Autumn 1969

Artificial Limbs

A Review of Current Developments

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Artificial Limbs

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Toward a New Professionalism

JOSEPH E TRAUB[1]

It is very apparent, judging by the advances in technology as applied to prosthetic-orthotic systems which are reported so well in this issue of *Artificial Limbs,* that the field is on the threshold of tremendous change. To be sure, since the end of World War II and the subsequent beginning of research and training programs, the practice of prosthetics and orthotics has changed dramatically. The major advances have resulted, however, from improving the knowledge about applying existing devices to patients and from modifying the designs of some of those devices to allow more freedom, comfort, and function. Only a very few improvements have been accomplished through the design of new and better hardware—a situation which happily is changing.

As encouraging as the technological developments are, the availability of professionals who are sufficiently trained to take advantage of them must also be considered, and here the picture is less bright. Although the progress in the development of prosthetics and orthotics as a profession over the past two decades has been gratifying, some recent attempts to transfer technological improvements to clinical situations have shown that there are deficiencies in the training programs for prosthetists and orthotists. For example, with the advent and widespread acceptance of the principles and practice of Immediate Postsurgical Prosthetic Fitting, we have seen that a professionalism greater than now exists is required of prosthetists and orthotists if they are to be truly qualified to practice at the optimal level. In sharp contrast with his role in other patient-management procedures, the prosthetist or orthotist working beside the surgeon in the operating room has considerable responsibility, and he must have a complete understanding of the technological and physiological principles he is expected to apply in various situations.

As we look to the future, we see other areas in which a more comprehensive blending of medical and technological skills will be re-

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quired. At the present time, research is underway, and excellent progress is being made, in such areas as myoelectric control, endoskeletal prosthetic attachment, and mechanical and electrical implants, to name but a few.

Who will apply these advanced technologies to patients, once the research and development phases have been completed and the devices are ready for general clinical use? The prosthetists and orthotists, as they are trained today, certainly will not be qualified; the physicians and surgeons, with some additional training in engineering, may be, but surely they already have enough to do; the engineers are of course not well enough trained in the biological and medical sciences to be able to assume this responsibility. Who then will understand both the technology and the medical factors well enough to make the applications of sophisticated equipment to patients, with their individual physical, psychological, vocational, and social problems?

Perhaps another kind of specialist, one trained in "clinical medical engineering," could fill this need. To illustrate, it might be helpful to compare the level of training and professional responsibility of such a practitioner to those of the prosthodontist and orthodondist. These specialists are by far the most highly trained and professionally responsible "prosthetists" and "orthotists" practicing today, yet their practice is limited to care of the oral cavity and adjacent tissues.

Is it not time that we recognize the need for other "medical engineers," who are trained to care in the same ways for the remainder of the human body? I believe it is.

At this point, let me assure the reader that these remarks are not intended as a criticism of the training program for prosthetists and orthotists conducted over the past eighteen years. The continuing-education programs in prosthetics and orthotics at the University of California, Los Angeles, New York University, and Northwestern University have accomplished much more than was even imagined when they were started. More recently, the long-term training programs at New York University, Cerritos Junior College, and Chicago City College have produced many excellent graduates, and of course should and will continue to do so. As excellent as those programs are, however, they seem to provide only limited professional training. True, the current generation of professionals is able to cope with most prosthetic-orthotic situations they meet in the field today. But what about tomorrow, when more widespread use of some of today's research developments will be needed and demanded by both patients and physicians?

There seems to be no way to train professionals who can meet the challenge of scientific advances in the provision of medical engi-

neering services to patients other than by establishing, in universities which contain medical and engineering schools, training programs which embody the necessary courses in biology, medical science, and engineering. These courses should be conducted at the graduate level, similar to medical school and for primarily the same reason. The maturity of the graduates of any training program which is directly concerned with human life and welfare is of paramount importance. Undergraduate programs, while perfectly capable of producing persons who are technically qualified in fairly narrow areas, do not usually instill in the individual sufficient maturity for him to deal effectively with a broad spectrum of human problems.

It seems likely that many graduates in engineering, physical therapy, occupational therapy, biology, medical technology, and other specialties would be interested in the practice of "applied medical engineering," if training for such a specialty were developed and offered by some of our leading universities.

Even though, realistically, it would be at least ten years before the full effects of such an educational program could be felt in the field, it is axiomatic that the longer we wait to initiate action toward a goal, the greater the time before we can attain that goal. The time to begin is now.

Recent Advances in Below-Knee Prosthetics

A. Bennett Wilson, JR.

The concept of constructing a below-knee prosthesis with side joints and a thigh lacer was set forth by the Dutch surgeon Verduin in 1696 (Fig. 1) and followed universally until the advent of the patellar-tendon-bearing prosthesis in the late 1950's (7). Although other innovations such as contact over the distal end of the stump, suction suspension, and "muley" sockets were introduced from time to time, they were never widely used, possibly because principles governing their use were not set forth in a systematic manner.

In 1957, the predecessor of CPRD, the Advisory Committee on Artificial Limbs, encouraged the University of California at Berkeley to study the problems of the below-knee amputee and to improve the then current management practices. As a result, some of the leading prosthetists in this country were invited to Berkeley later in 1957 for the express purpose of examining in detail the prosthetics practices for BK amputees and rationales for those practices *(17).* An analysis of the findings of that conference led to the development of the patellar-tendon-bearing prosthesis, known now as the PTB prosthesis.

The original version of the PTB prosthesis was a plastic laminate socket which was formed over a modified plaster-of-Paris model of the stump, and which contained a soft inner liner that contacted the entire surface of the stump *(22,23).* The major weight was borne by the medial flares of the tibia and the patellar tendon. No knee joints or thigh corsets were used, suspension being effected by a fabric strap around the thigh just above the femoral condyles (Fig. 2).

The PTB concept was offered in formal education programs in this country and gradually gained acceptance, so that by 1961 slightly more than half of the below-knee prostheses provided in the United States were of that type *(16).* The concept also has been accepted widely in other countries, and the PTB now is generally considered to be the standard prosthesis for below-knee amputations.

In recent years, research groups and individual prosthetists have introduced improvements to the basic concept *(6).* This article describes the advanced practices in the management of the below-knee amputee that have been developed since the introduction of the PTB prosthesis.

THE HARD SOCKET

The original PTB socket design called for a lining of leather or Naugahyde backed by sponge rubber. Perspiration caused problems in many instances, however, because Naugahyde does not "breathe" and leather deteriorates rapidly in the presence of sweat. This problem prompted some prosthetists to eliminate the liner, and the "hard" PTB socket has become increasingly popular.

THE PTS SOCKET

The suspension strap for the PTB prosthesis, as designed originally, was usually satisfactory, but there were enough dissatisfied amputees to prompt a number of

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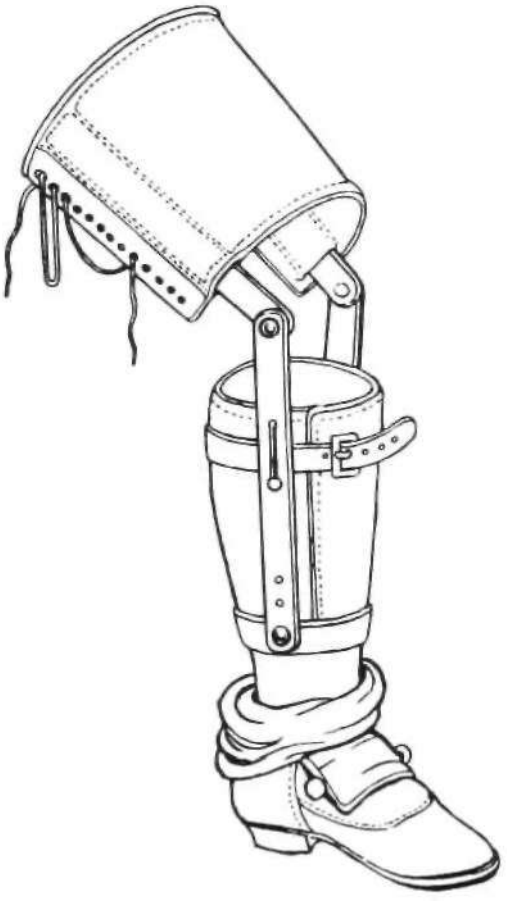

Fig. 1. Verduin leg (1696). From MacDonald, J., *Amer.J. Surg.,* 1905.

prosthetists to seek improved suspension methods. In addition to developing different strap designs (Fig. 3) (5), several groups experimented with new configurations for the proximal border of the socket. The research team at Nancy, France, introduced the "prothese tibiale a emboitage supracondylien," popularly known as the PTS, in which the proximal border extends above the patella and the femoral condyles (Fig. 4) *(20),* thus holding the socket on the stump. This concept was introduced into the United States by Nitschke and Marschall *(18,19)* and the PTS prosthesis is being used at an increasing rate in the United States. The technique may be used with or without a liner. Hamontree *(12),* in reporting his experiences with 94 cases, noted that, although he believed that the majority of the patients could have been satisfied with the original version of the PTB, a certain percentage could have been successfully fitted only with the PTS version.

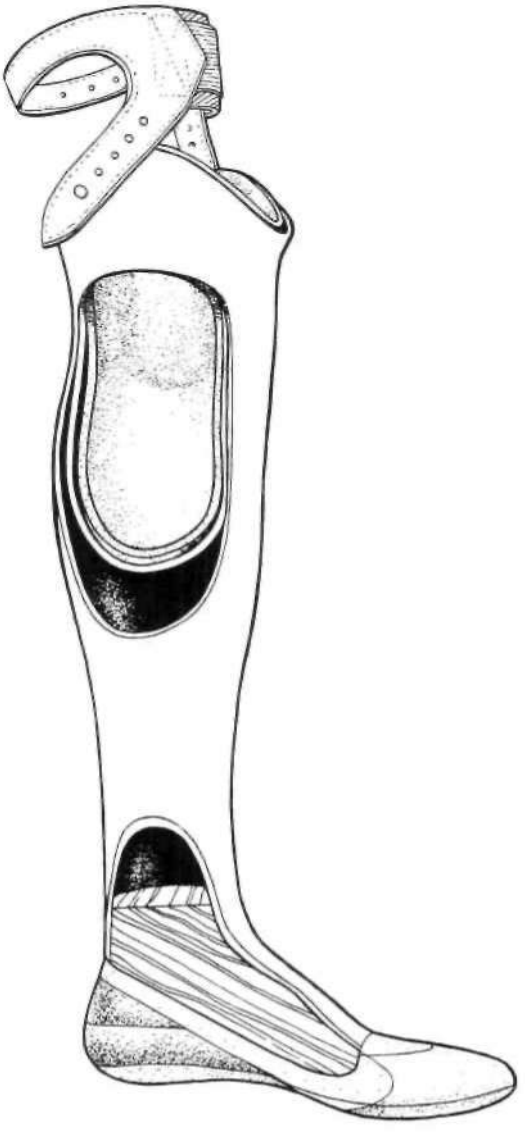

Fig. 2. Cutaway view of the original patellar-tendon-bearing (PTB) prosthesis.

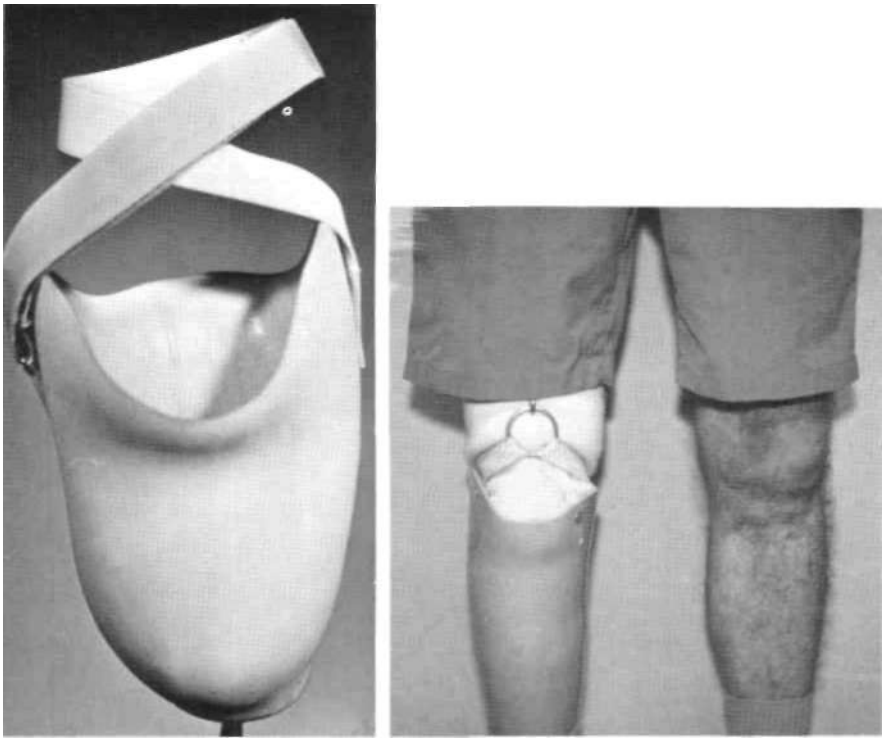

Fig. 3. *Left,* continuous-strap suspension arranged in a figure eight with Velcro for adjustment; *right,* anterior view of two inverted V-straps looped through a ring and attached inside a hard socket close to the brim.

WEDGE SUSPENSION SOCKET

Another attempt to improve upon the strap type of suspension resulted in the KBM (Kondylen Bettung Munster) prosthesis *(15),* in which a small wedge is inserted between the proximal area of the socket and the area of the stump along the medial condyles of the femur (Fig. 5). Developed at the University of Miinster, this concept was introduced into the United States by Fillauer *(10)* and is now known as the supracondylar-wedge suspension system. The wedge system may be used with or without a socket liner, but generally no liner is used.

AIR-CUSHION SOCKET

In an effort to develop a socket that would permit the stump to bear the optimum amount of the weight load over its distal end, Wilson and his associates *(25)* designed and developed the "air-cushion socket" (Fig. 6), which reduces the magnitude of the vertical components of weight-bearing forces at other points on the stump.

The air-cushion PTB consists of an elastic inner sleeve (stockinet impregnated with silicone rubber) suspended from the level of the tibial tubercle in a rigid outer shell that is closed distally. Stump support is provided by the tension of the sleeve itself and by the compression of the air in the chamber between the inner sleeve and outer cap.

Trials in the United States, Denmark, and Yugoslavia *(6)* have shown that the air-cushion version of the PTB is particularly useful for patients with very sensitive stumps. In fact, there appear to be few, if any, contraindications to the use of

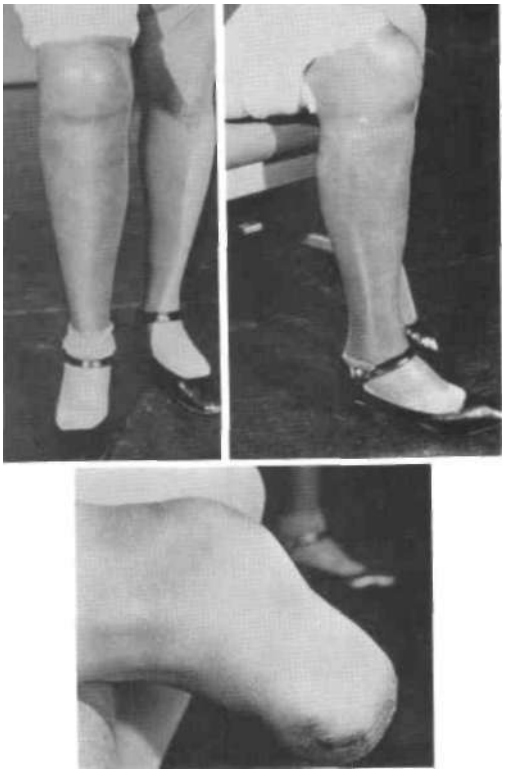

Fig. 4. A right, below-knee stump and the amputee wearing a PTS-socket prosthesis.

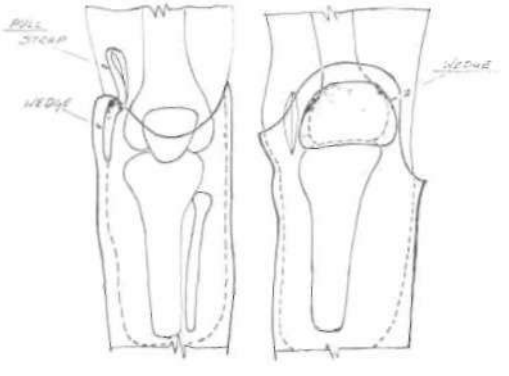

Fig. 5. The supracondylar-wedge suspension method.

the air-cushion socket, the only disadvantages being that slightly more time is required to fabricate the socket and that few modifications can be made after it has been fabricated.

POROUS SOCKET

In seeking ways to alleviate the problems caused by perspiration, the U. S. Army Medical Biomechanical Research Laboratory developed a porous plastic laminate *(9,14,21).* Conventional epoxy resins and filler materials are used in the fabrication, but special care must be taken in controlling the proportions of the ingredients and in curing. The first porous laminates developed by AMBRL were satisfactory for upper-extremity sockets, but they were not strong enough for routine use in lower-extremity sockets. Subsequently, the technicians developed a fabrication technique using epoxy resins that overcame the major shortcomings of the earlier laminates *(21).* New York University, after studying 20 children and young adults, reported that the porous-laminate socket appeared to be a "significant and worthwhile addition" to below-knee prosthetics specifically and to limb prosthetics generally *(9).* There were fewer problems with perspiration, and skin eruptions were ameliorated. In addition, the prostheses with porous-laminate sockets weighed less. When perspiration was a major problem, the two disadvantages cited—slightly increased fabrication time and greater difficulty in maintaining socket cleanliness—were far outweighed by the advantages.

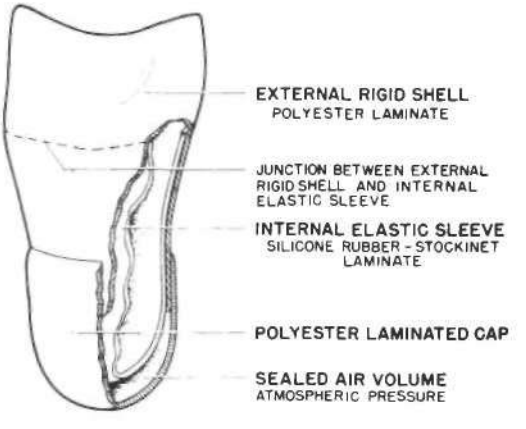

Fig. 6. Cutaway view of the air-cushion socket.

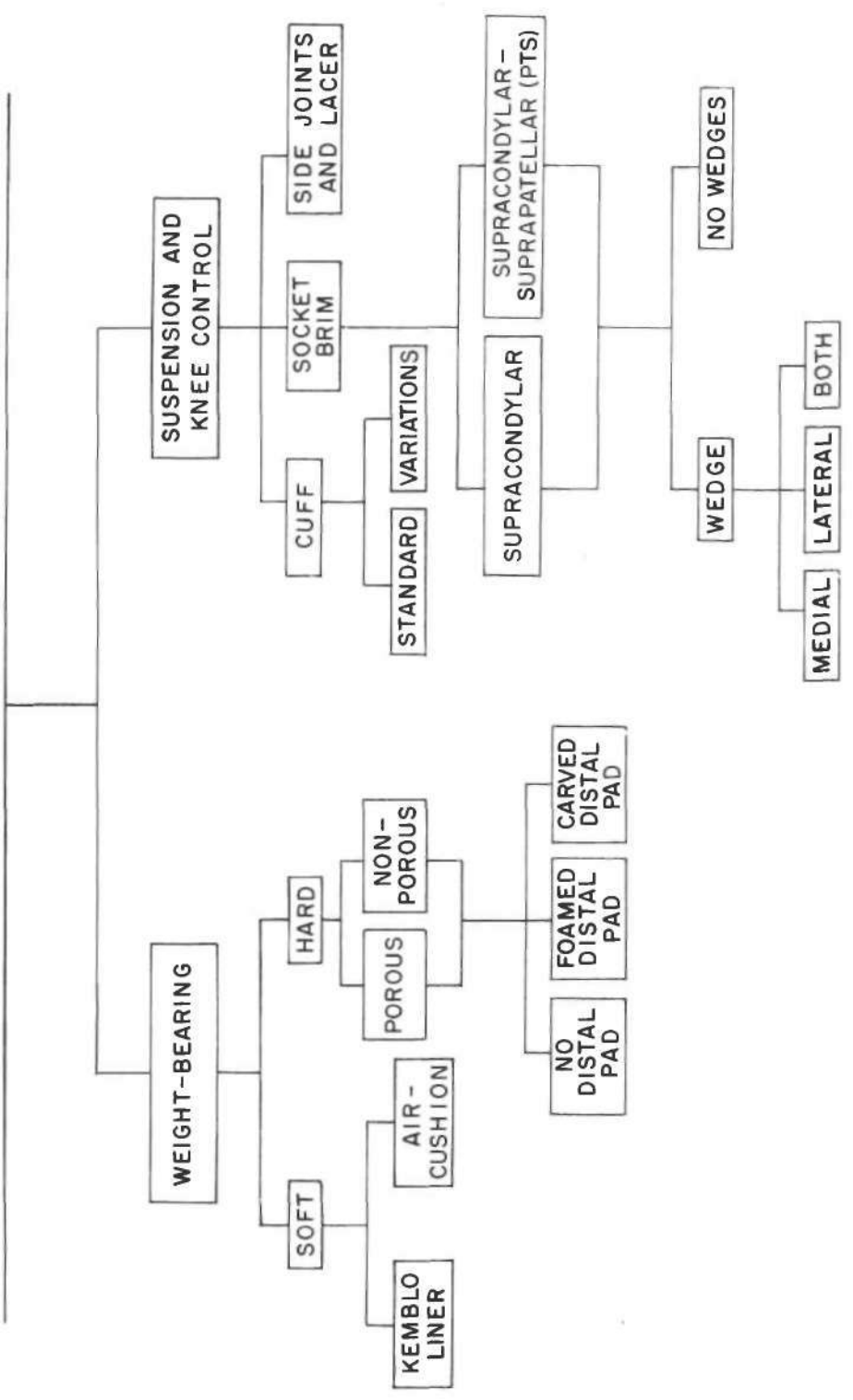
VARIATIONS OF THE PATELLAR-TENDON-BEARING (PTB) PROSTHESIS
WEIGHT-BEARING
SOFT
KEMBLO LINER
AIR-CUSHION
HARD
POROUS
NON-POROUS
NO DISTAL PAD
FOAMED DISTAL PAD
CARVED DISTAL PAD
SUSPENSION AND KNEE CONTROL
CUFF
STANDARD
VARIATIONS
SOCKET BRIM
SIDE JOINTS AND LACER
SUPRACONDYLAR
SUPRACONDYLAR-SUPRAPATELLAR (PTS)
WEDGE
NO WEDGES
MEDIAL
LATERAL
BOTH

Fig. 7.

