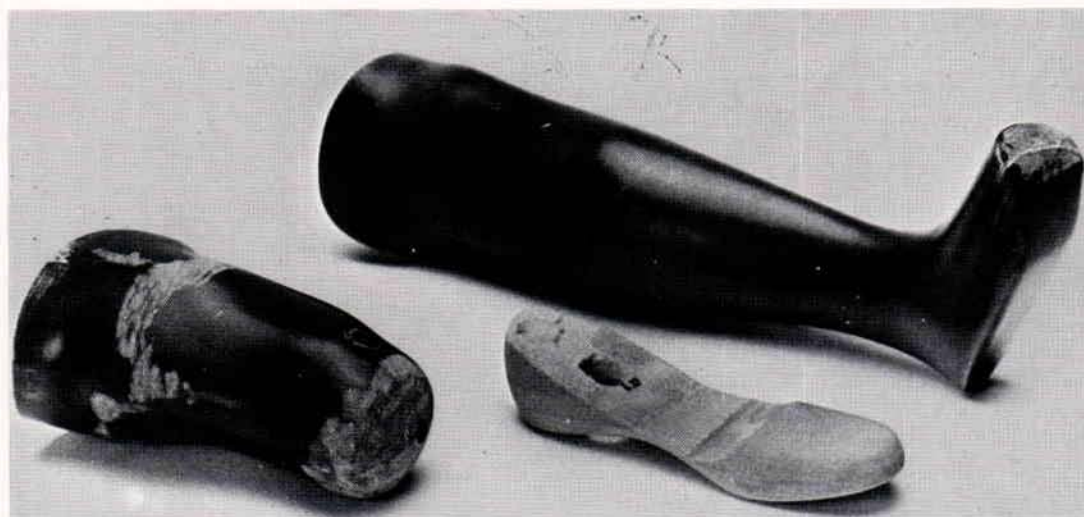


Fig. 1. Major components of the ultralight below-knee leg using acrylic resins for lamination.

low-knee prostheses for both male and female patients, from 23 years of age to a 98-year-old gentleman. Patient weights have ranged from 87 lbs. to 226 lbs. Activity levels have varied from a cosmetic leg for a wheelchair user to our super active 23-year-old rock singer (on weekends) who won't sit down.

Thus far there has been no breakage. On old users, I have not seen the patients as often for problems as I did before making the ultralight prosthesis.

The 23-year-old presented the greatest problem with acceptance of the new leg because she did not believe a prosthesis that light would support her. It took two to three weeks for her to become accustomed to the absence of weight. Now, she doesn't want to take off the prosthesis for fear I will pour lead into the hollow section.

Finished weights of the prosthesis range from one pound, nine ounces to two pounds, fourteen ounces (without corset and joint uppers) and suspension from cuff to supracondylar to supracondylar/suprapatellar to joints and corset. Only two patients have wanted to use waist belts because they felt "naked" without them.

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Larry Mott
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 610 Indiana Ave. North
 Minneapolis, MN 55422

New Publications

Functional Electrical Stimulation—
A Practical Clinical Guide, by Laurel A. Benton, Lucinda L. Baker, Bruce R. Bowman, and Robert L. Waters; Rehabilitation Engineering Center, Rancho Los Amigos Hospital, Downey, California; 133 pages, 75 illustrations; \$10.00.

Functional electrical stimulation, or the use of electrical current to cause functional contraction of muscle, has been the subject of a great deal of study in the United States and Europe for the past twenty years, and workers at Rancho Los Amigos Hospital have been among the leaders in this field.

It is gratifying to see a useful text on functional electrical stimulation emerge from the research ranks.

A fascinating history of the use of electricity in attempts to cure medical problems through the ages is followed by a very practical review of neurophysiology related to the basis of nerve and muscle excitation which, in turn, is followed by a chapter on the principles of electrical stimulation.

Most of the remainder of the book is devoted to instructions for use of electrical stimulation for:

- (1) Maintenance of range of motion
- (2) Correction of contractures
- (3) Strengthening of muscles
- (4) Facilitation of voluntary motor function
- (5) Inhibition of spasticity
- (6) Substitution for traditional orthoses

Detailed instructions are outlined for use of functional stimulation to improve function about each of the major joints in the lower and the upper limbs.

A glossary of terms and a very comprehensive bibliography are included.

This manual is well written and illustrated. It is devoid of jargon and can be easily understood by the clinicians for whom it is intended. The only shortcoming I can see worth noting is omission of information concerning availability of devices and the various characteristics of those devices that can be obtained presently. Perhaps the authors had a good reason, but they seem to have not included it in this edition.