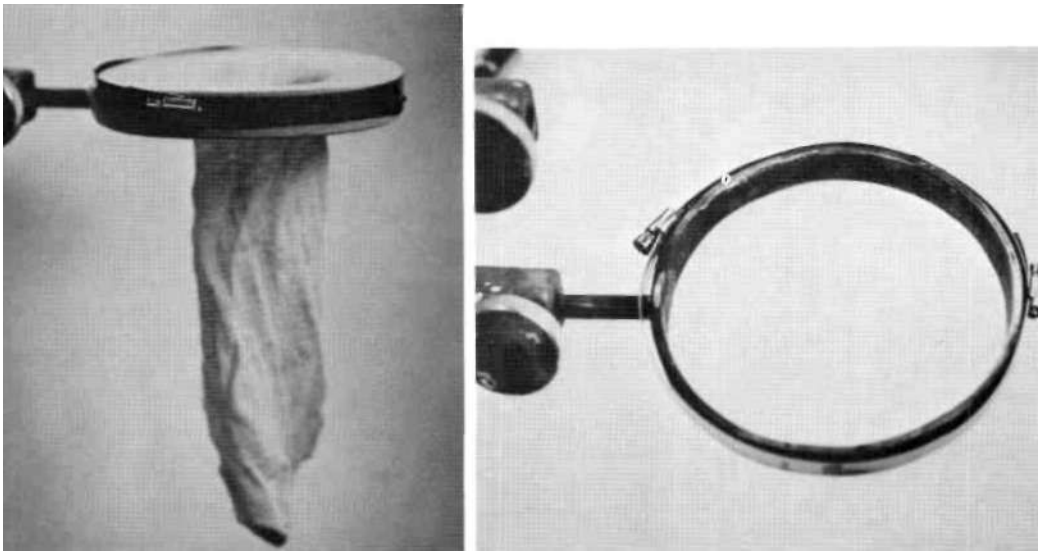

Fig. 8. Ring and sock for suspension casting of the below-knee stump.

Because most of the innovations to the original PTB design are not mutually exclusive, it was possible to develop a chart showing the combinations of features that can be used to devise a below-knee prosthesis that best meets the needs of the individual patient (Fig. 7).

CASTING METHODS

The method for obtaining a model of the stump for fabrication of the PTB socket, as described in the original manuals, consisted of wrapping the stump with plaster-of-Paris bandages, shaping the wrap with the fingers, and subsequently modifying the male mold produced from the female cast, or wrap. Any number of attempts have been made to devise a procedure that would require less skill. One such method that has been accepted by many prosthetists is the sling-casting, or suspension-casting, technique developed by Hampton *(13)* (Fig. 8).

In the suspension-casting technique, the stump is wrapped while it is held in a vertical position that simulates weight-bearing during standing. Felt patches to provide relief for sensitive areas of the stump can be applied directly to the stump, and a minimum amount of modification is necessary, although the need for modification is not eliminated entirely.

Research workers and clinicians have been searching for years for a material that will enable the prosthetist to form a socket directly over the stump, thereby eliminating the need for plaster wraps and male molds. Experience with a synthetic rubber, Polysar[2] X-414, has shown that this material definitely has a place in the fabrication of sockets *(24)*. Temporary, or provisional, below-knee prostheses consisting of a synthetic-balata socket and pylon-type components are proving to be useful. Because it becomes pliable at temperatures easily tolerated by the skin, synthetic balata can be applied directly over the stump. Extruded tubing of various diameters with walls 1/4-in. thick is available. A piece of tubing slightly smaller in diameter than the stump is heated in water to about 160 deg F, then forced over the stump, which has been padded in appropriate areas (Fig. 9). To give proper shape to the socket, a length

[2] Registered trademark of Polymer Corporation Limited.

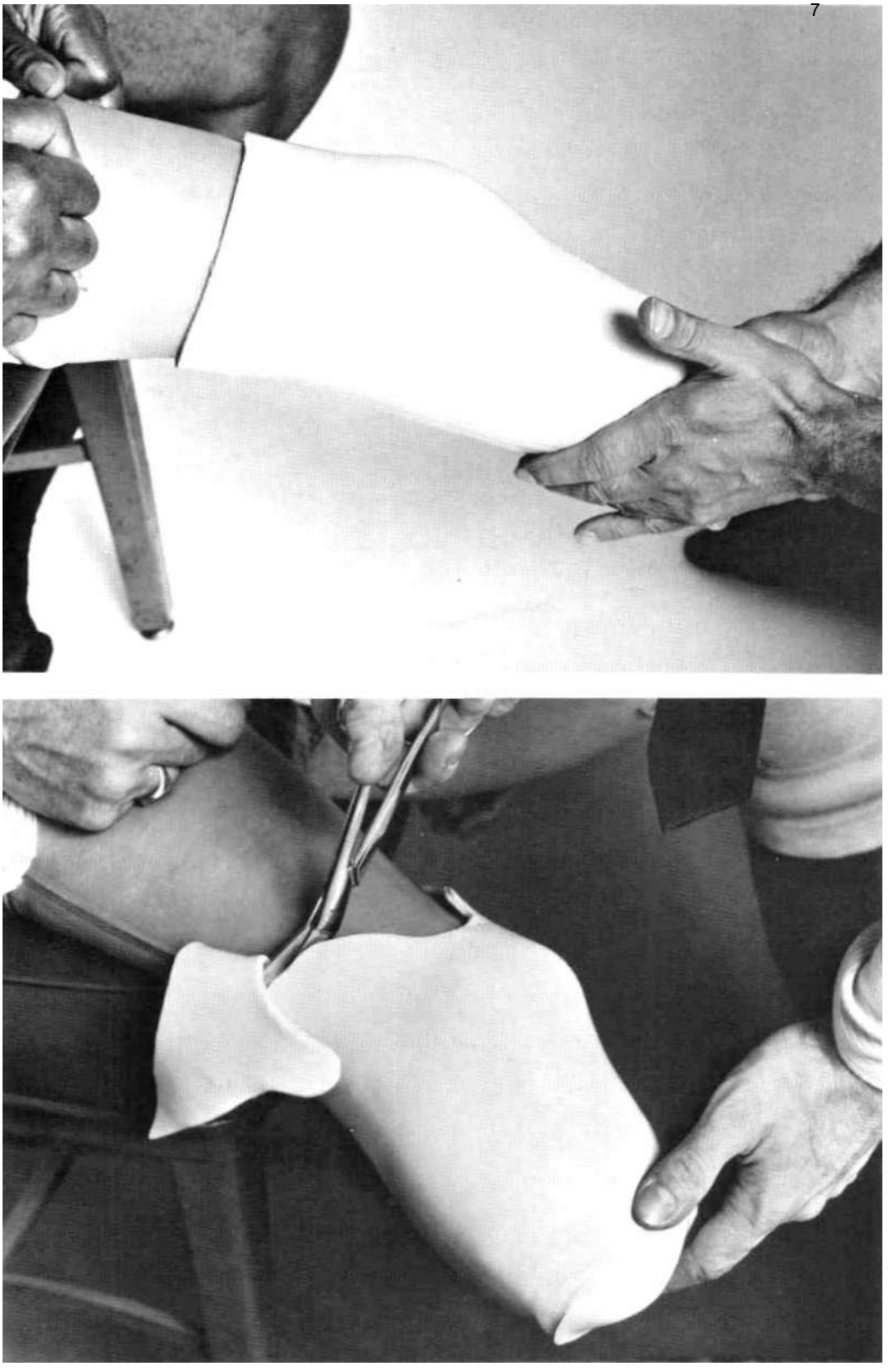

Fig. 9. *Top,* application of socket tube to the stump; *bottom,* trimming of socket brim prior to final molding.

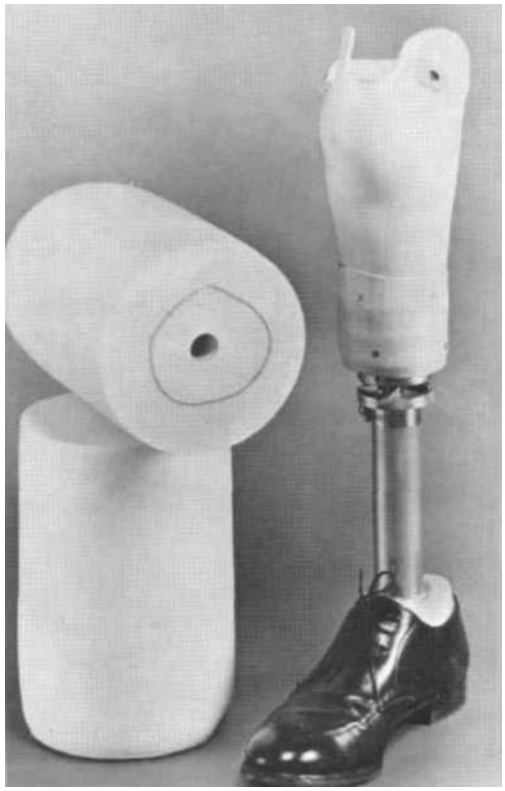

Fig. 10. Foam blocks for fitting over pylon and socket.

of pressure-sensitive tape, 1 in. wide, is wrapped over the outside, and final forming is carried out manually. To provide total contact, the distal end is filled with "foam-in-place" silicone. The socket is easily mounted on a pylon unit for use as a temporary prosthesis, or a more permanent one if desired. The prosthesis can be given a natural appearance by applying and shaping semirigid blocks of Koroseal "Spongex"[3] (Fig. 10). Contours of the socket can be changed at any time by heating the area with a heat gun and reshaping it manually.[4]

[3] B. F. Goodrich Co.

[4] Sockets of this material should not be left near radiators or in an abnormally warm environment, such as the interior of a closed automobile parked in sunlight on a warm day, because synthetic balata becomes pliable at temperatures as "low" as 120 deg F.

TIME OF FITTING

During the past decade, the advantages of fitting a prosthesis as soon after amputation as possible have been demonstrated repeatedly. Goldner and his associates *(11)* demonstrated that "early" fitting—that is, providing the patient with a temporary prosthesis as soon as the wound has healed rather than waiting for a maximum amount of shrinkage to take place—could drastically reduce time and costs of rehabilitation. Even more dramatic results have been obtained by fitting artificial limbs immediately after surgery, especially with below-knee amputees *(2-4,8)* (Fig. 11).

The technique of immediate postsurgical fitting was originated in France by Berlemont, was carried further by Weiss in Poland, and, after a considerable experimentation period in the United States, is now being taught routinely in the prosthetics education programs in this country *(7).* The technique consists of applying a rigid dressing over the stump and attaching an adjustable pylon and foot. Standing and ambulation is begun as soon as the patient's condition permits. For young, otherwise healthy patients, some ambulation can begin on the day following amputation.

Usually the rigid dressing is left in place until the wound has healed and the sutures can be removed—about 10-14 days postoperatively. A second rigid dressing is provided for another 10- to 14-day period, at which time a "permanent," or definitive, limb can be provided. The advantages of immediate postsurgical fitting include reduction of edema, less pain, shorter periods of hospitalization and therapy, and fewer contractures. The technique has become standard practice in many centers with trained teams (7).

HARDWARE

To make early fitting and immediate postsurgical fitting easier, a number of ad-

justable pylons have been developed. Those currently available are shown in Figure 12. Some of their characteristics are given in Table 1. These units are strong enough and light enough for extended usage with or without some sort of cosmetic cover. A number of approaches to cosmetic treatment such as the use of

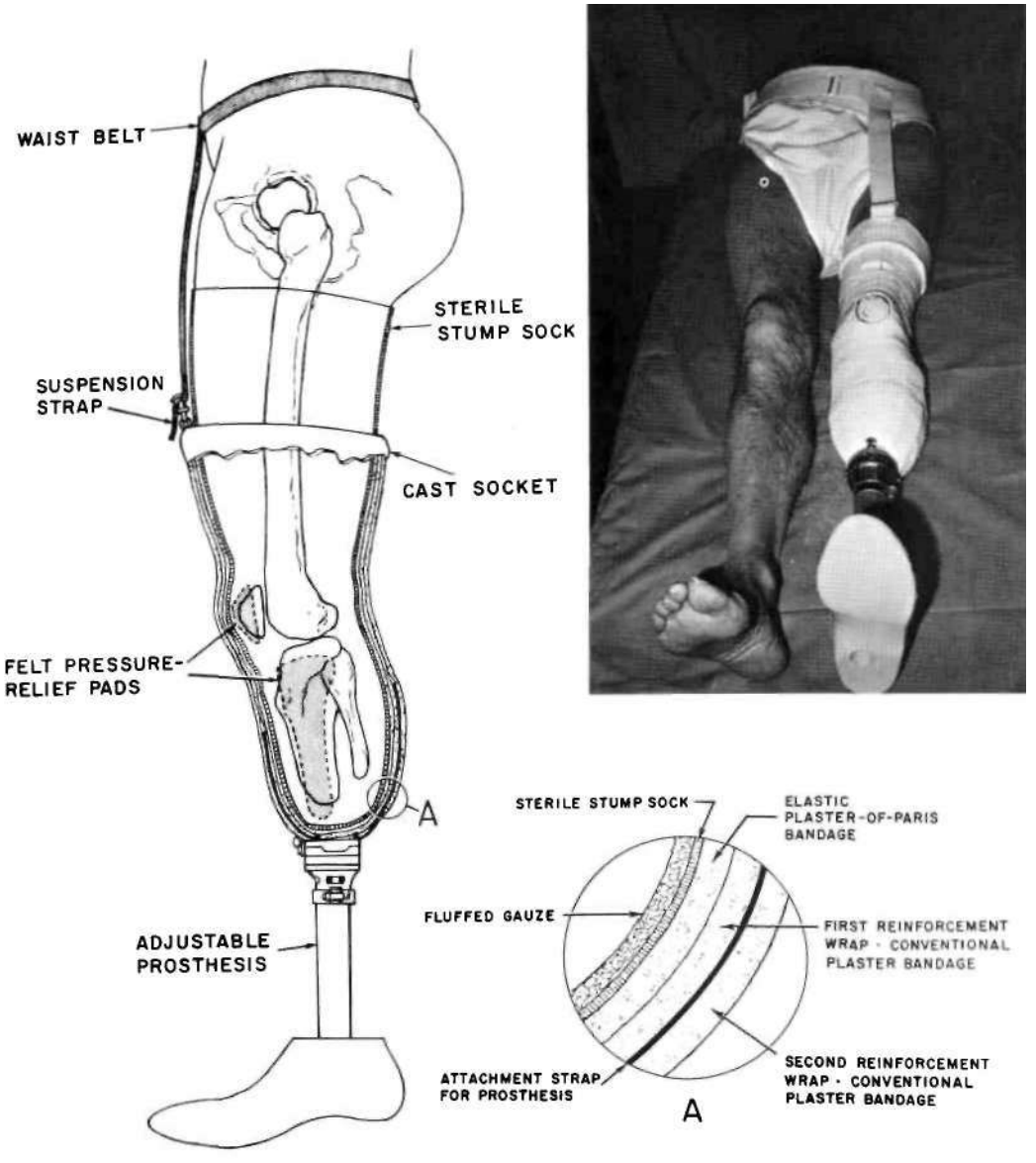

Fig. 11. Schematic cross section showing the major elements of a prosthesis as applied immediately following surgery to a below-knee amputee. The suture line, silk dressing, and drain are not shown. The fluffed gauze does not extend beyond the area indicated in "A." *Inset:* A below-knee amputee fitted with the immediate postsurgical prosthesis.

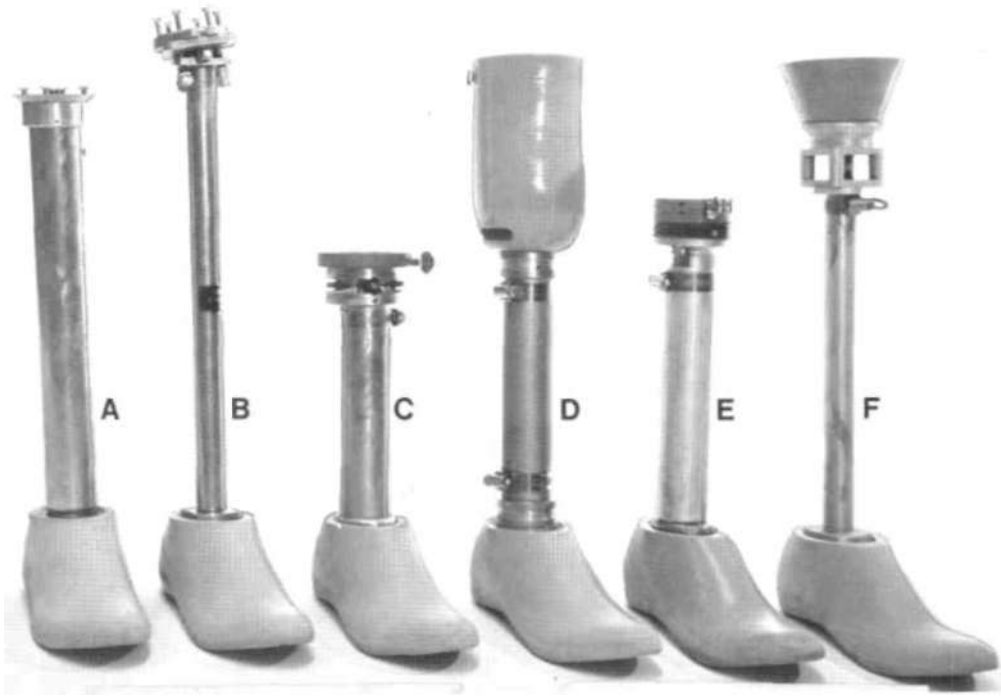

Fig. 12. Below-knee pylon-type prostheses that can be used for fitting immediately after surgery. *A*, Hosmer Postoperative Pylon; *B*, Northwestern Pylon (Hosmer); C, Veterans Administration Prosthetics Center (VAPC) "Standard" Pylon; *D*, Canadian "Instant" Prosthesis (Hosmer); *E*, United States Manufacturing Co. Pylon; *F*, Finnie-Jig (Arthur Finnieston Co.). Metal straps for attachment to a plaster-of-Paris socket are available, but not shown. *Courtesy of Veterans Administration Prosthetics Center.*

TABLE 1. SOME CHARACTERISTICS OF AVAILABLE BELOW-KNEE PYLON-TYPE PROSTHESES

	Hosmer Postoperative Pylon	Northwestern Pylon	VAPC "Standard" Pylon	Canadian "Instant" Prosthesis	U S Mfg Co Pylon	Finnie-Jig
Weight without tubes and straps (lb)	0.5	0.75	0.75	1.0[a]	0.75	1.0
Wall thickness of tube (in.)	0.0625	0.0625	0.0625	0.0625	0.0625	0.09375
Outside dia. of tube (in.)	1.625	1.0	1.625	1.625	1.625	1.0
Length of total assembly without tube (in.)	4.0	5.0	3.75	5.0	4.5	6.0
M-L adjustment range (in.)	1.0[b]	1.25	0.75	1.0[b]	0.875	0.875
A-P adjustment range (in.)	1.0[b]	1.0	0.75	1.0[b]	0.875	0.875
Socket flexion-extension adjustment range (deg)	10[b]	10	8	10[b]	10	10
Socket abduction-adduction adjustment range (deg)	10[b]	10	8	10[b]	10	10
Quick disconnect for socket removal?	Yes	No	Yes	No	Yes	No

[a] With plastic socket.

[b] Linear adjustments must be subtracted from angular adjustment or *vice versa* because the adjustments are not independent of each other.

Spongex, mentioned above, have been offered, but none have been accepted widely by prosthetists. Work on this problem is continuing.

EDUCATION AND RESEARCH NEEDS

At the December 1968 "Symposium on Below-Knee Prosthetics" *(6),* sponsored by the Committee on Prosthetics Research and Development, a number of suggestions for improving prosthetics education and practice were offered.

1. The body of knowledge about BK prosthetics that has been developed in recent years should be made available to practicing prosthetists and other clinicians.

2. All institutions offering prosthetics-education courses should include the information presented at the symposium in their curricula.

3. Opportunities for continuing education, such as postgraduate-type courses for clinic teams in the latest prosthetics techniques, should be provided.

4. Additional manuals and other instructional materials should be prepared. In addition, a central group that would be responsible for the orderly preparation and dissemination of technical information is needed.

5. Current research efforts in BK prosthetics should be continued, but with emphasis placed on the development of a truly refined theory of fitting.

Because most of the recent improvements to the design of the below-knee socket, especially in suspension techniques, have been accomplished by practicing prosthetists, there is little need for the research centers to devote their time to developing additional improvements. On the other hand, there is very little knowledge about the basic principles underlying optimum fitting of prostheses. Therefore, the research centers should be encouraged to obtain basic information about the effects of pressure and shear forces on tissues, and to more clearly indicate the biomechanical forces required in the various phases of walking. Following that work, methods by which those principles could be put into practice should be developed, including the use of hydrostatic sockets and other methods that might provide automatic adjustment.

As a result of these suggestions, a pilot course in advanced below-knee prosthetics practices was held at Northwestern University (see "News and Notes") on August 4-13, 1969, for prosthetist instructors from the University of California at Los Angeles, New York University, and Northwestern University. The University Council on Prosthetics Education is now developing a curriculum for short-term postgraduate courses in below-knee prosthetics. The advanced techniques will also be offered in regular courses in below-knee prosthetics.

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The NYU Transparent Socket Fabrication Procedure[1]

Thomas Grille, [2]
Ronald Lipskin, [3] and
Richard Hanak

It has been recognized for a long time that a transparent socket that could be made to fit the stump would be a useful tool in studying the relationship between the amputation stump and the socket of a prosthesis. Early attempts by a number of investigators to devise sockets of acrylics such as Plexiglas and Lucite were abandoned because of the difficulty encountered in controlling the contours and because of the inordinate amount of time required for fabrication of a single socket.

In 1966, the New York University Prosthetics and Orthotics group undertook a comprehensive study to develop a practical method of fabricating a transparent socket using newer materials and fabrication techniques.

The criteria for the selection of the transparent material to be utilized for the socket were that it be water-clear with good transparency, have adequate strength and fracture resistance, and be non-toxic. The method of fabrication was to be reasonably simple and was not to require an excessive amount of actual working time or sophisticated equipment; the materials and equipment were to be readily available.

Two basic approaches were explored: vacuum forming and casting.[4] Transparent polycarbonate sheet material was used in the attempts to make a socket using the vacuum forming method. Below-knee sockets were made by this method, but it was necessary to form the socket in two parts and to bond them together, a procedure which was time-consuming and which required extreme care if accuracy was to be obtained.

Both epoxy and polyester resins were tried for casting transparent sockets. Satisfactory results could be obtained with epoxy resins, but excellent results were obtained consistently with polyester casting resins when RTV silicone rubber was used on the outer surface of a male plaster slush mold and the casting surfaces were covered with polyvinyl chloride film. This article describes the procedures, in a step-by-step fashion, for fabrication of a transparent socket using polyester casting resins.

[1] This study was conducted under the general supervision of Sidney Fishman, Ph.D., Project Director, Prosthetics and Orthotics, New York University Post-Graduate Medical School, New York, N. Y. 10016; under Grant RD-2372-M from the Social and Rehabilitation Service, Department of Health, Education, and Welfare.

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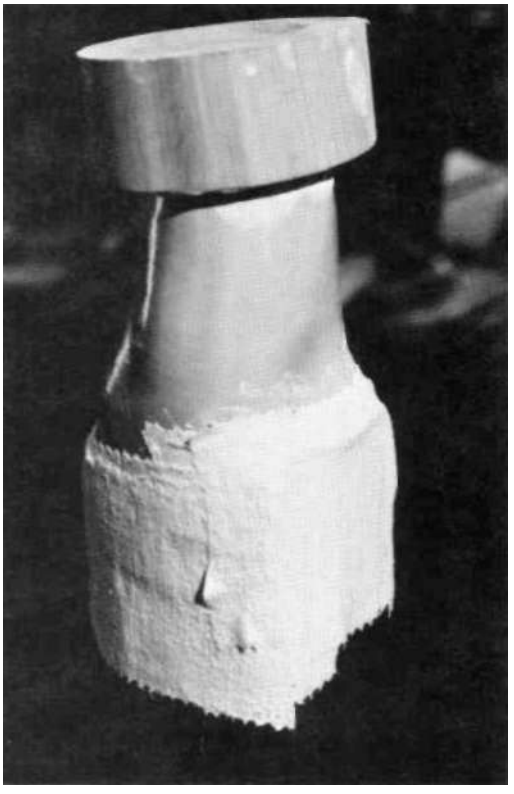
[3] Present address: Prosthetics Center, Bioengineering Research Service, 252 Seventh Ave., New York, N. Y. 10001.

[4] R. Lipskin and T. Grille, "The Development of the NYU Transparent Socket Fabrication Technique," November 1968.

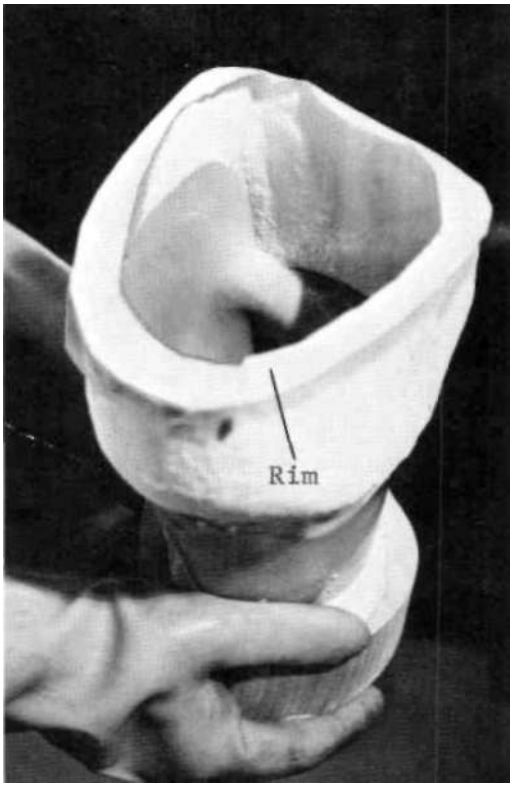
SILICONE MALE MOLD

A conventional hard socket is supported on a wood attachment block during the fabrication of the silicone rubber male mold.



1. Using approximately five layers of plaster bandage, the proximal trim line of the conventional socket is built up to the level that existed prior to trimming (about 1 in. above the proximal end of the socket with the interior surface made reasonably flat). After the plaster bandage has hardened, any rough interior areas are sanded smooth, and any plaster that interferes with the interior contour is removed.

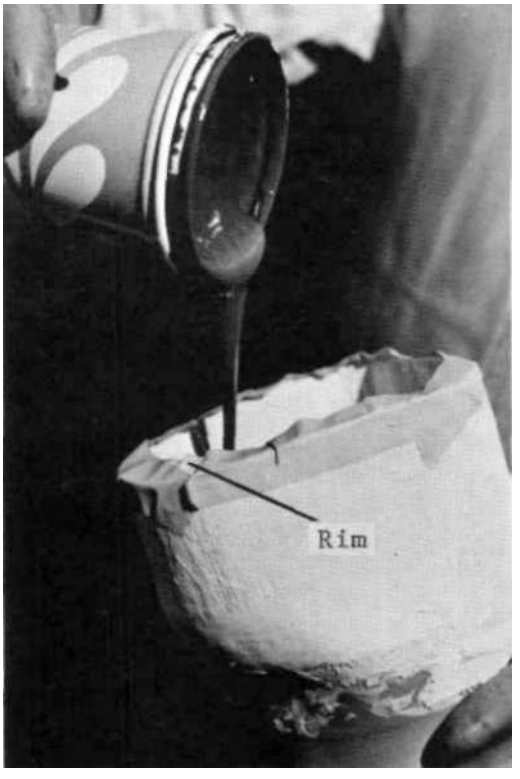
2. To facilitate separation of the silicone shell from the hard socket, the interior surface of the hard socket is sprayed with Dow Corning Silastic RTV Mold Release.



3. In order to retain the liquid silicone rubber in the hard socket, masking tape is used to form a V2-in.-wide rim around the proximal edge of the plaster-bandage buildup.

4. Dow Corning Silastic D RTV Silicone Rubber is mixed with 5% by weight of Silastic D RTV thinner. One-half to one lb of silicone is used for BK sockets and 1-1/2 to 2 lb are used for AK sockets, depending upon socket size.

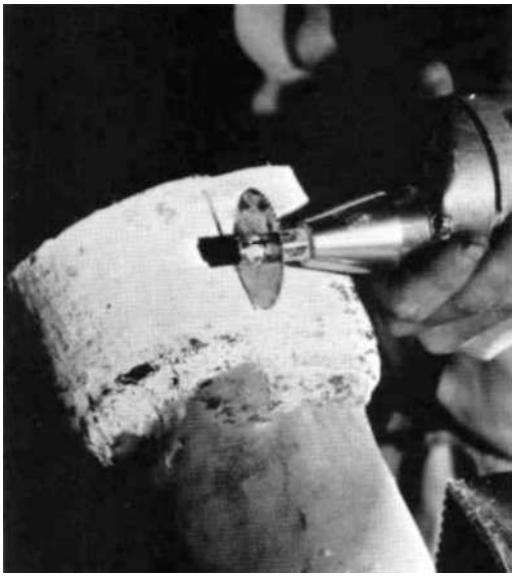
5. Stannous octoate catalyst is added in a ratio of 100 drops or 2.2 gm to 1 lb of silicone rubber. This provides a 10-min working and a 1-hr curing time, which is the optimum for this procedure. The working time can be changed by varying the amount of catalyst. (Although this catalyst recommendation differs from the product-use instructions, its use is suggested because it has been found to be more convenient.) If stannous octoate is not available, a proportion of one part of standard catalyst to five parts of silicone rubber is used.



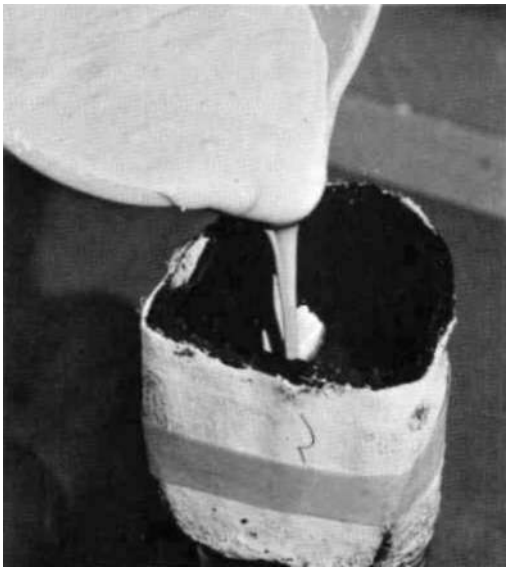
6. The mixture is poured into the hard socket, then the socket is rotated by hand so that the entire inner surface is covered. After this has been accomplished, the socket is rotated only in one direction to insure an even distribution of the mixture to a uniform thickness of approximately % in. The rotation (in one direction) is continued until the mixture is set (10-15 min); the mixture is then allowed to cure at room temperature for 45 min.

A uniform wall thickness of approximately 1/8 in. is important in order to provide adequate shock absorption during break-out and to avoid the formation of an undersized socket.

7. The silicone-rubber shell is pulled away from the medial wall, and a slit is made down the medial side of the socket. The slit will simplify the removal of the completed male mold by permitting the



hard socket to be spread open. The slit is started *V2* in. below the proximal brim and ended 2 in. short of the distal edge. (A wooden tongue blade and a clamp can be used to keep the silicone shell away from the medial wall while cutting the socket.)

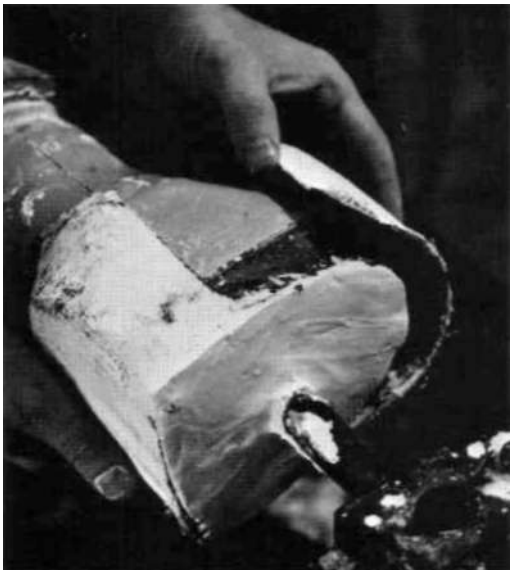


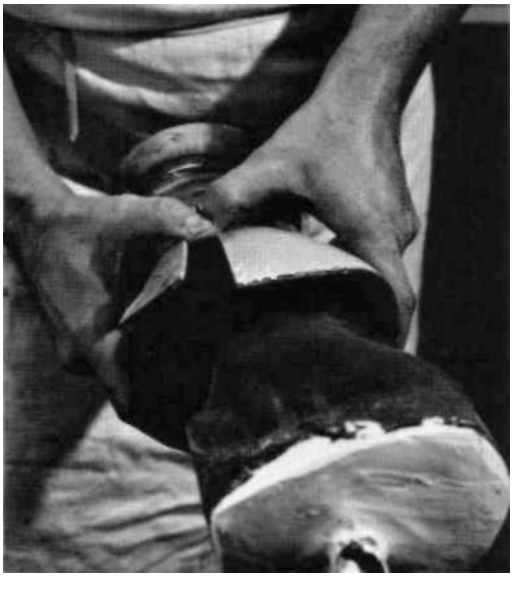
8. The male mold will be fabricated with a hollow core in order to simplify breaking it out of the transparent socket.

With the silicone shell in the hard socket, a plaster slush mold is poured to a 3/4-in. thickness, except at the distal end, where the thickness should be approximately 1-1/2 in. The plaster is allowed to set.

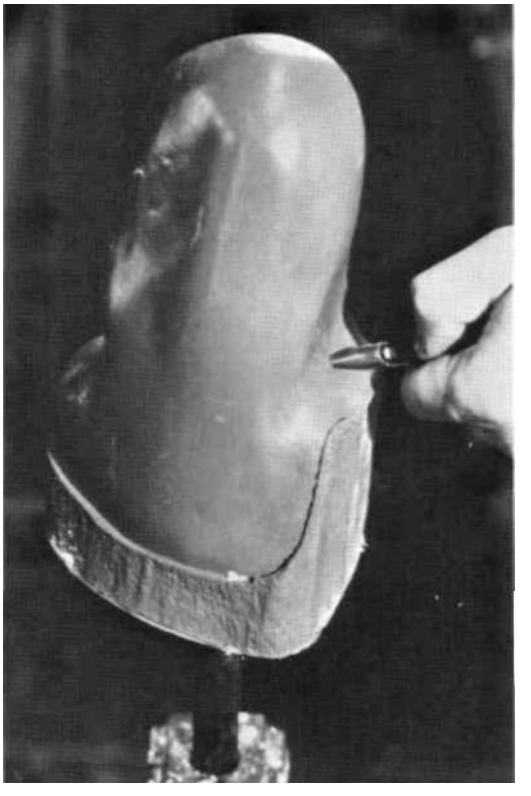
9. A pipe drilled with a few vacuum holes is inserted as a mandrel into the slush mold, and secured at its distal end with additional plaster. The middle section of the mold is filled with paper, and plaster is added at the proximal end of

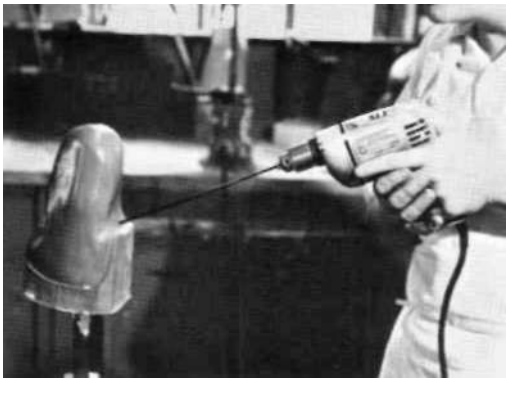
the mold to secure the mandrel. The plaster is allowed to set.



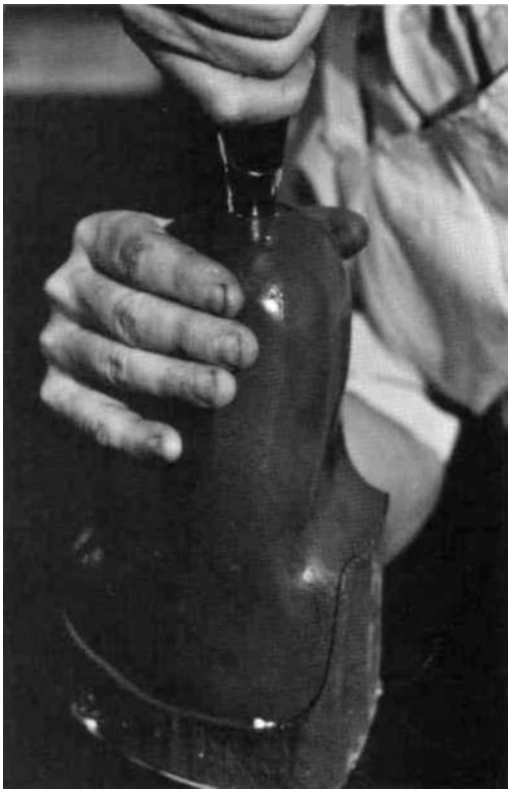


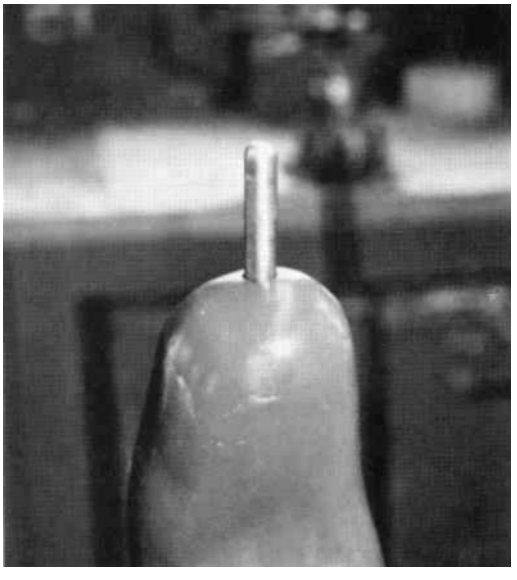
10. To separate the completed male mold from the hard socket, the plaster-bandage buildup is removed, the socket is opened along the slit, and the socket is slipped off.





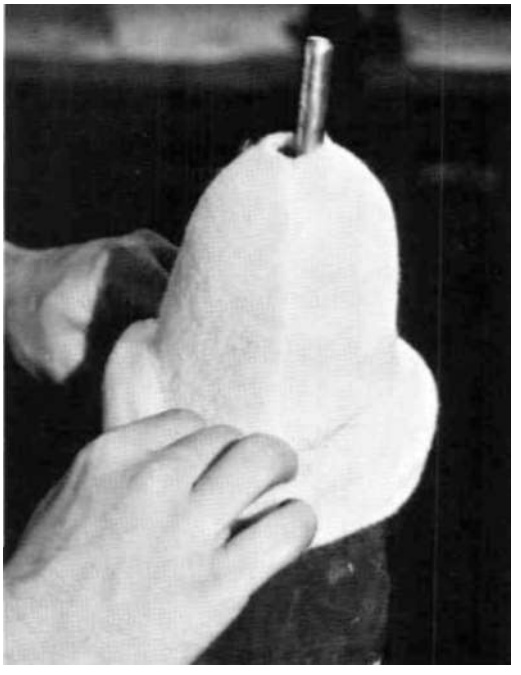
11. To permit the application of vacuum to the undercut areas, 1/8-in. holes are punched through the silicone shell and Vs-in. holes are drilled through the underlying plaster. The holes must be cut through to the void space in the male mold.

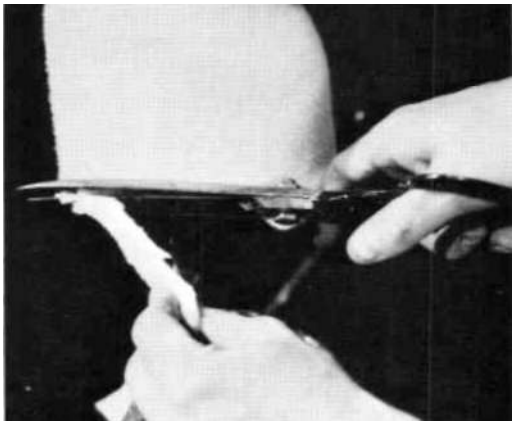




FEMALE MOLD

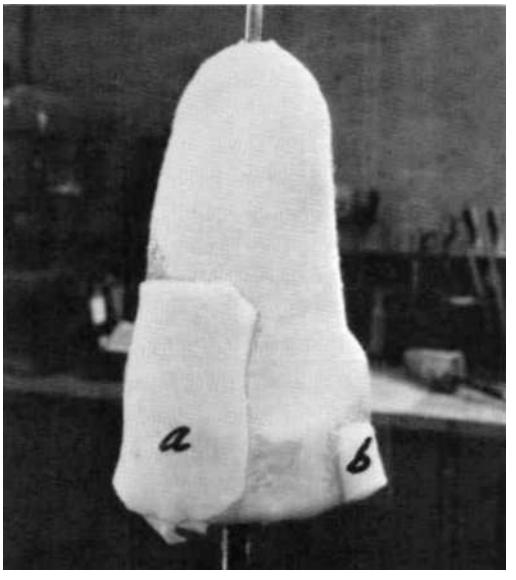
12. An alignment pin is used to insure correct alignment of the distal ends of the male and female molds during casting of the transparent socket. A hole 1/2 in. in diameter is punched in the silicone shell, and one 1/2 in. in diameter and 3/4 in. deep is drilled into the distal aspect of the male mold. An alignment pin, cut 1/2 in. in diameter by 3 in. long of nonferrous metal rod. is inserted into the distal hole.





13. In order to provide a 1/4-in. wall thickness for the transparent socket, a 1/4-in. Dacron felt sleeve, a 1/8-in. Dacron felt sleeve, and a cotton stockinette sleeve are prepared, all to fit over the male mold. Compression eventually will reduce the thickness of the sleeves to the desired

1/4 in. Holes 1/2 in. in diameter are cut in the ends of the sleeves to permit clearance of the alignment pin. The two felt sleeves are pulled over the male mold and trimmed even with the proximal edge of the mold.

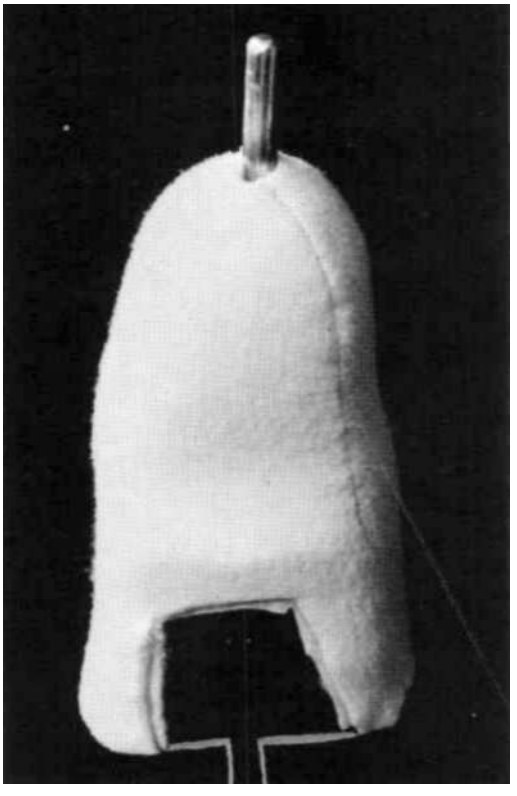


AK Sockets Only

To reinforce the proximal-lateral wall, a 5-in. x 7-in. strip of 1/8-in. felt is attached to the outer sleeve with Barge cement (*a*).

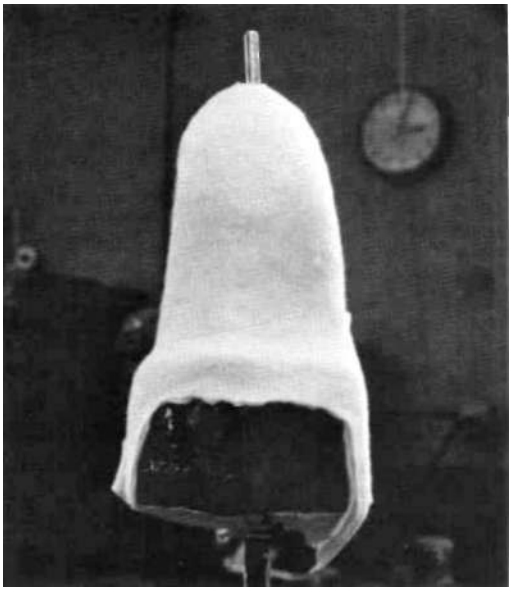
Because of limited space between the male and female molds for AK sockets, a means for pouring the polyester resin into the completed female mold must be provided by creating a lip, or inlet, at its proximal anterior brim (*b*). A triangular piece of 1/4-in. felt is rolled to form a funnel and fastened with Barge cement to the anterior brim of the outer sleeve so that the top of the funnel is even with the top surface of the mold. (The funnel is not needed in the below-knee socket fabrication, because in that case there is adequate space between the male and female molds.)

14. To facilitate alignment of the male and female molds, and to insure a uniform wall thickness of the transparent socket, the felt is cut away in the region above the posterior socket trim line as illustrated. The female mold will be contoured so that a proximal surface of this mold will contact the corresponding surface of the male mold.



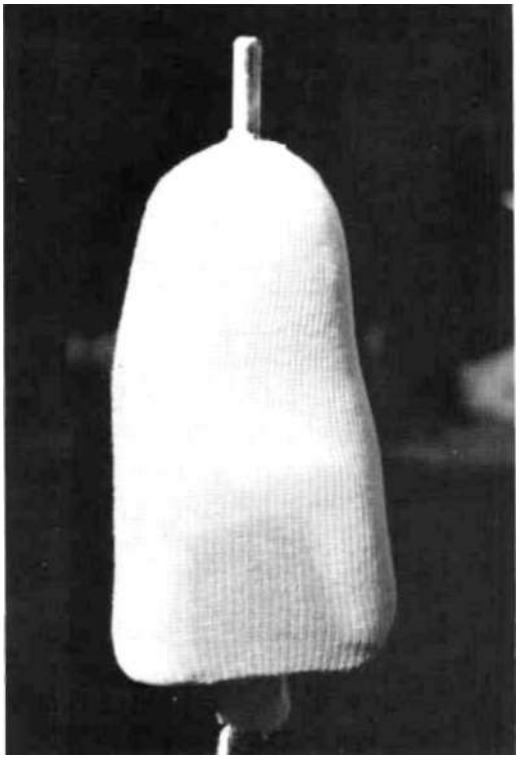
BK Sockets Only

The felt layers are cut out in the region above the popliteal trim line. The cutout should not cross the popliteal trim line.