Copies may be ordered directly from the Professional Staff Association of Rancho Los Amigos Hospital, 7413 Golondrinas Street, Downey, California 90242.

A. Bennett Wilson, Jr.

Boating for the Handicapped—
Guidelines for the Physically Disabled by Eugene Hedley; published by Human Resources Center, Albertson, New York; 1979; Library of Congress Catalog No. 79-91181; 114 pages (from a 14-page insert in Braille), numerous illustrations; paperbound; individual copies free.

This little treatise was prepared by the Research and Utilization Institute of the National Center on Employment of the Handicapped at the Human Re-

sources Center under a grant provided by the United States Coast Guard.

The purpose is to inform physically handicapped individuals and rehabilitation personnel of the opportunities in recreational boating available to the "disabled".

Emphasis quite properly is on safety afloat and access to and from boats. About a third of the text describes briefly, but accurately, the various types of recreational craft available—canoes, rowboats, various types of sailboats and power boats. Appendices include a list of books recommended for further reading, a partial listing of recreational organizations for the handicapped, legislation affecting accessible recreation, and a description of a very interesting project involving the study of the desirability to make rowing available to paraplegics. The book concludes with an eight-page annotated bibliography.

Boating for the Handicapped would be an excellent item for the waiting room of each prosthetics and orthotics facility. Certainly, the price is right!

A. Bennett Wilson, Jr.

Orthopaedic Surgery Continuing Education Review by Joseph A. Kopta, Carlos Garcia-Moral, William A. Grana, Richard H. Gross, and J. Andy Sullivan; Medical Examination Publishing Co.,

Inc. (an Excerpta Medica Company), Garden City, New York; August 1980; Library of Congress Card No. 80-80366; 216 pages, no illustrations; paperback.

This little paperbound volume contains 363 essay-type questions that are designed to help clinicians to keep up to date in orthopaedic surgery as the field expands and changes as a result of both basic and clinical research. Dr. Kopta is Professor and Chairman of Department of Orthopaedic Surgery and Rehabilitation, University of Oklahoma Health Sciences Center, and the other authors are members of his staff.

Each of the questions posed are answered in one or two succinct paragraphs which include the background and rationale for the current practice. Appropriate references are listed at the end of each answer. The coverage is comprehensive and the language is clear and concise. Dr. Kopta and his staff are to be commended for a fine job.

Although written with the practicing orthopaedic surgeon in mind, the material presented is of such a nature that this book should be read closely by every orthotist and then kept as a ready reference in his daily work. Orthopaedic Surgery Continuing Education Review should also be considered by the Prosthetics and Orthotics Education Programs as an adjunct text.

A. Bennett Wilson, Jr.

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WANTED experienced orthotists-prosthetist and prosthetist. Does not need to be certified, but should be experienced in all facets of the field. Prosthetist should have VA required courses. Send resume and salary requirements to San Jose Orthopedic Service, 48 Race St., San Jose, CA 95126, (408) 288-6677.

ORTHOTIST—Large northern Virginia hospital located near the Washington D.C. metropolitan area is seeking a certified orthotist. Primary responsibility will be providing care to patients, with disabling conditions of the limbs and spine, by fitting orthoses. Individual should be certified by the American Board of Certification or equivalent or eligible with a minimum of 2 years' clinical experience. Well established department has the latest equipment and tools. We offer a good benefit package with competitive salary. Send resume (including salary history) to: The Fairfax Hospital Employment Office, 3300 Gallows Road, Falls Church, Virginia 22046. M/F EOE.

CERTIFIED PROSTHETIST/ORTHOTIST—for Southern Coastal location. Unlimited opportunity for right person. Reasonable pay, good fringe benefits. Possibility of part or full ownership of old established facility doing in excess of quarter-million. Only highly dedicated and sincere persons need apply. Replies confidential, AOPA Box 12806, 717 Pendleton St., Alexandria, VA 22314.

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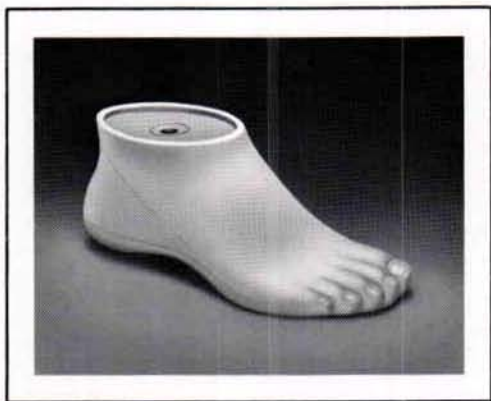
The Juvenile

Liberty. Freedom from intervention by a more dominant force. The very thought forces us to fairly burst with pride upon reflection of our historic roots. Who, though, desires liberty more than a wild animal or child—especially a child who is an amputee?