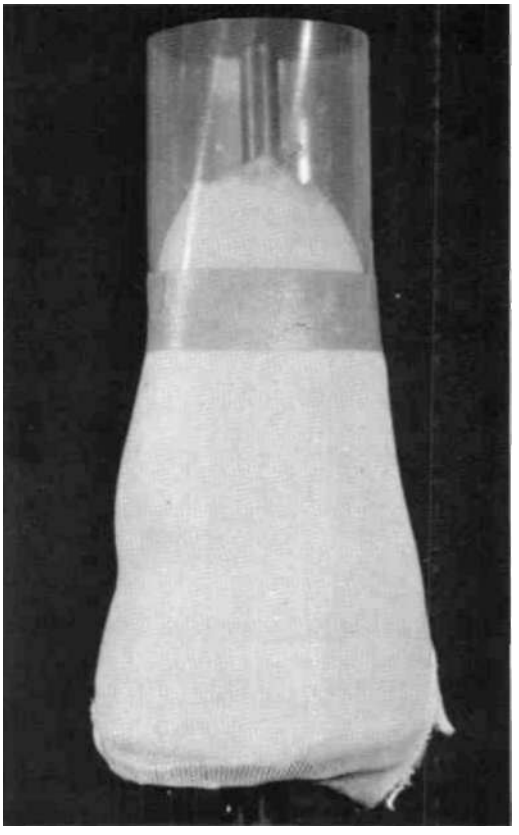


AK Sockets Only

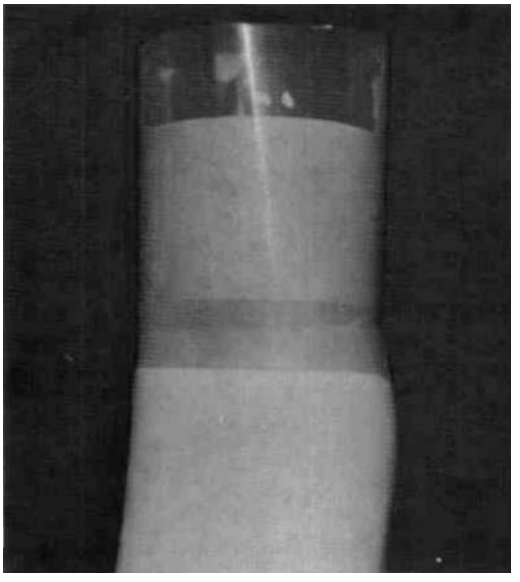
The Dacron layers are trimmed in the flat areas above the posterior and medial brims, leaving approximately 1 in. of uncut material above the socket trim lines.

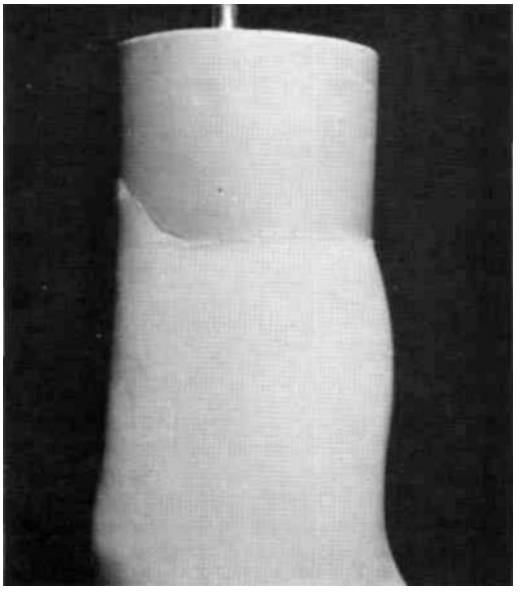


15. The stockinette sleeve is now pulled over the felt on the male mold and tied to the mandrel.

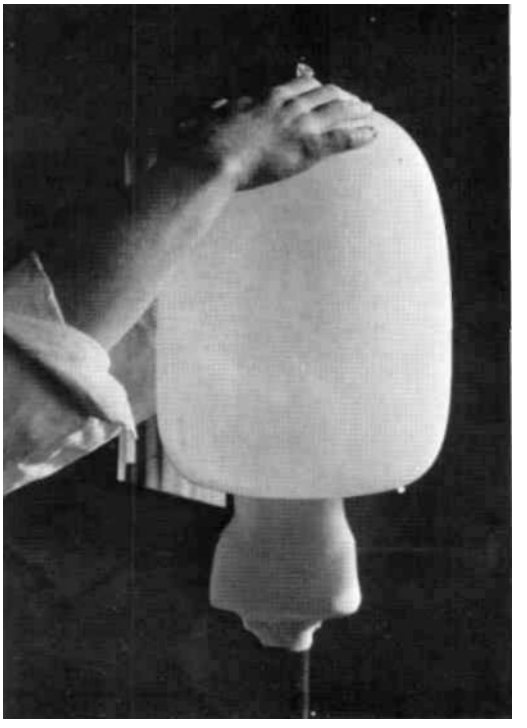


16. To provide for the transparent socket pedestal, a piece of 1/32-in.-thick plastic sheet is wrapped around the distal end of the male mold, over the sleeve, beginning at the point where the male mold starts to slope in and extending to the distal end of the alignment pin. The vertical seam and horizontal juncture line are sealed with tape.

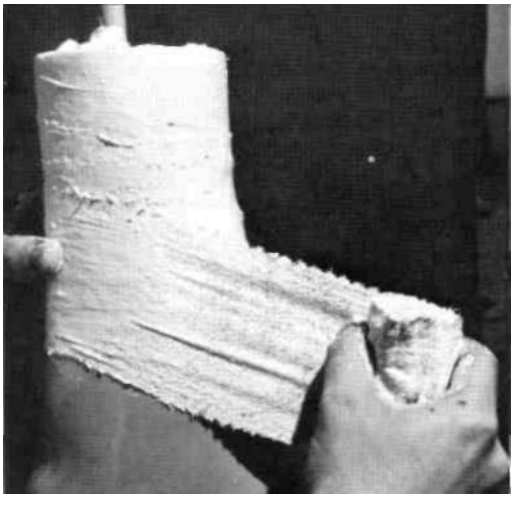




17. Plaster is poured into the cylindrical cavity formed by the plastic sheet, leaving 1/2 in. of the alignment pin exposed above the plaster level. The plaster is allowed to set, and the plastic sheet is removed.

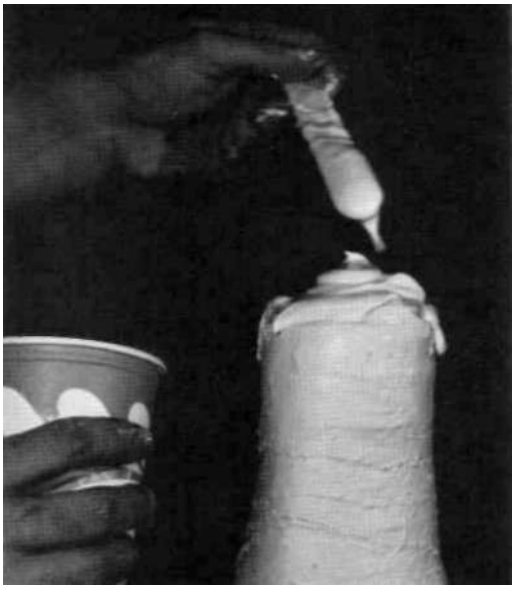


18. An inflated balloon is inverted over the lay-up and pushed downward as the air is slowly released. The distal end of the balloon is tied off around the alignment pin, and the proximal end around the mandrel. The balloon is then covered with a coat of silicone spray.

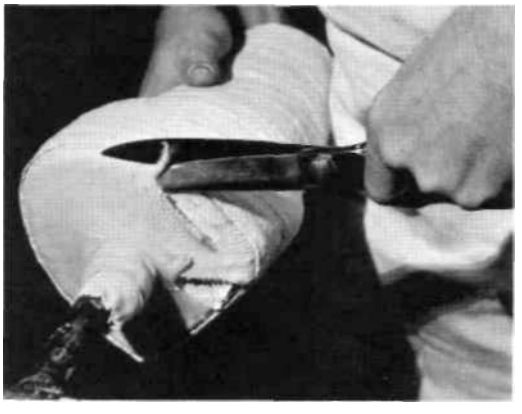


19. To fabricate the female mold, 4-in. plaster bandage is wrapped around the

balloon-covered male mold, starting at the distal end and overlapping each previous wrap by approximately 3 in. until a 4- to 6-layer thickness is achieved. Care is taken to avoid using excessive tension while applying the plaster bandage so as to prevent compression of the felt and reduction of the wall thickness of the transparent socket. In addition, the undercuts *{e.g.,* the patellar region in BK sockets) are minimized or reduced by bridging the bandage in that area.

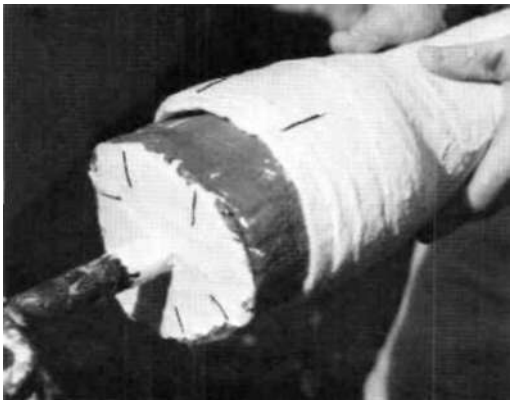


To provide a good receptacle for the exposed length of the alignment pin, it is covered with additional plaster, and the plaster is allowed to set.



20. The balloon and stockinette are trimmed off to expose the proximal end of the mold.

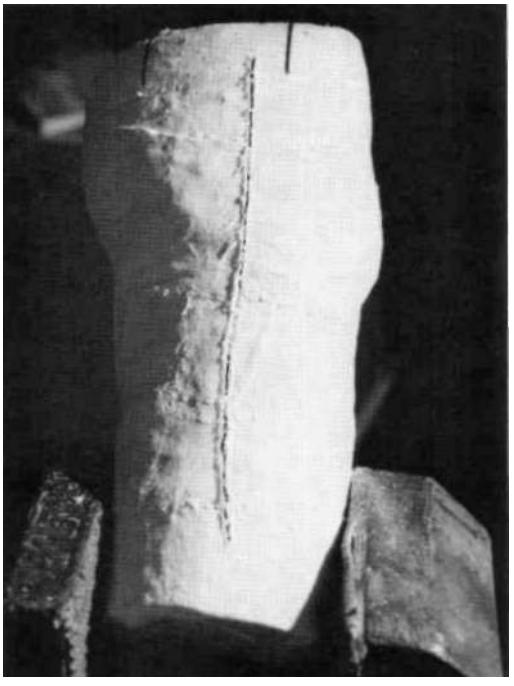
21. Using a combination square or a strip of metal bent to 90 deg as a guide, orientation lines are drawn on the proximal ends of the molds to provide references for their realignment. Two lines on each of the four sides are sufficient.

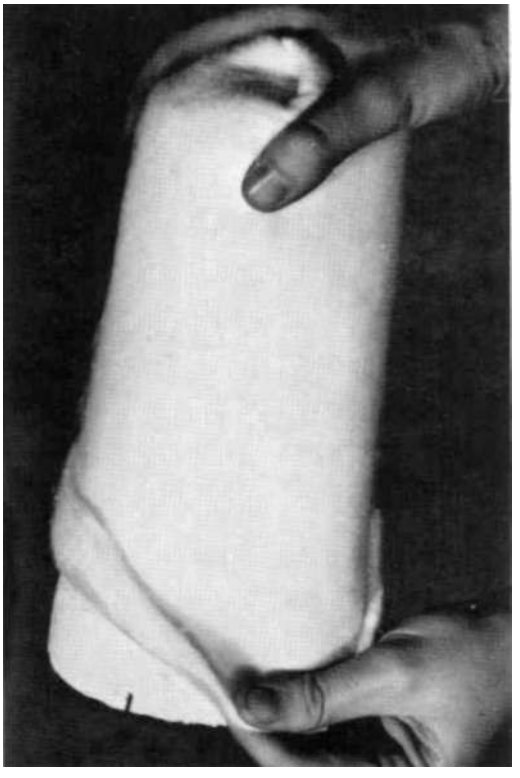


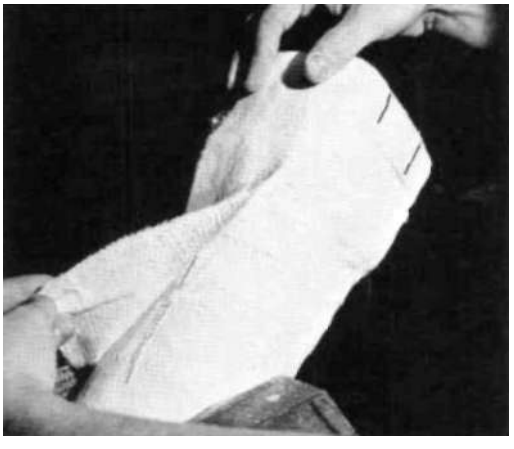
22. The molds are separated, and the felt and stockinette lay-up is removed from the inside of the female mold.

23. The plaster pedestal is broken out of the female mold, and the balloon and the alignment pin are removed without breaking the pin's receptacle.

24. At this point, a slit is made in the female mold to simplify its removal from the transparent socket after casting. Starting 1 in. below the proximal rim on the







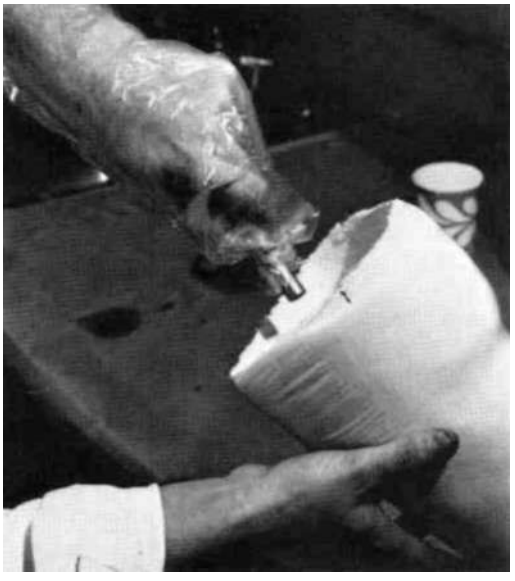
medial side, a cut is made vertically along three-quarters of the socket length. The cut is covered with two vertical layers of plaster bandage on the exterior surface. The interior surface is smoothed where necessary.

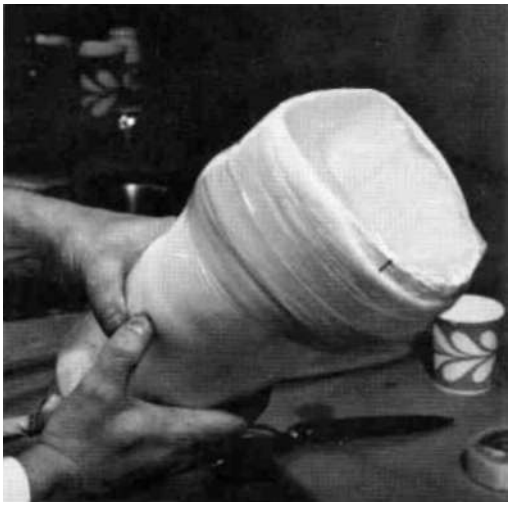
25. To complete the mold, 1/16-in.-dia vacuum holes are drilled in the undercut area of the female mold to insure the correct surface contour on the transparent socket.

ALIGNMENT OF THE MOLDS AND CASTING

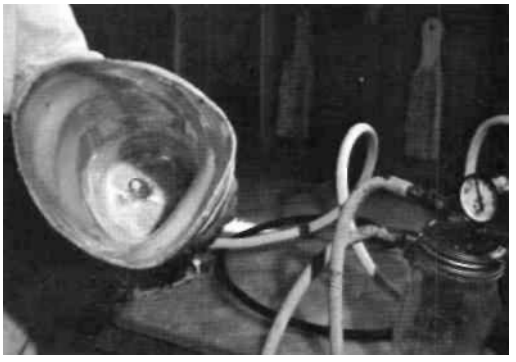
26. The outer surface of the female mold is covered with a 1/4-in. felt sleeve. A PVA bag is pulled over this sleeve, and both covers are trimmed even with the proximal edge. A vacuum tube is attached to the distal end of the PVA bag and secured with plastic tape.

27. A heavy coating of Vaseline petroleum jelly is applied to the inside surface of the female mold.



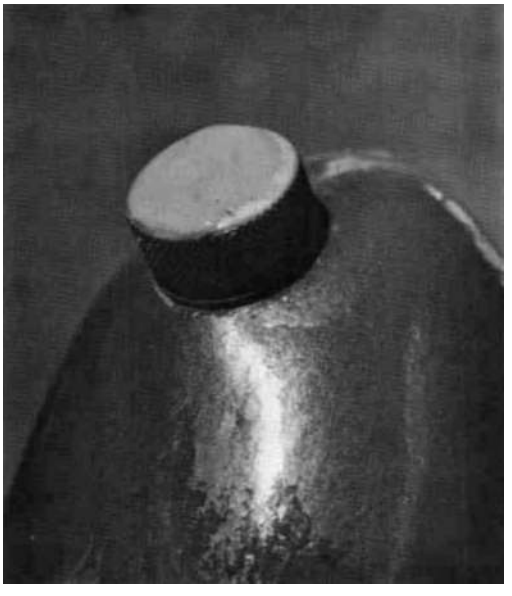


28. The end of a second PVA bag is fastened to the alignment pin with a rubber band and then both are inserted (glossy side in) into the alignment pin receptacle in the female mold. The interior PVA bag is lapped over the exterior PVA bag and sealed with pressure-sensitive tape. At least 4-in. overlaps must be provided because this PVA bag will later be fastened to the male mold mandrel.



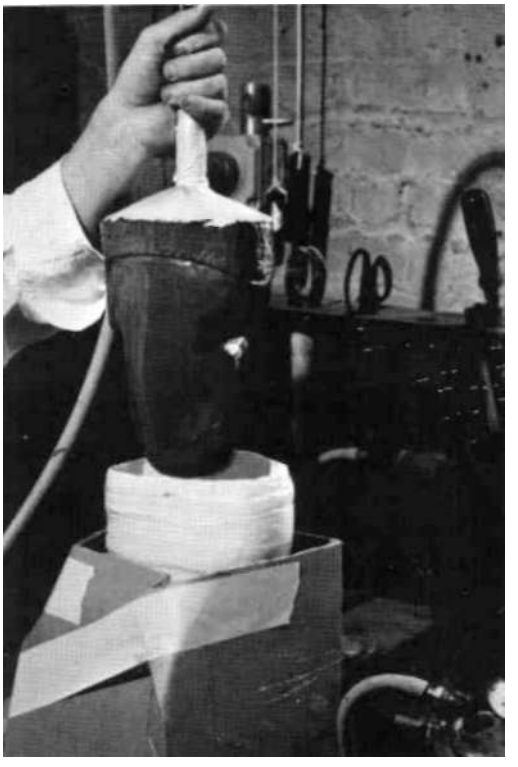
29. Vacuum is applied and the wrinkles are smoothed out on the interior PVA bag. This lining provides the smooth exterior surface of the transparent socket.

30. A PVA sheet (glossy side out) is pulled over the male mold and fastened to the mandrel with plastic tape. The sheet is reinforced around the alignment pin with plastic tape, and a 1/2-in. hole is cut through the tape and the PVA bag for the alignment pin. Vacuum is applied and the wrinkles in the PVA sheet are smoothed out.

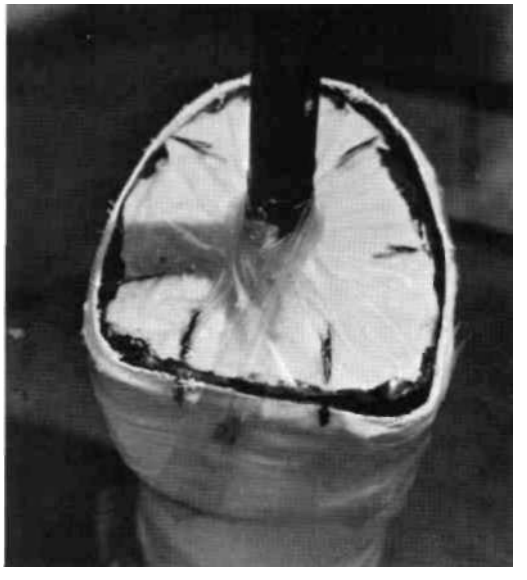


AK Sockets Only

The valve body may be placed before or after casting. If placement is done before casting, the valve body is filled with beeswax and glued with Barge cement to the PVA sheet on the male mold in the appropriate location. The valve body must be so located that it will not subsequently contact the wall of the female mold during the casting procedure.



31. The female mold is placed in a bench vise or other supporting device, with the proximal end up and proximal edges horizontal. The male mold is oriented in the female mold by means of the alignment pin and placed all the way down on the pin.

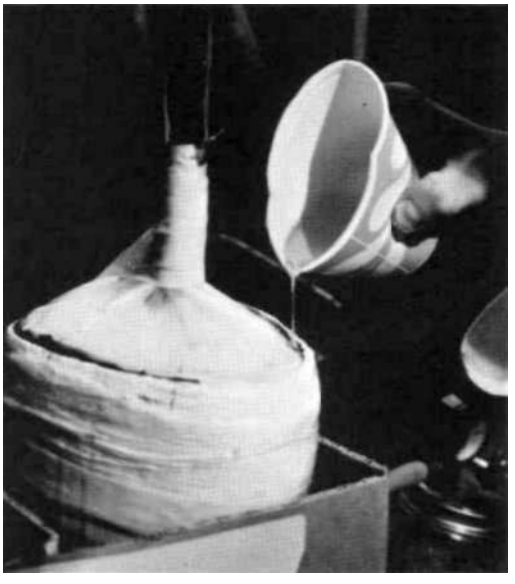


BK Sockets Only

The posterior surfaces of the molds are butted in the region superior to the popliteal trim lines, and the orientation marks are aligned. The molds are taped together securely to maintain the alignment.

AK Sockets Only

The surfaces superior to the posterior and medial brims are butted and the orientation marks aligned. The molds are secured with tape.

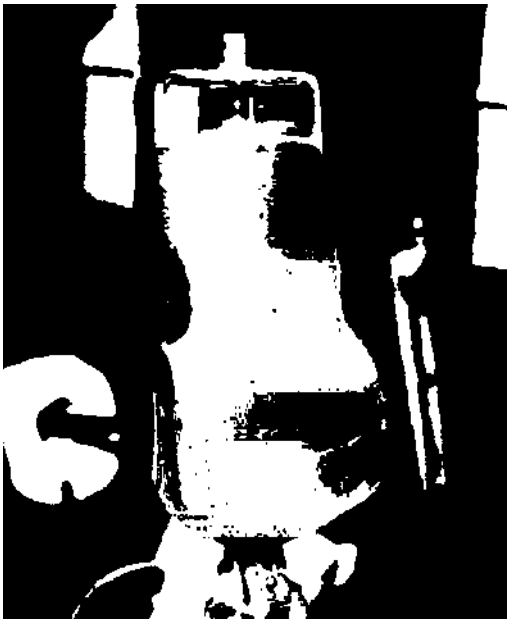


32. One to 1-1/2 qt of polyester casting resin for below-knee or 2 to 3 qt for above-knee sockets (depending on the size) are combined with the catalyst, with constant stirring. The manufacturer's instructions are followed regarding the amount of catalyst required to obtain a "slow setting time." Ideally, the resin should have a 1/2-hr gel time, which is adequate time for pouring. The resin is poured slowly and continuously while the female mold is simultaneously tapped to prevent any air bubbles being entrapped in the casting.

33. After the resin has set to a soft gel (about 30 min), the tape around the PVA bags is removed, and the outer PVA bag and Dacron sleeve are removed. The male mold PVA bag is punctured around the pipe, and the female mold PVA bag is pulled secure and tied to the mandrel.

34. After the resin has set to a firm gel (about 1 hr after pouring), the plaster strips are peeled off the slit in the female mold. The female mold is then removed

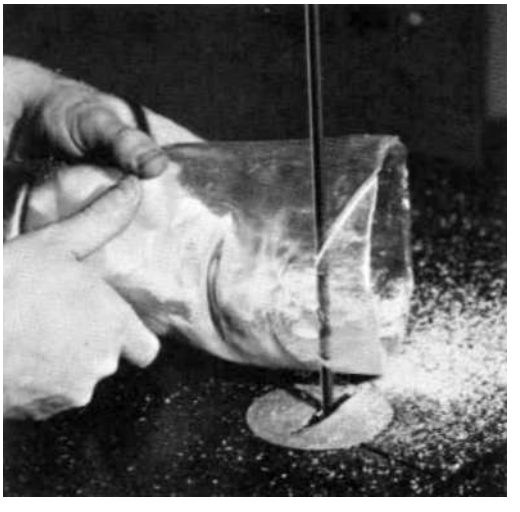
by spreading the slit open, with care being taken not to tear the PVA bag on the transparent socket. The resin is allowed to cure for an additional hour at room temperature.



35. The vacuum equipment is removed. The transparent socket (on the male mold) is heated in the oven at 165 deg F for 4 hours. The oven is turned off, and the socket is left until the oven cools to 125 deg F. This heat-treating helps to eliminate any internal stresses that may have developed during the curing phase.

FINISHING THE SOCKET

36. The PVA bags are cut along the proximal edge of the male mold. To protect the transparent socket surfaces from scarring, the PVA bags are left in place. The plaster slush mold is carefully chiseled away, and the mandrel and silicone shell are removed.



37. The socket is cut down to the proximal trim lines, using a band saw and electric sander. The rough edges are smoothed by hand-rubbing with fine-grade sandpaper. The transparency can be restored to these edges by applying a surface coating of resin to the area, covering with a PVA sheet, and allowing to cure.

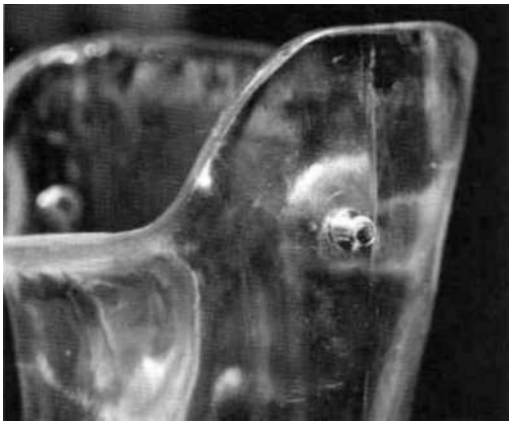
38. Any flashing on the interior surface around the alignment pin is removed, and the bottom of the hole is sealed with tape. The hole is filled with resin and allowed to cure.

AK Sockets Only

If the valve body was placed before the casting, a hole saw of the same size as the valve body diameter is now used to bore through to the valve body. To improve the boring angle, the distal corner of the socket pedestal is sawed and ground down.

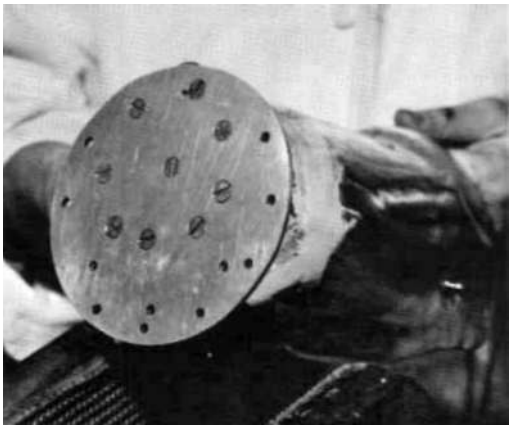
If the valve body has not yet been placed, the anteromedial corner of the socket pedestal is sawed and ground off to provide a flat surface. Then, using a hole saw of the same size as the valve body diameter, a hole is bored through the socket wall. The valve body is carefully secured in place with either polyester resin or epoxy cement so that the inner surface of the valve body is flush with the inner surface of the socket.

39. Before the socket is attached to an adjustable leg, the pedestal base is sanded flat and to the proper alignment angulation, using a disk sander.



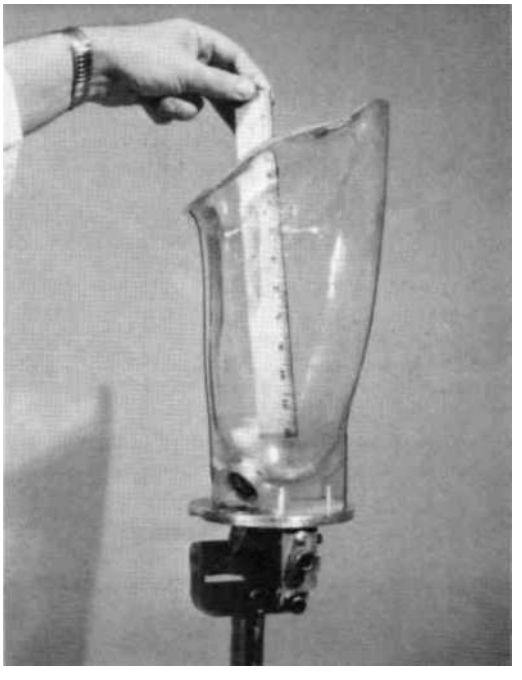
BK Sockets Only

Suspension-strap retainers are attached to the below-knee socket with #8-32 flat-head machine screws. The holes may be countersunk by using an inside countersink tool.

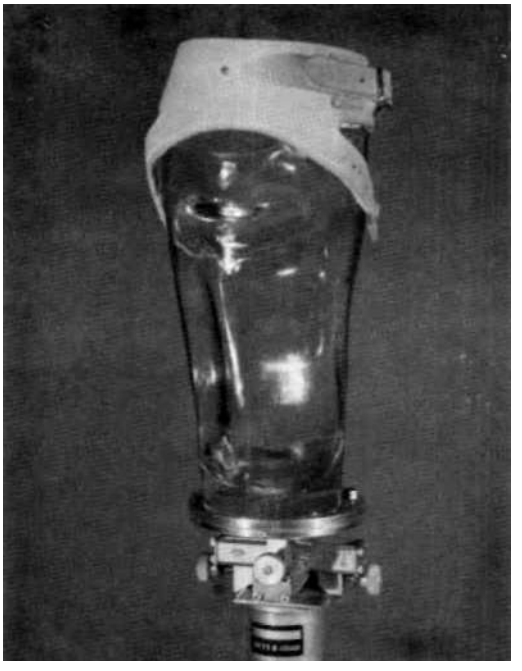


40. The socket attachment plate is fastened to the transparent socket by drilling and tapping eight holes in the pedestal base and securing with flat-head machine screws.

41. The PVA bags are removed, and the completed transparent socket is polished with silicone spray and a soft cloth. (This spray is also a good lubricant to facilitate donning the socket.)



Completed above-knee socket mounted on an adjustable leg.



Completed below-knee socket.

A Method for Location of Prosthetic and Orthotic Knee Joints

Henry F. Gardner [1] and
Frank W. Clippinger, JR , M.D.[2]

When it is necessary to use a mechanical knee joint, whether it be in a below-knee prosthesis or a long-leg brace, ideally there should be no relative motion between the patient's limb and the appliance during its use. Because the human knee is not a single-axis joint, analogues of the human knee employing more than one axis of rotation have been developed but none have proven practical, owing largely to bulkiness, but to some degree to cost. At this time, therefore, we are faced with the problem of determining a method of placing the center of rotation of a single-axis mechanical knee joint with respect to the knee so that the least amount of relative motion will occur between the patient and the appliance.

This article describes a method of determining the optimum location of single-axis knee joints, based on data accumulated recently from X-rays and from cadaver dissection.

FUNCTIONAL CHARACTERISTICS OF THE KNEE

Both the medial and lateral condyles of the femur appear as helical curves, the radii of which become progressively smaller from anterior to posterior. Only a small portion of the surface of the femur is in contact with the tibia at any given moment. Weight, however, is distributed over a larger area by the menisci, which provide smooth contact at any position.

The knee structure is stabilized by cruciate and collateral ligaments, which control the range of motion of the joint and the relative positions of the articulating condylar surfaces. Because the medial and lateral condyles of the femur are not the

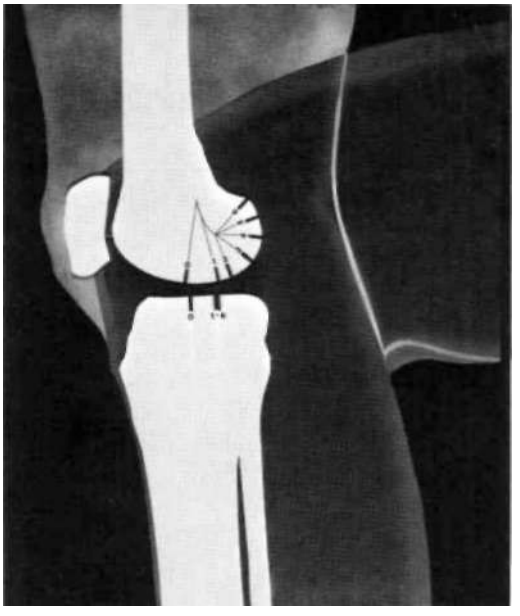


Fig. 1. Points of contact between the femoral condyle and the tibial plateau during knee flexion and extension. The majority of translation occurs in the first 15 deg of knee flexion from a position of hyperextension (point "0"). Successive flexion beyond this point concentrates the point of articulation between points 1 and 6. In prosthetics application, restriction of the knee to 10 deg before full extension confines the instantaneous center of femoral rotation between points 1 and 6.

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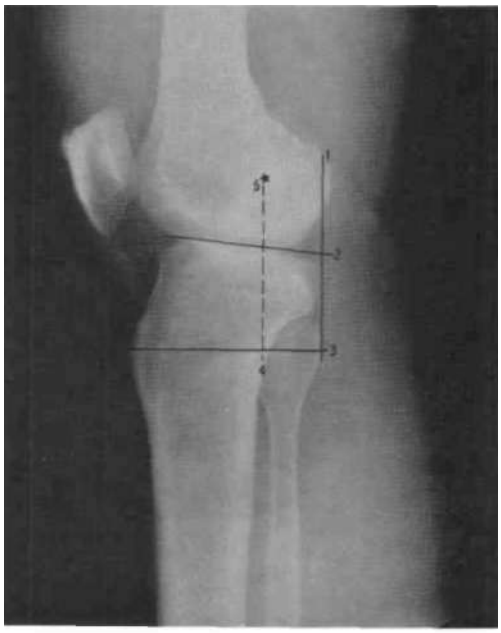

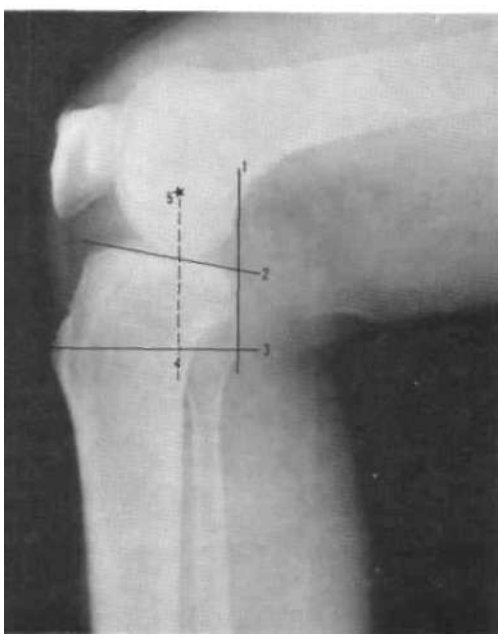

Fig. 2. Typical transverse soft-tissue X-ray views of a normal knee showing the vertical relationship of the posterior borders of the major bony knee segments with the knee in the extended position and in 90 deg of flexion.

TABLE 1

Cadaver	Sex	Measurements (in.)			
		Right		Left	
		Tibial Tubercle to Posterior Fibula	Medial Epicondyle to Lateral Epicondyle	Tibial Tubercle to Posterior Fibula	Medial Epicondyle to Lateral Epicondyle
1	M	2 5/8	3 1/8	2 5/8	3 1/8
2	M	2 7/8	3 1/8	2 7/8	3 1/8
3	M	2 5/8	3	2 5/8	3
4	M	2 5/8	3	2 5/8	3
5	M	2 5/8	3	2 5/8	3
6	F	2 1/4	2 1/2	2 1/4	2 1/2
7	M	2 3/4	3 1/8	2 3/4	3 1/4
8	M	2 3/4	3	2 3/4	3 1/8
9	M	2 3/4	2 7/8	2 3/4	2 3/4
10	F	2 3/4	3	2 3/4	3
11	F	1 3/4	2 1/2	1 3/4	2 1/2
12	F	2 3/8	2 5/8	2 3/8	2 5/8
13	M	2 1/8	2 3/4	2 5/8	2 7/8
14	F	2 1/8	2 1/2	2 1/8	2 1/2
15	F	2 1/8	2 1/2	2 1/4	2 1/2
16	F	2 1/8	2 5/8	2 3/8	2 5/8
17	M	2 3/4	3	2 3/4	3
18	M	2 5/8	2 7/8	2 5/8	2 7/8
19	F	2 5/8	2 7/8	2 5/8	2 7/8
20	M	—[a]	—[a]	3	3 3/8
21	M	2 3/4	3	2 5/8	3

[a] Right above-knee amputation.

same size, a transverse rotation of the femur takes place as the knee approaches full extension, causing the collateral and cruciate ligaments to tighten, and binding the femur and tibia tightly together in the weight-bearing position. Thus, as the knee begins to flex from the extended position and the femur rolls on the head of the tibia, the medial condyle rotates approximately 15 deg while the lateral condyle rotates approximately 20 deg. Then a slipping or gliding motion begins. Although the total flexion-extension range of the knee is approximately 160 deg, the first 110 deg is the most useful segment for prosthetic application, since this arc includes the full range required for walking (70 deg) and for sitting (100 deg).

The numbered references in Figure 1 show the areas on the femoral condyle and the tibial plateau where contact is made

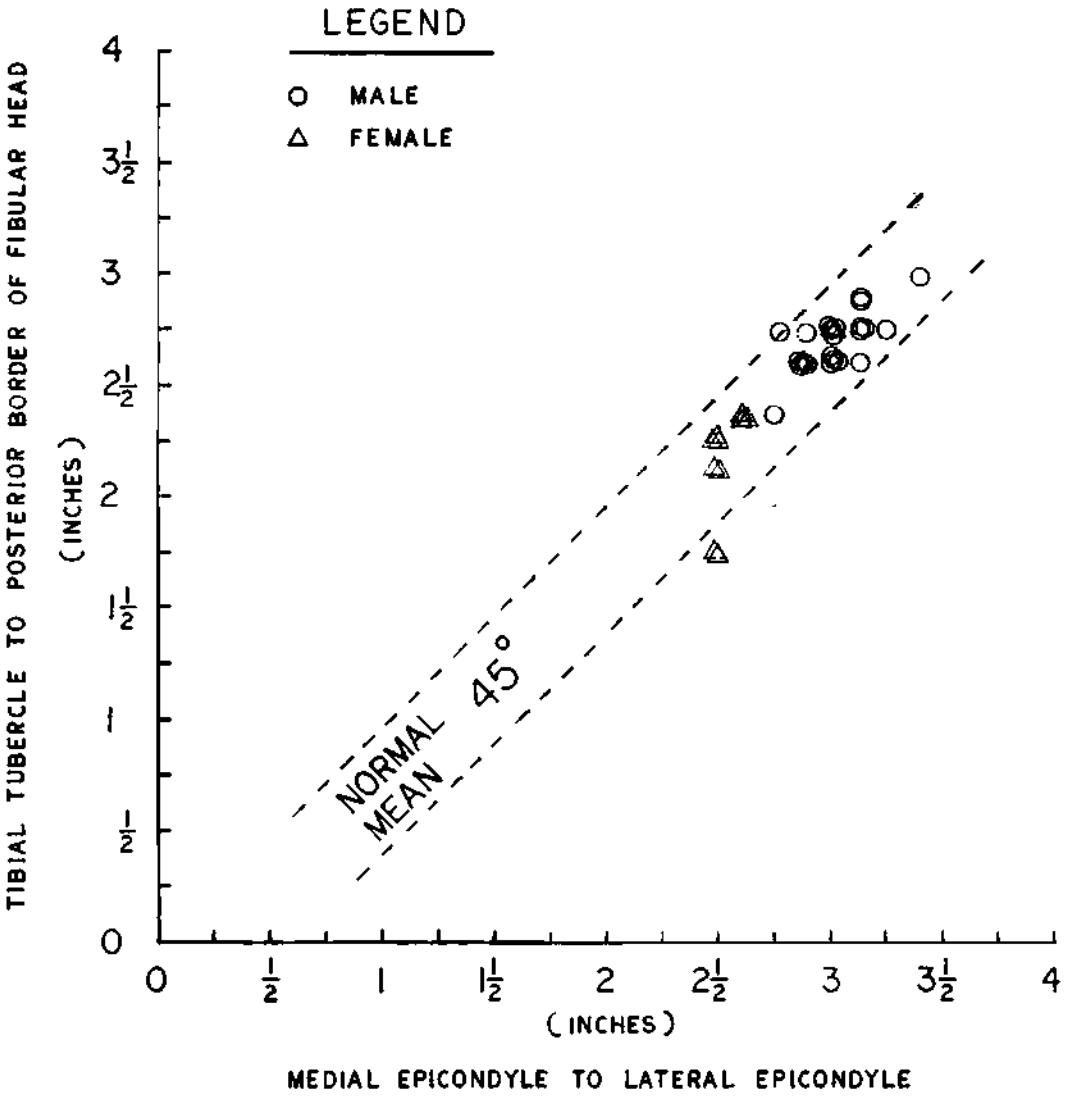

Fig. 3. Dimensional proportionality of widths at the femoral epicondyles related to the measurements between the tibial tubercle and the posterior border of the fibular head.

successively as the knee is flexed or extended. Points "0" on the femur and tibia indicate the contact relationship between the bones when the knee is in 5 deg hyperextension. During the first 20 deg of knee flexion, the condylar surfaces of the femur roll posteriorly on the tibia from point "0" to point "1." The greatest migration of the instantaneous center of rotation takes place during the first 15-20 deg of flexion. During the latter portion of the first 20 deg of knee flexion, a progressive sliding begins (between points "1" and "2"). Once the center of rotation reaches point "2," it remains relatively fixed during the remainder of the flexion range. This point is considered to be the optimum location for single-axis mechanical joints, especially if the knee is not permitted to extend fully. However, the usefulness of this point de-

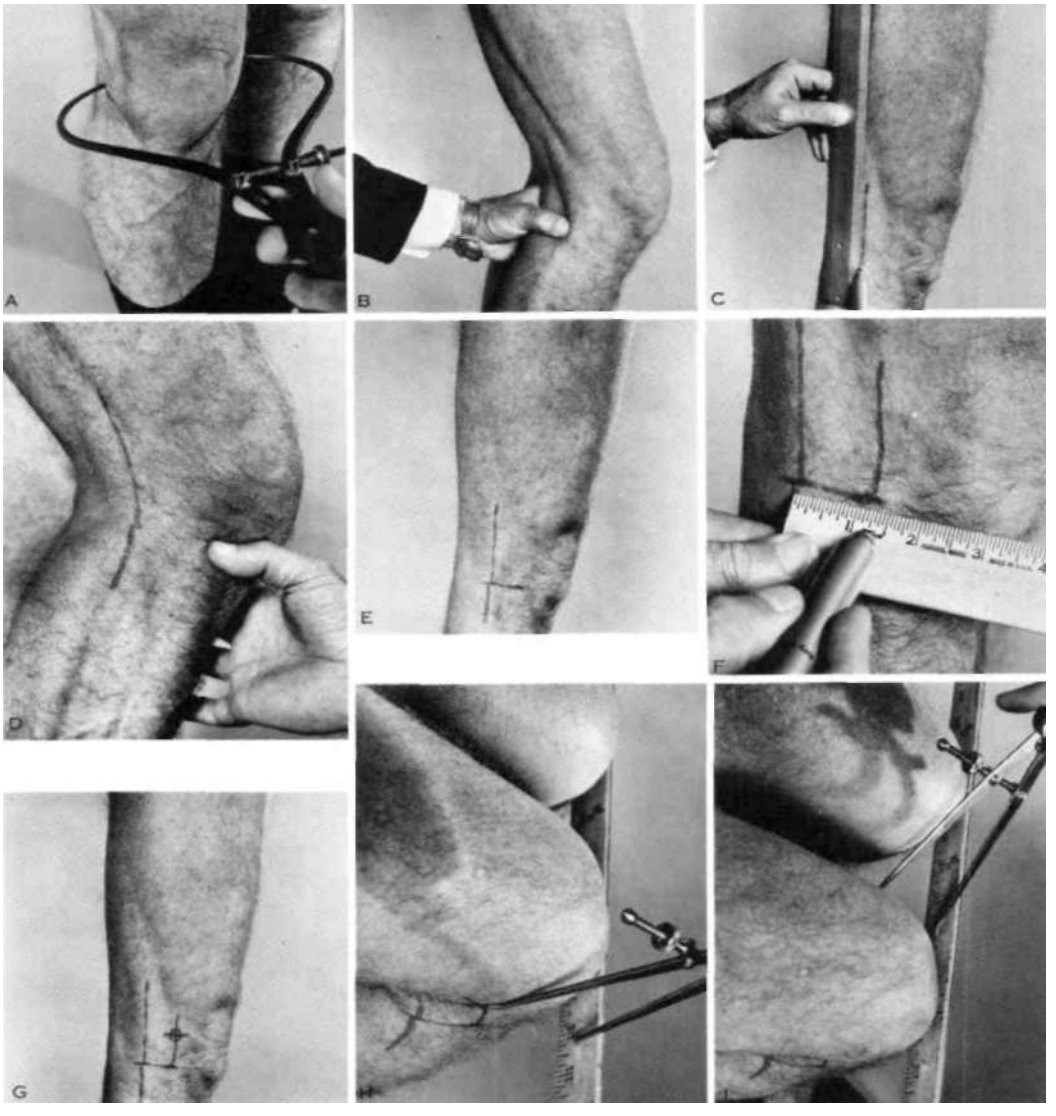

Fig. 4. Steps in locating functional knee center.

pends on one's ability to locate it by reference to external bony landmarks.