One is never sure whether fate has seriously deprived a crippled child of not only his freedom to succeed, but also his freedom to fail—but one is sure that the best cosmesis and prosthesis certainly creates a better opportunity for choice.

Kingsley Mfg. Co. builds such a device for children, the Juvenile sach foot with Natural Toes™. This normal width foot is available in medium or soft heels and in metric lengths from 14 cm to 22 cm. The inert Medathane construction assures the child freedom of comfort from the beach to the opera.

Even up those odds for the child amputee with the Kingsley sach foot with Natural Toes™ for children, the Juvenile. Liberty should be every child's right—where he takes that freedom is up to him—that's the American dream—that's the power of choice.



Catalog K06

Unless specified "without toes," orders for all Kingsley Mfg. Co. "Juvenile" feet are now filled with the new Natural Toes™.



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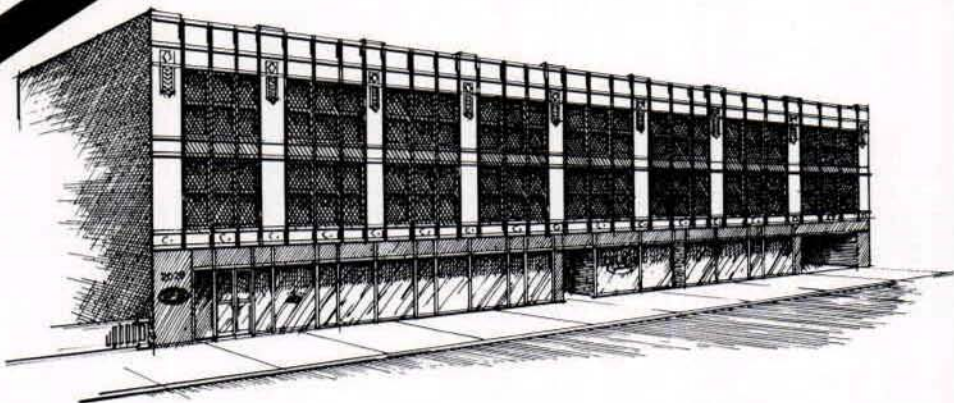
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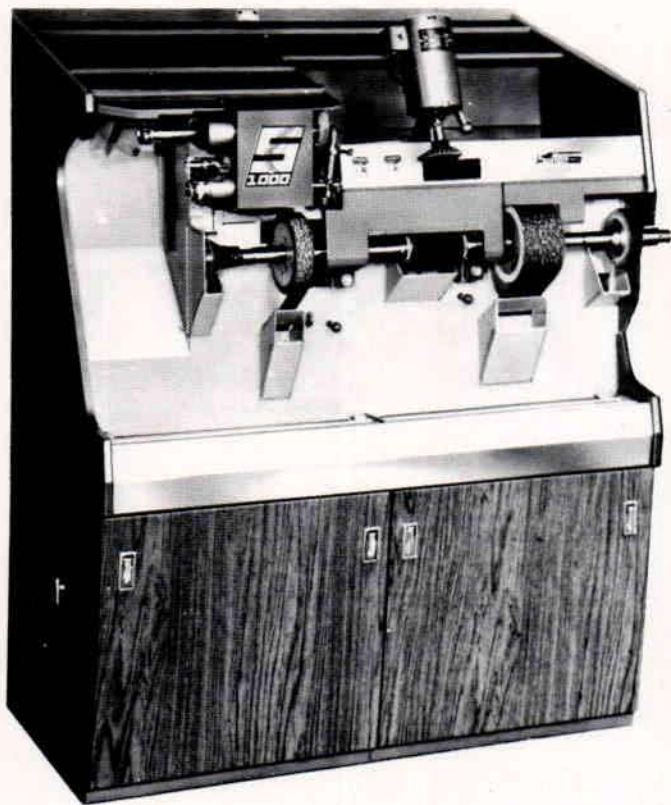
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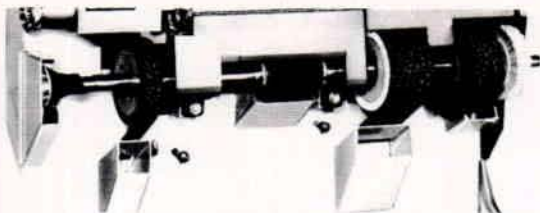
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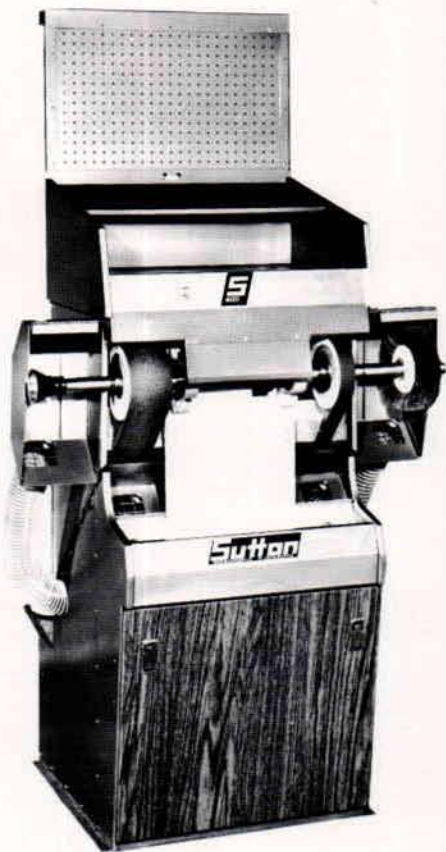
S1000