X-RAY STUDIES OF THE KNEE

X-ray studies of knee motion were undertaken in an attempt to find landmarks that had a constant relationship to the optimum center of rotation. Analysis of over 500 X-rays of the knee, such as those shown in Figure 2, taken in various phases of extension and flexion revealed that the posterior femoral condyles, the posterior tibial condyles, and the posterior border of the head of the fibula are in approximately vertical alignment throughout the useful range of flexion-extension (lines 1, 2, and 3). Although the patella and the anterior fleshy-knee outline appear to recede posteriorly under the tensions exerted by the quadriceps, the posterior aspects of the

TABLE 2

Mediolateral Dimension of Knee (in.)	Measurement from Posterior Border of Fibular Head Forward at Tibial Plateau (in.)
4½	1⅜
4¼	1¼
4	1⅛
3¾	1
3½	⅞

Example: Locating the functional center of knee rotation for a medial-to-lateral fleshy-knee measurement of 4¼ in. requires placing the vertical reference line 1¼ in. anterior from the posterior border of the fibular head and 1¼ in. above the tibial plateau on the vertical reference line.

femoral and tibial condyles and the posterior border of the fibula remain in the same relative posterior vertical alignment.

Because there is only very thin tissue covering the anterior border of the tibia and the tibial tubercle, they are easily palpable, and therefore should make better reference points than the poples.

ANALYSIS OF THE KNEE JOINT BY DISSECTION

The knee-joint measurements obtained from 21 adult cadavers are given in Table 1 and Figure 3. An analysis of these measurements indicates that the difference between the anterior-posterior measurements of the stump and the actual bone dimensions is approximately 3/4 in. The mediolateral dimensions vary approximately 3/4 in. between the external measurement and the actual epicondylar width.

LOCATION OF KNEE CENTER

Based upon the dimensional relationships shown in Table 1 and Figure 3, a method (Fig. 4) is advanced for locating the approximate functional knee center, using the figures in Table 2.

A. With the patient standing and leg extended, measure the knee width at the condyles.

B. With the patient standing, knee flexed and relaxed, locate the posterior border of the fibular head.

C. With the patient standing and the knee vertically extended, mark a reference line up the knee and lower thigh.

D. With the patient standing, leg unweighted and knee slightly flexed, locate the lateral tibial plateau by pressing into the knee with the thumb.

E. Keeping the thumb in position to maintain the exact location as the patient extends the knee, mark the tibial plateau level horizontally.

F. Using the applicable figure from Table 2, mark the measurement at the plateau level and extend a line vertically from that point toward the thigh.

G. Using the same measurement as in step F, mark the axis reference on the anterior vertical line horizontally.

H. To mark the knee center references on the medial side, have the patient sit with the medial aspects of the knees 1/2 in. apart, flexed at 90 deg. Place a straight edge across the patellas. Measure the distance from the straight edge to the lateral reference (step G) and mark the measurement on the medial side (I). Measure the distance of the lateral reference from the floor and mark the measurement on the medial side.

ACKNOWLEDGMENTS

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Radiographic Evaluation of Stump-Socket Fit[1]

C. B. TAFT[2]

The critical relationship between accurate fit of a prosthesis and amputee comfort and function constitutes the foundation of all prosthetic fitting. Consequently, one of the most important features of a lower-extremity prosthesis is the distribution of the pressures applied to the stump by the socket. Since World War II, considerable progress has been made in the design of sockets, leading to the widespread use of "total-contact" sockets for amputations at all levels. However, reliable objective information regarding the relationship of the stump to the socket below its proximal brim is masked by the opaqueness of the socket material. The use of conventional materials *(e.g.,* chalk, talcum, clay, and lipstick) to determine the adequacy of fit and the achievement of total contact has proved of limited value in the accurate diagnosis of fitting problems.

The use of X-rays as a means of checking stump-socket fit has been discussed by several investigators *(1-5).* Conventional X-ray films of the stump in the socket from the front and side under weight-bearing conditions have been of considerable value in determining total contact, fit, and alignment, but the films obtained by conventional techniques do not always reveal a clear demarcation between the soft tissues of the stump and the inner surface of the socket (5). A radiographic method or procedure that would consistently give an adequate visualization of the stump-socket interface would provide valuable information for the physician and for the prosthetist in fitting patients. Such a procedure would also contribute to overall knowledge in this area of prosthetics, and this knowledge would aid in teaching the proper fabrication of sockets.

Some preliminary experimental work relevant to the above-stated deficiency, reported by Dr. N. C. McCollough, involved the topical application of an X-ray contrast material to the skin of the stump (5). Two or three coats of a saturated solution of sodium iodide in absolute alcohol were applied to the stump with a sponge and allowed to dry. The usual number of stump socks were then applied, the stump was inserted into the prosthesis, and films were made under weight-bearing conditions in the anteroposterior and lateral projections. The films obtained by this method provided a clear outline of the periphery of the stump, and any lack of total contact was easily recognized.

The purposes of the present study were to assess the value of radiopaque materials in the evaluation of stump-socket fit on a broader basis, and to develop a satisfactory procedure for routine clinical use in determining achievement of total contact and in diagnosing pressure problems more accurately.

SAMPLE

The sample for this study consisted of 16 adults (15 males and 1 female), of whom 8 were below-knee and 8 were above-knee amputees. The below-knee prostheses

[1] This study was conducted under the general supervision of Sidney Fishman, Ph.D., Project Director, Prosthetics and Orthotics, NYU Post-Graduate Medical School, 317 E. 34th St., New York, N. Y. 10016; with financial support from Grant RD-2372-M from the Social and Rehabilitation Service, Department of Health, Education, and Welfare.

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were the patellar-tendon-bearing type, with and without Kemblo inserts. The above-knee prostheses had quadrilateral sockets of various types: wood open end, wood distal air chamber, and plastic total-contact suction socket.

Prior to participation in the study, each prospective subject was questioned concerning previous X-ray exposure and allergy to iodine solutions, in order to exclude patients with a history of extensive X-ray exposure or iodine sensitivity. A statement of informed consent was executed by each subject.

METHODOLOGY

The study encompassed investigation of the following radiopaque materials and X-ray techniques.

MATERIALS

1. Hypaque-M, 90% (Winthrop): An aqueous solution of sodium and meglumine (methylglucamine) diatrizoates, water-soluble organic compounds, used primarily as a contrast medium in studies of the cardiovascular system. Each milliliter supplies 462 mg of iodine.
2. Sodium iodide: A saturated solution in absolute alcohol.
3. Sodium iodide: A saturated solution (44%) in isopropyl alcohol (70%). Each milliliter supplies 374 mg of iodine.

PROCEDURES

Two or three coats of the contrast medium were applied with a sponge to the entire surface of the stump; the skin was allowed to dry between coats. The procedure was varied by also applying the contrast medium to the inner surface of the socket insert, and by applying lead foil on pressure-sensitive tape to the inner surface of the socket (or socket insert) as a radiopaque marker. The patient then donned his prosthesis, and weight-bearing films were made in the anteroposterior and lateral projections, using either high-speed screens or Kodak Royal Blue Ready-Pack Medical X-ray Film.

The X-ray unit used was a Westinghouse with an 85-kv peak capacity, and the settings were varied from 100 ma, 1/2 sec, 70 kv, 36-in. tube distance, to 100 ma, 1-1/4 sec, 85 kv, 36-in. tube distance, depending on the type of film.

Additional films were taken *without* application of a contrast medium to the stump for half of the subjects. Also, in several instances films were taken while the artificial leg was bearing no weight, *i.e.,* in the mid-swing position.

RESULTS

The techniques used in this study were very satisfactory in providing a definite outline of the periphery of the stump. The films demonstrated a sharp demarcation between the soft tissues of the stump and the inner surface of the insert or socket, thereby clearly indicating the presence or absence of total contact and identifying pressure areas more accurately.

With the X-ray equipment used for this study, the optimum settings were determined to be:

High-Speed Screens: 100 ma, 75 kv, 1/2 sec, 36-in. distance

Ready-Pack Film: 100 ma, 85 kv, 1 sec, 36-in. distance

Excellent results were obtained with all three of the contrast media, and no significant differences were noted in the films obtained with the three solutions. The saturated solution of sodium iodide in absolute alcohol dries on the skin a little more rapidly than a saturated solution in isopropyl alcohol 70%, but because of Federal regulations, detailed record-keeping is required when absolute alcohol (ethanol) is used. Hypaque-M, 90%, while more expensive than a sodium iodide solution, has the advantage of being commercially available and therefore not requiring the services of a pharmacist for its preparation. Because the iodine compounds are highly water-soluble, they are readily washed off the skin with water after completion of the X-ray exposures. No adverse effects *(e.g.,* skin eruptions) were mani-

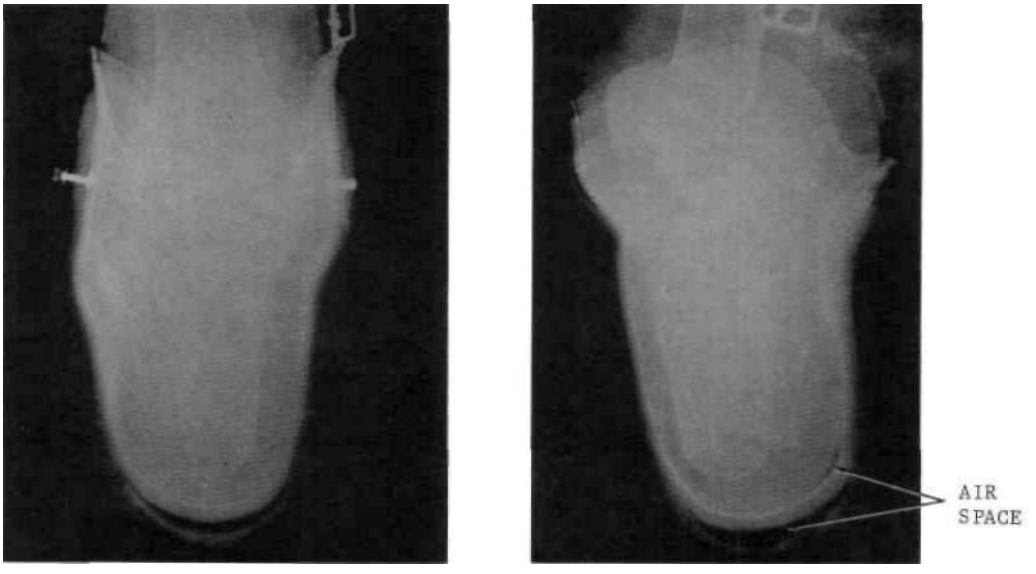

Fig. 1. *Left,* anteroposterior and *right,* lateral weight-bearing views of a below-knee stump, coated with contrast material, in a *well-fitting* PTB socket. Note excellent contact between stump and insert except for small air space posteriorly at distal end. Note also the undesirable space between insert and socket at distal end.

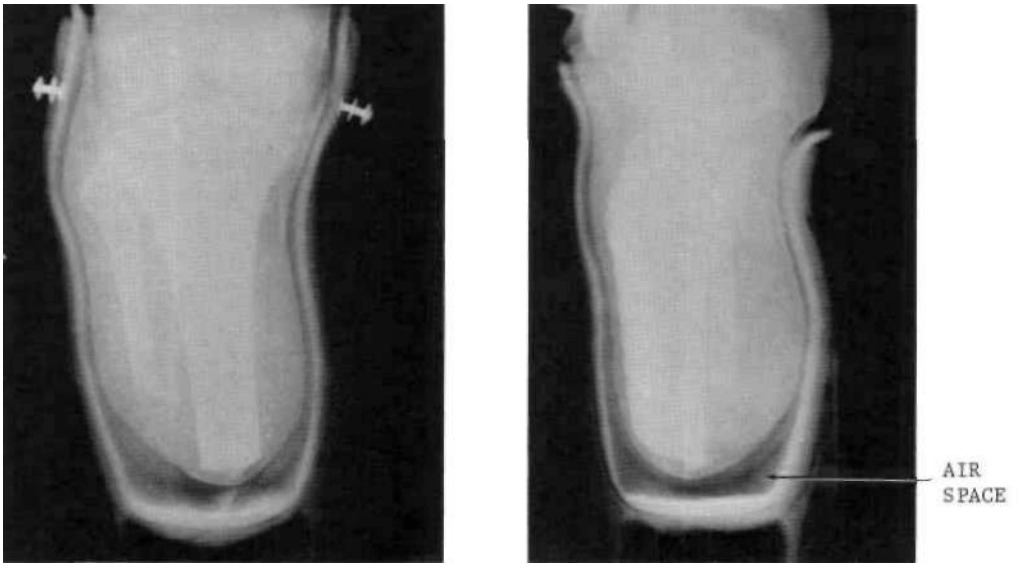

Fig. 2. *Left,* anteroposterior and *right,* lateral weight-bearing views of a below-knee stump, coated with contrast material, in a *poorly fitting* PTB socket. Note lack of distal contact and inadequate bearing on the patellar tendon.

fested by any of the patients as a result of these preparations.

Application of a contrast medium to the inside of the Kemblo insert (leather backed by rubber) or the inside of the socket (plastic or wood) was not found to be necessary in order to secure satisfactory results. The rubber backing of the Kem-

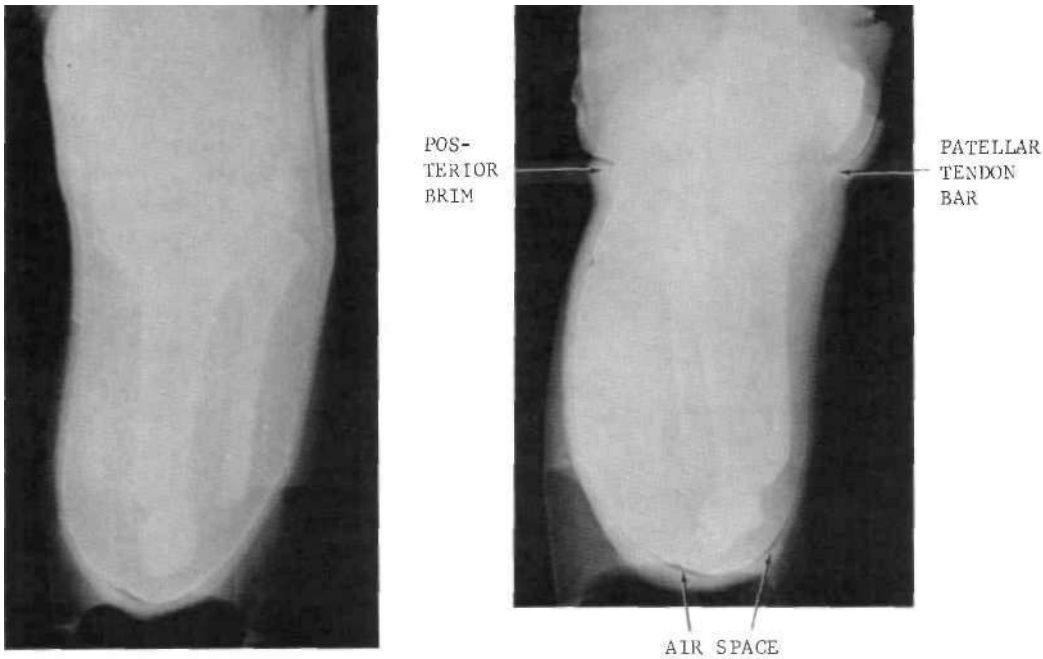

Fig. 3. *Left,* anteroposterior and *right,* lateral weight-bearing views of a below-knee stump, coated with contrast material, in a hard-socket PTS prosthesis with medial condylar wedge. Note that total contact is satisfactory, except for small air spaces at distal end, but the patellar-tendon bar is too high and the posterior brim is insufficiently flared to provide an adequate shelf in the popliteal area. Note also *(right)* the apparent increased radiodensity in the patellar-tendon weight-bearing area.

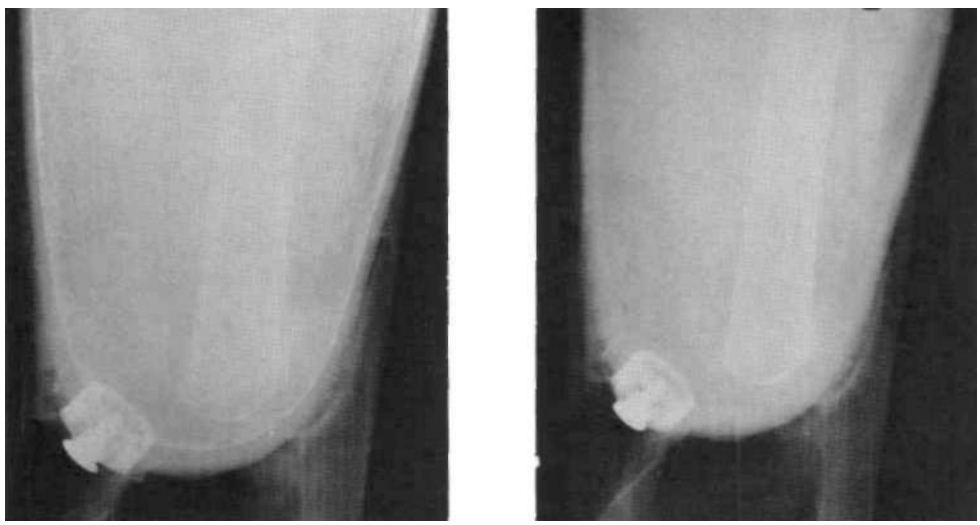

Fig. 4. *Left,* anteroposterior weight-bearing view of an above-knee stump, coated with contrast material, in a plastic hard-end total-contact suction socket. Note clear delineation of the stump-socket interface, showing excellent total contact. *Right,* conventional anteroposterior weight-bearing view of same stump and socket, using same X-ray settings. Note blurring of stump-socket interface.

bio insert and the plastic or wood of the socket are adequately radiopaque for clear demarcation of the inner surface of the prosthesis. The films obtained with the additional step were only marginally superior to those obtained without it, and furthermore, the contrast media tend to stain socket materials, particularly leather.

In several instances, lead foil was used successfully as a radiopaque marker of the interface between stump and insert, particularly in cases involving a removable distal-end pad which was not satisfactorily delineated otherwise. This material is available from the Minnesota Mining and Manufacturing Company as Pressure-Sensitive Tape #420-Lead Foil.

Examples of films obtained after application of a contrast medium to the stump are shown in Figures 1, 2, and 3. The periphery of the stump is clearly outlined in the films, so that the accuracy of socket fit may be readily determined: whether there is total contact; whether the suitable weight-bearing areas of the stump, such as the patellar tendon, the popliteal space, and the medial and lateral condyles, are being utilized to the best advantage; and whether adequate reliefs have been provided for the head of the fibula and the tibial tubercle.

Inspection of the contrast-medium films for objective indications of stump-socket pressure gradients tentatively suggests, as also remarked upon by McCollough, that areas of compression *(e.g.,* over the patellar tendon) show increased density of the contrast material. An example of this phenomenon is shown in the lateral view of Figure 3, where increased radiodensity is apparent in the patellar-tendon weight-bearing area.

Although X-ray films obtained by routine methods, without the use of a contrast medium, provide considerable useful information about stump-socket fit, they do not always reveal a clear demarcation between the soft tissues and the socket. This observation was confirmed in the present study on comparing films made with and without a contrast medium taken on the same patient, using the same X-ray settings for both series. With few exceptions, the contrast-medium films were superior to the routine films in outlining the periphery of the stump more sharply. An example of this superiority may be seen in comparing the two views in Figure 4. This improvement in the delineation of the stump-socket interface makes it easier to read the films and eliminates any doubts that may arise concerning the exact relationship between the stump and the socket at various stump levels.

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Clinical Study of the Application of the PTB Air-Cushion Socket[1]

Eric Lyquist [2]

From January 1966 to September 1968, the Orthopaedic Hospital in Copenhagen conducted a clinical evaluation study of the patellar-tendon-bearing (PTB) air-cushion socket (see p. 1).

The Prosthetic/Orthotic Research Department at the hospital fabricated the sockets, using the casting procedure described by Wilson and Lyquist (2) and the fabrication procedures described by Lyquist and his associates *(1).* These procedures and the results of fitting 45 amputees were published in September 1968.[3]

Forty-five amputees were selected for the test series and fitted with air-cushion sockets. Four patients were eventually dropped from the study, three because of their inability to return for re-examination, and one because of her confinement to a wheelchair as a result of progressive vascular disease.

The group of 41 amputees consisted of 30 males and 11 females, with ages ranging from 7 to 74 years (average age: 44).

CLINICAL EVALUATION

Seventeen of the amputees had been satisfied wearers of a PTB prosthesis for at least 12 months. After being fitted with air-cushion sockets, 13 noted improved comfort and function, 3 found no change in comfort and function, and 1 was dissatisfied because of nocturnal stump pain.

Seven patients had previously been fitted with the standard type of PTB prosthesis, but satisfactory fittings had never been achieved. With fitting of the air-cushion socket, 4 amputees obtained satisfactory comfort and function. One patient was able to wear a modified air-cushion socket with a soft insert. The remaining 2 had to abandon the socket; both had short stumps (2-1/2 in.) with distal hypersensitivity.

Seven amputees had previously worn prostheses, but with complications such as ulcerations and secondary distal edema. Six obtained satisfactory comfort and function with the air-cushion socket, but one who had a short stump (2 in.) and extensive skin transplants was fitted after four weeks with a standard PTB prosthesis.

Four amputees had successfully worn conventional BK prostheses for periods of 40, 30, 13, and 6 years. Nonetheless, when fitted with an air-cushion socket, each preferred it to the conventional prosthesis.

Of the remaining 6 amputees, 5 had never worn a prosthesis. Two of those had distal edema and ulceration, which healed when an air-cushion socket was applied. Another had stump problems not attributable to the prosthesis, but he managed well with the air-cushion socket. A fourth patient had no stump problems, and successfully wore the socket. One amputee had to be fitted with a different type of prosthesis because his stump was hypersensitive distally and the volume was constantly changing.

[1] Adapted from an article in *Below-Knee Prosthetics,* a report of a symposium sponsored by the Committee on Prosthetics Research and Development, held at the Veterans Administration Center, New York, N. Y., Dec. 16-18, 1968.

[2] Director, Prosthetic/Orthotic Research Department, Orthopaedic Hospital, Copenhagen, Denmark.

[3] Prosthetic/Orthotic Research Department technical report (Danish).

SUMMARY

Of the 41 amputees fitted with the air-cushion socket, 36 had previously worn prostheses. In that group, 27 noted increased comfort and function, 4 were considered unchanged, 3 returned to wearing a standard PTB prosthesis, and 1 required fitting with a conventional prosthesis. One amputee had previously been fitted with an air-cushion socket by a private prosthetist, and got along very well. Of the 5 amputees who had not previously worn a prosthesis, 1 was not successfully fitted, but 4 were able to manage well with the air-cushion socket.

At the time of this report, 36 of the 41 amputees evaluated in this study were wearing the air-cushion socket. Although extensive final medical examinations of the entire group have not been completed, it is unlikely that the information resulting from those examinations will differ greatly from the results presented in this report.

1. Lyquist, E., L. A. Wilson, and C. W. Radcliffe, *Air-cushion socket for patellar-tendon-bearing below-knee prosthesis, principles and fabrication procedures*, Technical Memorandum, Biomechanics Laboratory, University of California, San Francisco and Berkeley, 1965.
2. Wilson, L. A., and E. Lyquist, *Plaster bandage wrap cast*, Pros. Int., 3:4-5:3-7, 1968.

Evaluating the Temporary Pylon and Permanent Prosthesis in a Rehabilitation Amputee Clinic

O. D. Parker[1]

We in vocational rehabilitation need to stop occasionally and examine our procedures with a critical eye. We get engrossed in the job at hand, and find it amazingly easy to neglect determining whether there might be a better way to accomplish a task, thereby improving our services to handicapped people.

Recently, we decided to look at our amputee clinics in an attempt to evaluate two methods being used to fit recent lower-extremity amputees with prostheses. We had been following the conventional, medically recommended policy of seeing the amputee after the stump had healed and shrunk. At that time, the amputee was instructed in the proper method of wrapping the stump with elastic bandage to aid shrinkage, and the clinic chief determined when measurements for a prosthesis could be obtained. This seemed to be the way to prepare an amputee for an artificial limb. However, prosthetic clinic teams in other parts of the country began using a temporary pylon, or preparatory prosthesis, instead of wrapping with an elastic bandage, with good results. We felt the need to evaluate those two methods with the following questions in mind: What are the actual costs in each case? Which procedure permits the amputee to work sooner? From the medical viewpoint, does one method of fitting an amputee have advantages over the other?

In the past, when shrinkage was induced by wrapping the stump with elastic bandage, it was necessary to replace the socket or the entire limb on most new amputees within the first year. Even though the stump had shrunk to a point where a permanent prosthesis was indicated, problems began when the patient started weight-bearing and gait-training. Pressure from use of the prosthesis caused further changes in the stump; the new, expensive socket ceased to fit, and a new one had to be ordered. While waiting for the new prosthesis, the patient often had to "mark time."

Early fitting with a temporary pylon solves some of these problems. First, the amputee is spared the long period of waiting and wrapping before weight-bearing is permitted. The stump shrinks much more quickly, and the temporary pylon enables gait-training to begin almost immediately. When the permanent prosthesis is finally provided, we have avoided the purchase of a second permanent prosthesis. Often, the foot that was on the pylon can be used again, and in some cases other component parts can be converted to the permanent limb.

We know that amputees can return to work sooner if they are provided with a pylon first and started on a program of physical therapy, including gait-training. This seems to be a very significant factor, since it not only brings in family income sooner, but also increases rehabilitation benefits by improving the client's overall outlook regarding services. Many clients return to work with the temporary pylon even before obtaining the permanent prosthesis.

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Regarding the medical aspect, the physicians tell us that there are fewer medical problems in cases where clients are provided with a temporary, or preparatory, prosthesis. The healing process is enhanced, and many of the circulatory difficulties that could arise are avoided because regular short walking periods are possible, and the patient does not have to be inactive. Contractures no longer present a medical problem, and edema is reduced after initial fitting with the pylon.

In addition to these important factors, we needed to ascertain the outcomes for clients served by the two procedures. This is the only logical way to determine comparative costs. We needed to find out how many clients required a new limb the first year under the old method, how much sooner pylon wearers returned to work, and whether fewer gait-training sessions were required using the temporary pylon method.

We reviewed the records of 23 amputees who had received the permanent prosthesis originally and compared these with 23 new lower-extremity amputees who had been fitted with pylons. Charts were made and the individual case was reviewed, which provided information shown in Tables 1 and 2.

Of the 46 cases reviewed, the amputees fitted with the temporary prosthesis passed final checkout in the clinic 9.4 months sooner from date of amputation than did those who received a permanent prosthesis.

Temporary-pylon wearers received the final permanent prosthesis 8.3 months sooner than the 23 who were treated in the conventional way. (Three amputees required new sockets, each due to excessive weight gain. One was refitted three months from date of initial fitting with a permanent prosthesis, another at four months, and the third at five months.)

The total cost for rehabilitation per patient was $75.87 higher when early fitting was carried out. Not reflected in this cost, however, is the fact that permanent prostheses for the early-fitting cases cost $65.00 more than those for the control cases, an amount which almost offsets this difference. Furthermore, there were 11 above-knee amputees in the early-fitting group, and only 7 in the control group. When the additional cost of above-knee prostheses, which is $100, is taken into account, the

TABLE 1. CHARACTERISTICS OF AMPUTEES STUDIED

	Conventional Fitting (N = 23)	Early Fitting (N = 23)
Male	17	13
Female	6	10
Average age	39.9 yr	41.6 yr
Median age	35.0 yr	44.6 yr
Below-knee amputation	16	12
Above-knee amputation	7	11
(Reasons for amputation)		
Accidental injury	14	7
Vascular insufficiency and arteriosclerosis	1	6
Bone tumor	1	1
Diabetes	4	4
Cellulitis gangrene	0	1
Osteomyelitis and post-fracture infection	3	4

TABLE 2. COMPARISONS BETWEEN CONVENTIONAL AND EARLY FITTING OF LOWER-EXTREMITY PROSTHESES

Time and Costs	Conventional (N = 23)	Early (N = 23)
Elapsed time from amputation to initial fitting	7.0 mo	4.8 mo
Elapsed time from initial fitting to 2nd prosthesis	10.4 mo	3.9 mo
Elapsed time from amputation to 2nd permanent or final prosthesis	17.4 mo	8.7 mo
Elapsed time from amputation to final checkout	21.0 mo	11.6 mo[c]
Average cost of rehabilitation per patient	$599.78[b]	$675.65

[b] Includes 3 amputees who required new sockets.
[c] When this figure is adjusted for increase in price between the time of the fitting of the two series and for the difference in price between AK and BK prostheses, it becomes $682.17.

average cost of prostheses for the patients fitted early is actually about $17 less than for those fitted conventionally.

The average time for gait-training, from 20 to 30 hours, was cut in half when temporary pylons were used, thus saving these costs.

Of the 23 amputees who received permanent prostheses in the conventional manner, 18 required a completely new limb in 10.4 months. The remaining 5 required new sockets. This indicates that most new lower-extremity amputees will need a second replacement limb no matter which of the two methods is used.

CONCLUSIONS

The cost of the rehabilitation is almost equal, whether conventional methods or early-fitting procedures are employed. The amputee who receives a temporary pylon is able to ambulate and accept a final prosthesis much sooner. The most important benefit, however, is his ability to return to employment 9.4 months sooner. Obviously, the client then can aid in the support of the family sooner and become a productive tax-paying member of society.

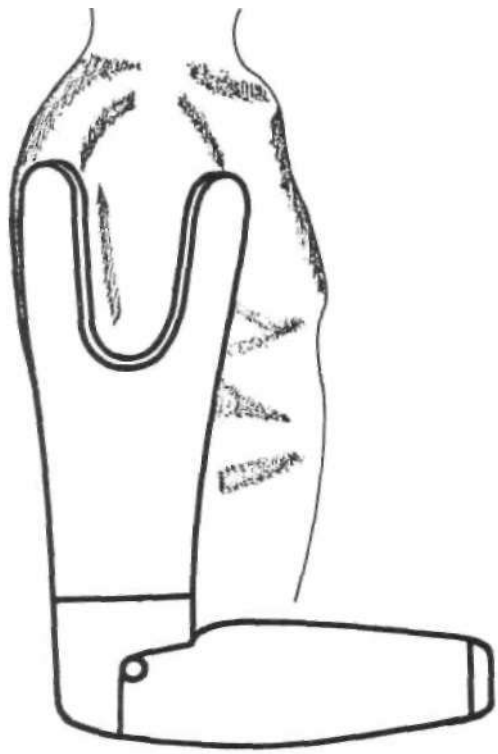
Medical complications such as contractures and circulatory difficulties are minimized when an amputee can begin weight-bearing as soon as the condition of the stump will allow following amputation.

Another factor that should be mentioned is one which we must assume since it has not been proven. We enhance the psychological outlook of an amputee or any client if we can speed up the process of rehabilitation involvement. By getting an amputee up on a limb sooner, the long waiting period is avoided, and the amputee finds that his ability to walk has not been lost. This in itself often provides the incentive and desire without which few cases are successfully rehabilitated.

Finally, it should be noted that the average elapsed time between amputation and fitting was 4.8 months. It is felt that even better results could have been obtained if these patients had been referred for fitting much earlier.

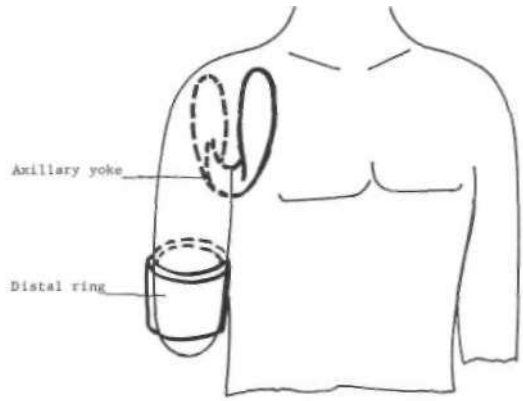
Fabrication Procedures for the Open-Shoulder Above-Elbow Socket

C. A. McLaurim, P.Eng.[1]
W. F. Sauter, CPO,[2]
C. M. E. Dolan, M.S.,[2] and
G. R. Hartmann, CPO[2]

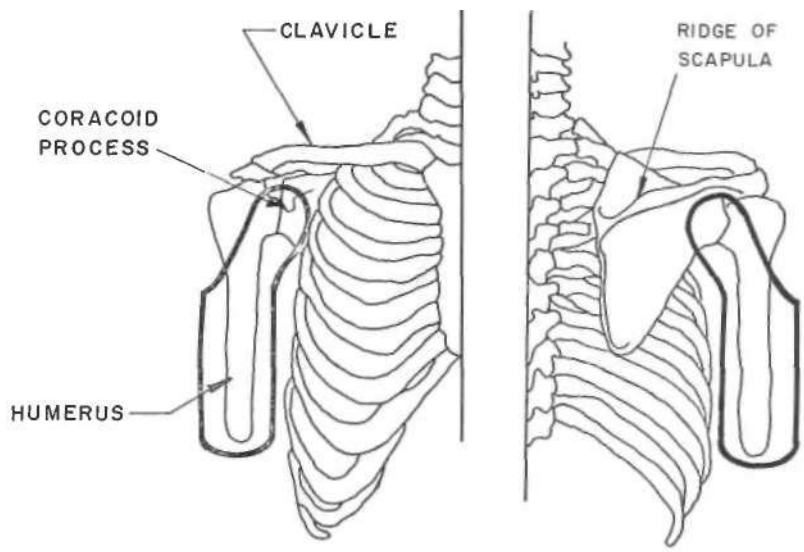


The Open-Shoulder, Above-Elbow Socket is a new design that offers several advantages over others. Unnecessary parts of the socket have been eliminated, particularly from the deltoid area. Use of this simplified socket in combination with careful fitting of the essential areas provides a prosthesis of less bulk and contact with the skin, and yet one with greater stability and mobility.

[1] Ontario Crippled Children's Centre, 350 Rumsey Road, Toronto, Ontario, Canada.
[2] Prosthetics and Orthotics, New York University, New York, N. Y. 10016.

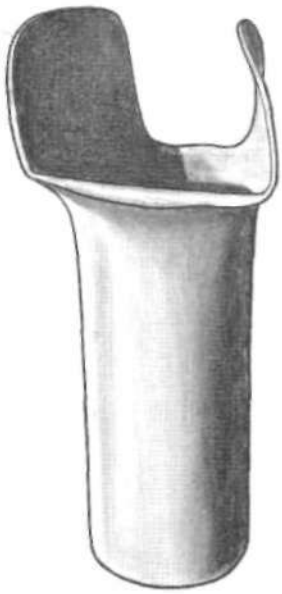


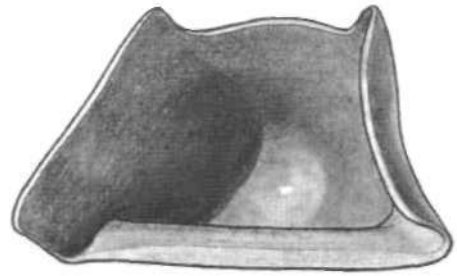
The two critical features of the open-shoulder, above-elbow socket are shown: the axillary yoke for stabilization of the proximal end, and the distal ring for stabilization of the distal end of the socket with respect to the stump. These two parts of the socket are all that need to contact the stump; the remainder of the socket is needed only for structural integrity.



The relationship of the socket to the skeleton is shown. Note that the anterior proximal extension fits medially to the humeral head, just beneath the clavicle, covering the coracoid process of the scapula. The medial edge is flared to conform with the chest wall.

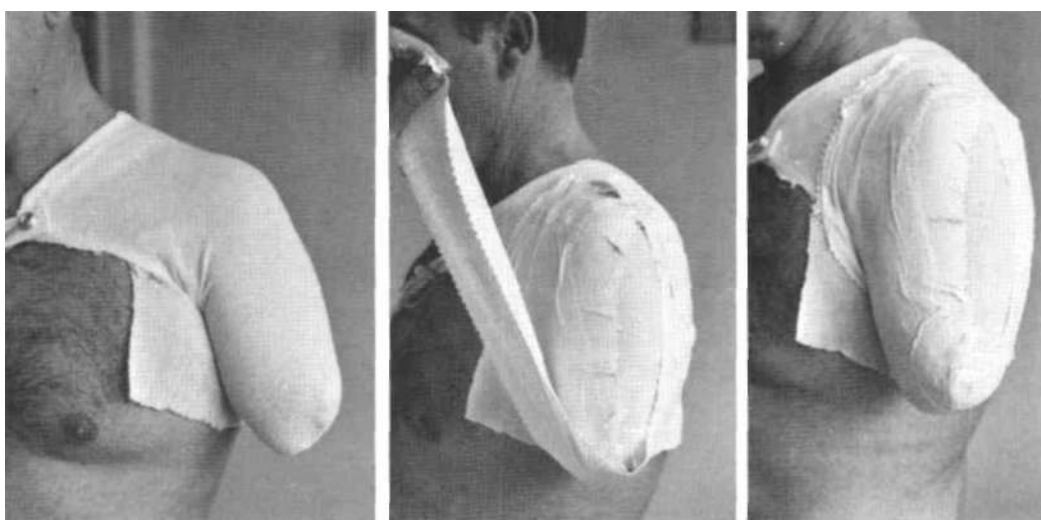
The posterior proximal edge extends up to but not over the ridge of the scapula. It may extend further medially than the anterior extension, but normally not beyond the center of the scapula. The anterior and posterior extensions of the socket should be flexible, ideally with flexibility graded from nearly rigid in the socket proper to quite flexible at the proximal medial edge of the extensions, this being accomplished by a progressive reduction in layers of stockinet from distal to proximal areas. The lateral opening of the socket follows the natural line of the deltoid muscle group. It normally does not extend distal to the level of the medial brim of the socket, and in short stumps it may be considerably proximal to that level.





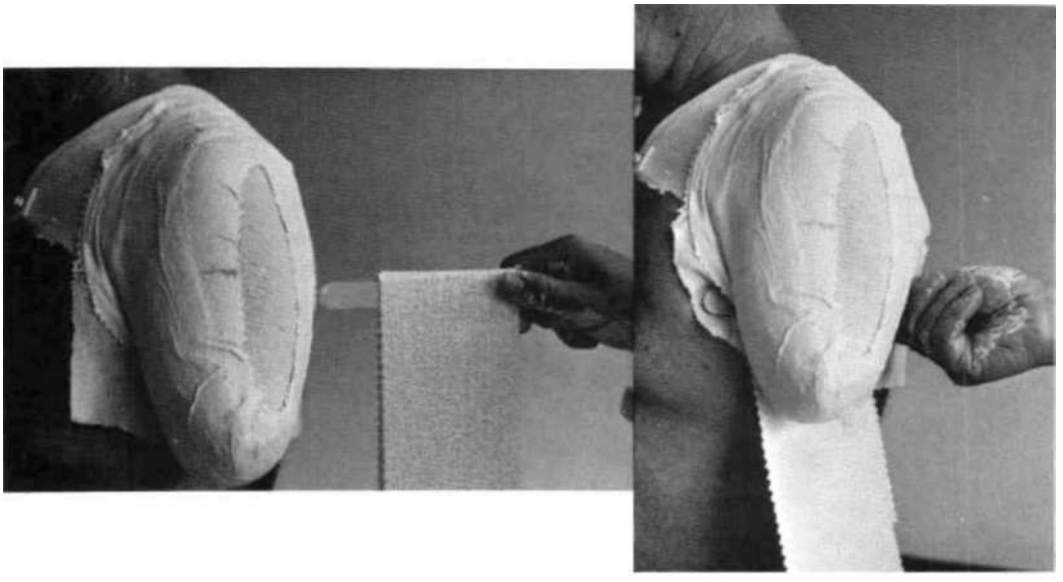
The medial brim of the socket is essentially straight in the anteroposterior plane. It is not thicker than 1/4 in., and has a well-rounded edge. Excessive thickness is likely to cause discomfort from pressure on the nerves that are medial and slightly anterior to the humerus. Generous radii or curves are essential in order to flare the straight medial brim into the anterior and posterior extensions.

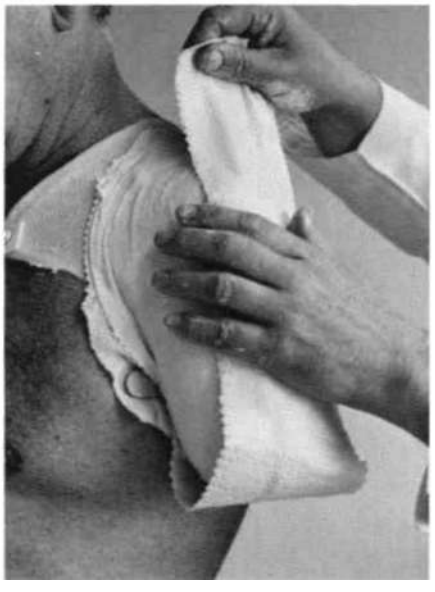
The proximal portion of the socket is elliptical in cross section, with a flat medial wall. Between this point and the elbow turntable, the cross-sectional shape gradually changes from that of the flattened ellipse to a circle.



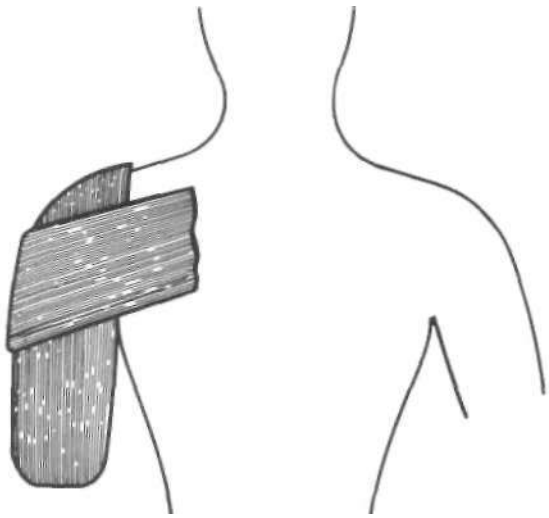
There are no special preparations required in casting the stump. A protective axillary "apron" should be used. Necessary measurements are the stump length, the stump circumferences at 2-in. increments beginning at the axillary level, and the length of the segments of the contralateral limb.

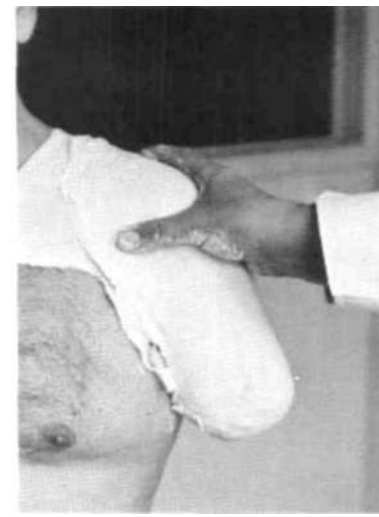
To provide a smooth cast requiring the least modification, a three-step cast-taking procedure is recommended: an anteroposterior (A-P) wrap, a mediolateral (M-L) wrap, and final cast shaping. Three layers of plaster bandage, at least as wide as the stump M-L diameter, are used. The slabs (splints) should be long enough to allow a 2-in. overlap at the top of the shoulder. The first wrap (A-P) is applied from back to front, fitting well medial to the acromion.



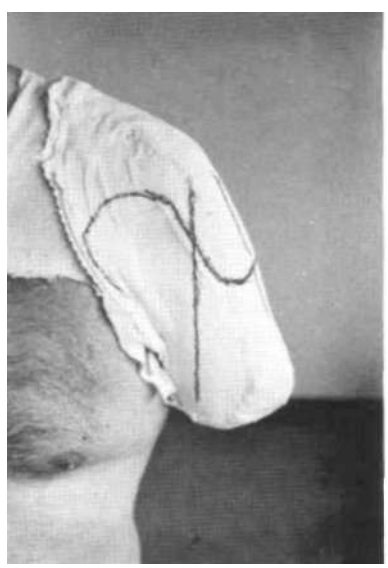


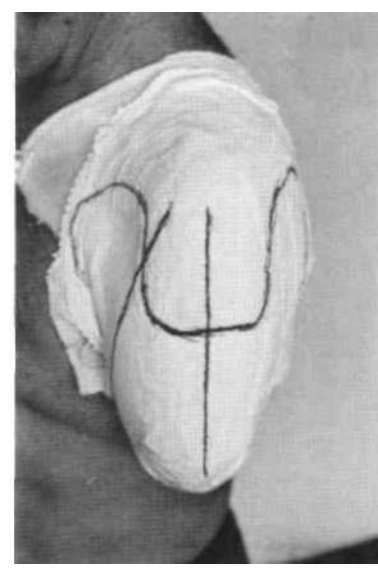
The M-L wrap is applied before the A-P wrap begins to set. One end of the plaster bandage should be draped over three tongue depressors, which are then held in the axilla snugly but not uncomfortably tightly while the rest of the bandage is draped over the end of the stump and up the lateral side.