The S1000 has two ultra-high speed 60" quick change belts, the new Quik-Adjust sole trimmer that lets you dial any size edge iron to a #36 while the machine is running, and a fully ducted dust control system that is so efficient it doesn't even need a bag shaker. The S1000 fits into a 50-inch space and comes with a heel breaster, 1-9/16" wide belt, a 4 1/2" bottom sander, a 4" belt, and a drum sander. Alternate shaft configurations available.

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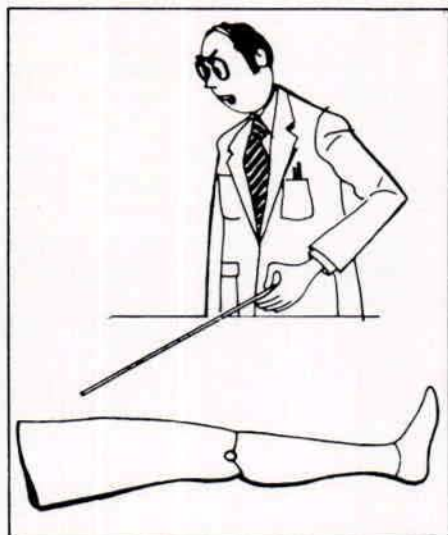
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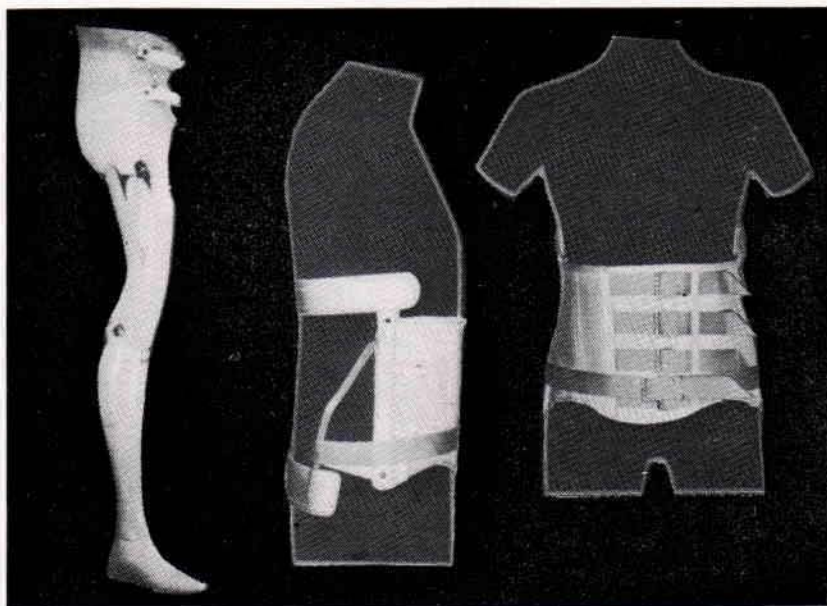
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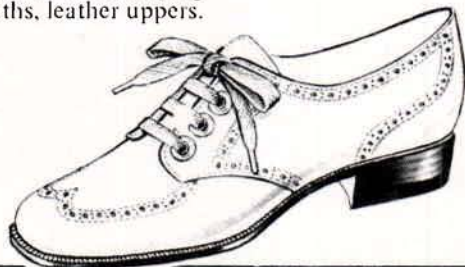
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