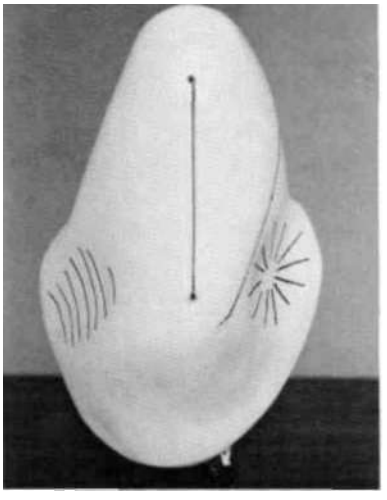


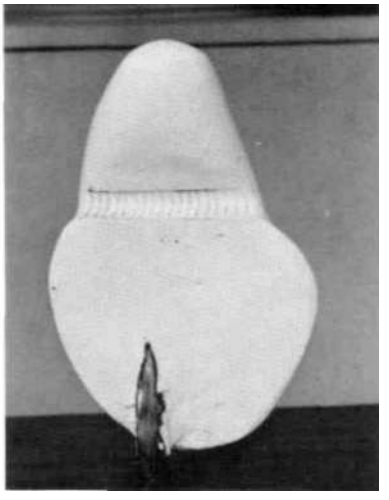
To ensure adequate covering of the anterior and posterior proximal extensions, an extra slab of plaster may be used. The wrap is then smoothed gently, and the final shaping is obtained by placing the hand as illustrated. Note that the stump is held in the adducted position, thereby compressing the stump mediolaterally. The thumb is placed anterior to the shoulder joint, with the fingers posterior to the joint, over the scapula, to ensure a snug fit in the anteroposterior direction. Typically, the thumb and index finger will lie along the distal portion of the deltoid bulge. For a large amputee, it may be necessary for another technician to assist by holding the tongue depressors while the A-P shaping is performed. This position of the stump is maintained until the plaster wrap is set.





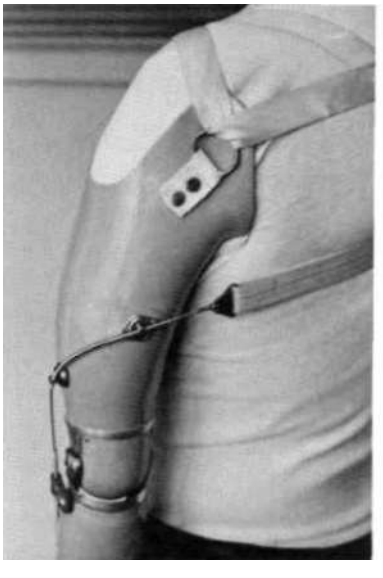
Before removing the wrap, plumb lines should be drawn on the wrap on the anterior and lateral surfaces, with the stump in a relaxed position. The outlines of the proximal brim of the socket should also be marked.

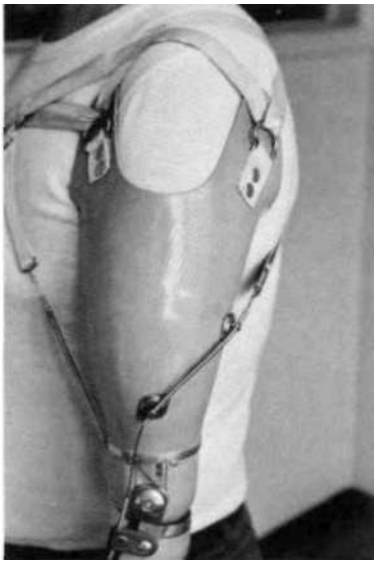




The plaster wrap is then removed from the patient, and the positive cast is poured in the usual manner with a metal pipe inserted as a mandrel. The markings of the wrap are transferred to the cast by means of a sharp awl before the wrap is removed. The lines indicated by the awl markings are drawn in on the positive cast after the wrap is removed.

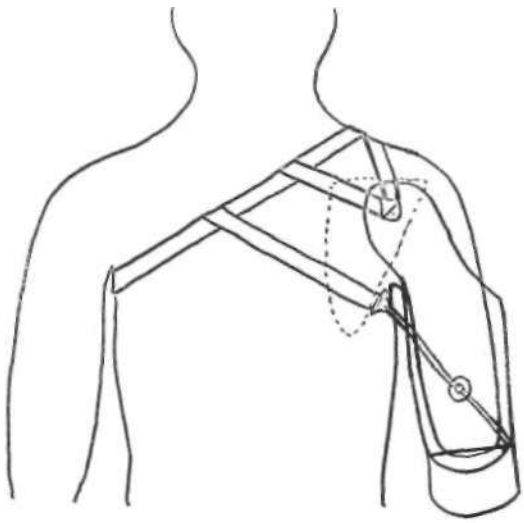
The cast is trimmed in any areas showing ridges and in the axillary area, where a smooth radius is required. The contours of the cast are then gently smoothed and treated with a suitable separating agent, prior to lamination of the socket.

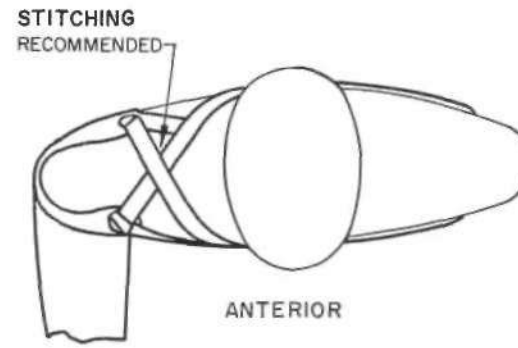


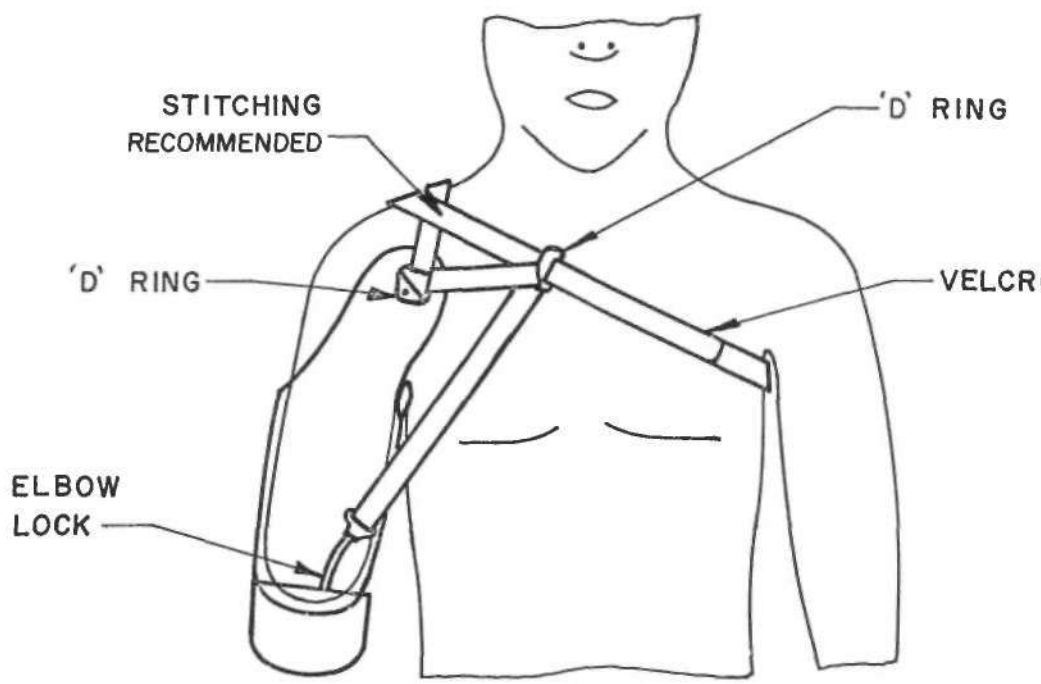


The permanent socket is laminated with conventional polyester resins, using a mixture that is approximately 50% flexible and 50% rigid. The socket is trimmed according to the principles described on pages 47-48.

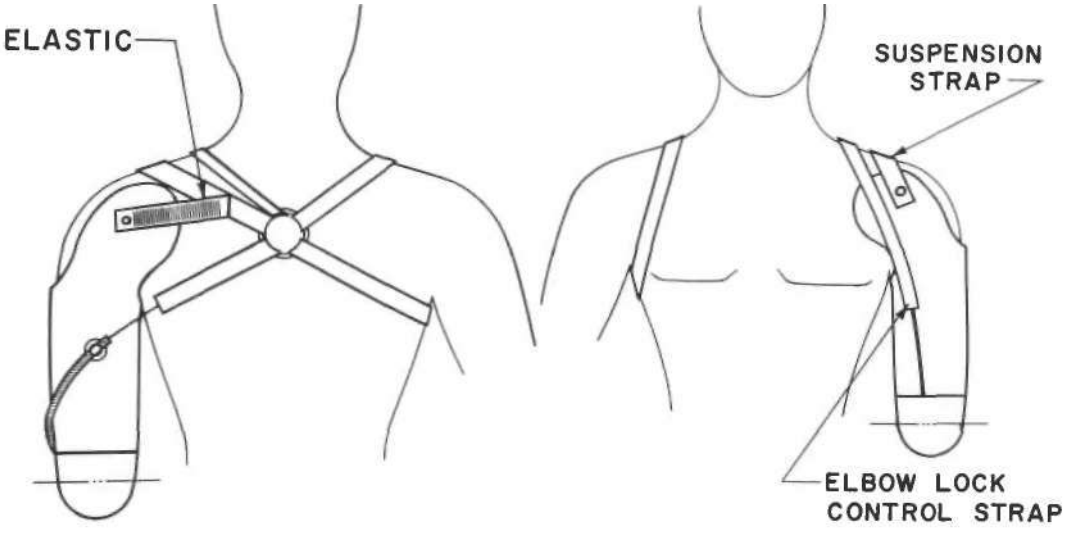
A typical completed open-shoulder, above-elbow socket is shown.



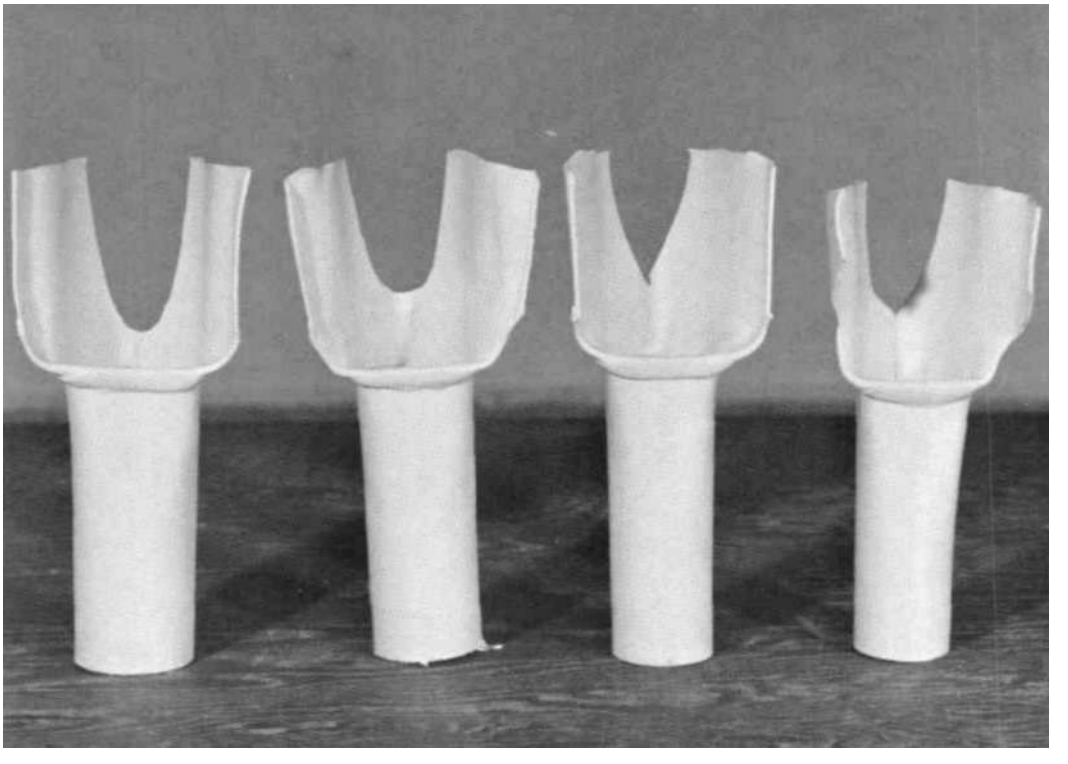




Although other harness patterns can be used, the illustration depicts the pattern that is currently used and recommended by Ontario Crippled Children's Centre. This type of harness is more comfortable in the opposite axilla than is the figure-eight type. The actual position for fastening the elbow lock control strap and the control strap may be varied somewhat from that shown in the illustrations, following the principles of conventional shoulder-saddle or chest-strap systems *(1).*



Slight modification of the standard figure-eight harness adapts that pattern to the open-shoulder socket.



PREFABRICATED SOCKETS

Several successful fittings have been made utilizing San Splint[3] sockets, prefabricated in a series of standard sizes. The advantage of this material is that it can be heated in warm water to a temperature of 140 deg F and then reshaped on the stump to provide an accurate, individual fit. The material also has a satisfactory degree of flexibility, so that a comfortable fit may be maintained as the stump is moved to various positions. The distal end of the socket, after trimming for correct length, can be attached directly to the metal elbow turntable, using epoxy paste. The paste is applied to the turntable, and the roughened distal end of the socket, heated locally to 140 deg F, is placed over the turntable. A hose clamp or flexible electric tape will hold the socket firmly in place. Room-temperature vulcanizing Silastic foam[4] may be injected to provide total-contact distal fit.

[3] "San Splint" is the trade name for a thermoplastic material (synthetic balata) developed by the Polymer Corporation, and suppli
[4] Dow Coming R.T.V. 5370.

1. Anderson, Miles H., Harness and control systems, Chap. 9 in *Manual of upper extremity prosthetics*, 2nd ed., William Ft. Santschi,

Myoelectric Immediate Postsurgical Procedure: A Concept for Fitting the Upper-Extremity Amputee[1]

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F. L. Hampton, C.P.,
C. N. Lambert, M.D.,
R. G. Thompson, M.D., and
M. J. Schrodt, M.D.

The advantages of immediate postsurgical fitting in the management of upper-extremity amputees have been pointed out by Sarmiento *et al. (4)* and Loughlin *et al. (3).* These advantages, which are similar to those for the lower-extremity amputee, are: reduction of postoperative pain, control of postsurgical edema, early use of a prosthetic appliance, early psychological adjustment to the disability, reduction of hospitalization time, and, hopefully, a higher rate of prosthesis acceptance by the amputee, particularly the unilateral amputee. Thranhardt (*1*) has confirmed the psychological and economic advantages of this procedure and has suggested that the problems of adapting present upper-extremity components for use with rigid dressings be examined.

It would seem that almost any upper-extremity component could be adapted for use with rigid dressings. Indeed, it would appear that externally powered devices, if they offer significant benefit to the patient, could be used as well as body-powered units. One of the authors (Hampton) suggested that an externally powered prosthetic appliance, controlled myoelectrically, might be used to significant advantage with immediate postsurgical fitting of the upper-extremity amputee. The application of myoelectric control would encourage the early use of muscles remaining in the stump, which should improve circulation and reduce stump muscle atrophy.

This paper summarizes the experience of the authors with the immediate postsurgical fitting of myoelectrically controlled prostheses. One primary amputation and a stump revision have been managed in this manner with very satisfactory results.

MYOELECTRIC IMMEDIATE POSTSURGICAL FITTING CONCEPT

Basically, the technique is to place sterile electrodes on the skin over the remaining stump muscles immediately following wound closure. These metal electrodes are held in place by a tubular elastic bandage underneath the rigid plaster dressing. This makes it possible to detect myoelectric activity from proximal muscles in the stump and to use these signals to control an externally powered prosthesis.

Electrode positioning must be guided solely by anatomical considerations when they are positioned immediately following wound closure. Therefore, optimum positioning of the electrodes with this technique may be difficult. Consequently, it is desirable to use a myoelectric amplifier

[1] This report was submitted by the Northwestern University Prosthetic-Orthotic Center, 401 East Ohio St., Chicago, Ill. 60611. The work was supported by Veterans Administration Contract No. V1005M-1079.

of moderately high sensitivity and to use rather large electrodes that are spaced some distance apart in order to detect signals from a wide area. Electrodes 1 in. x 1/2 in. in dimension, spaced approximately 1 to 2 in. apart, are presently being used. A myoelectric unit that operates the terminal device when the peak-to-peak input signal is greater than 50 uv has proven to be satisfactory.

Poor positioning of the electrodes may result in inadequate separation of the myoelectric signals from various muscles in the stump of a below-elbow amputee. The myoelectric activity of supinator-pronator muscle groups may produce the same effect as the activity of the flexor-extensor groups. This is not a major problem, since the rigid plaster cast dressing of the Munster type *(2)* does not allow supination or pronation of the stump. However, the amputee should be instructed to use the flexor-extensor groups (assuming two-electrode systems are used) so that new control methods do not have to be learned should a permanent myoelectric prosthesis be prescribed.

It is preferable that the pick-up electrodes be sterile and that they do not require conducting paste. Therefore, the attached electronic equipment must be compatible with electrodes of this type. Systems using either one set or two sets of electrodes are practical. In the procedure described in this paper, a two-electrode, commerical system was used (Viennatone) because it met the requirements, was readily available, and was convenient to use.

CASE HISTORY

Mrs. G. M., a 27-year-old female, first noticed a small nodule on the dorsum of the left fourth metacarpophalangeal joint at age 7. At age 22, this became dark brown and painful and was locally excised. She was told it was a fibroma. The pain recurred in October 1967, at age 25, and a nodule over the dorsum of the left fifth metacarpophalangeal joint was excised, along with the fourth digit and metacarpal. This was reported to be a low-grade fibrosarcoma. The wound ulcerated and tumor tissue reappeared at the wound edges. In September 1968, the fifth digit and metacarpal were excised. Again, the report was compatible with fibrosarcoma. The patient was first seen at Presbyterian-St. Luke's Hospital in Chicago in March 1969, with the complaint of knife-like pain at the area of the old surgical scar and a palpable mass. This was biopsied and reported as fibrosarcoma. On March 24, immediately after a left-wrist disarticulation, a myoelectric prosthetic fitting of the left hand was done. Tissue examination revealed tumor cells above the site of the disarticulation. Therefore, she was readmitted to the hospital, and on April 17 the extensor muscle group to the 2nd, 3rd, 4th, and 5th digits of the left hand was excised. Again, the patient underwent immediate postsurgical fitting of the myoelectric prosthesis. The final pathology specimen showed that the tendons had been excised well above the level of the tumor. The patient was discharged from the hospital on the fourth postoperative day.

PROCEDURE AND EXPERIENCE

A left-wrist disarticulation was performed. Following closure of the wound, approximately 3/8 oz of sterile lamb's wool

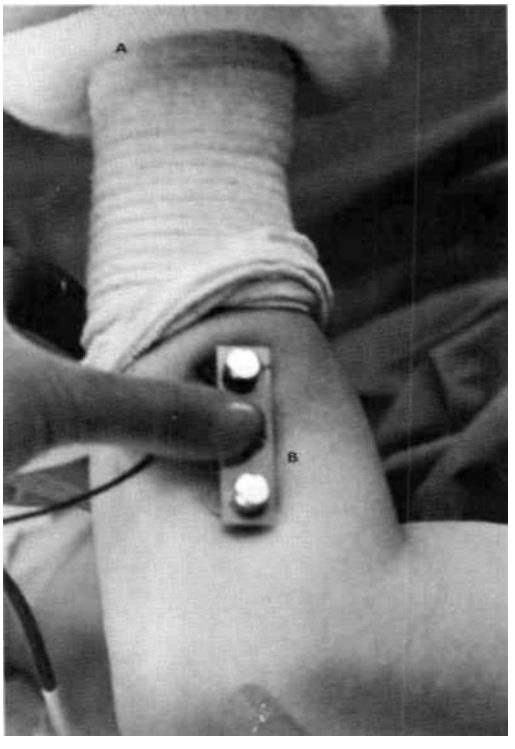

Fig. 1. View of forearm immediately following wrist disarticulation surgery. The tubular bandage has been pulled over the stump, and a stump sock has been positioned at the distal end (point "A"). A set of electrodes is shown being positioned near point "B". (The electrode pair is turned over to show the metallic surfaces.)

was applied over the dressing at the distal end of the stump. A length of sterile tubular elastic bandage (Tubigrip), closed at one end, was pulled over the stump, and a sterile stump sock was positioned for application, as shown in Figure 1, point "A." The electrodes were then positioned on the stump (Fig. 1, point "B"). The lateral set of electrodes was positioned approximately 2 in. distal to the epicondyle and 1/2 in. anterior to this point. The medial set of electrodes was placed approximately 1 1/2 in. distal to the medial epicondyle. The ground electrode was placed posteriorly on the stump between the two sets of electrodes. The electrodes were held in place by non-allergenic paper tape and then covered with the tubular elastic bandage. Experience showed that the commercially available electrodes (Viennatone) created too much local pressure on the skin of the stump, and a modification of this technique, which is discussed later, had to be developed. The stump sock was then pulled over the stump to the mid-humerus level and held under tension. Patches of 1/8-in., self-adhering foam rubber were placed over the olecranon, the medial and lateral epicondyles, and the distal end of the stump (Fig. 2). The stump was then wrapped with a roll of elastic plaster bandage, beginning distally, and this was reinforced with a roll of standard plaster bandage. A Hepp-Kuhn (Munster-type) socket was molded, with the elbow maintained in approximately 90 deg of flexion during the molding procedure. After plaster hardening, the wrist connector was contoured to the shape of the cast and bound to the rigid dressing with additional wraps of plaster bandage (Fig. 3). The hand was then attached (Fig. 4). The resultant overall prosthetic length was ap-

Fig. 2. A rubber cushioning material, attached to the stump sock, protects sensitive areas of the stump.

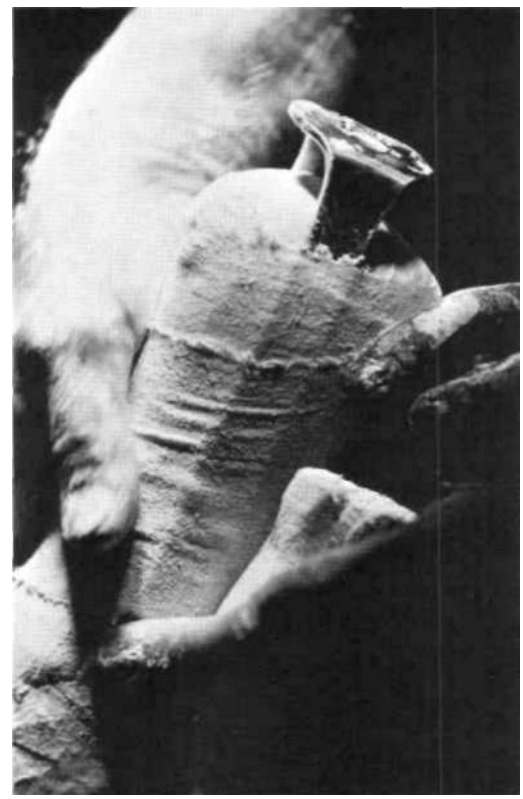

Fig. 3. View showing the attachment of the wrist connector to the plaster cast.

Fig. 4. Hand being attached in operating room.

proximately 1 in. longer than the remaining normal arm. The patient is shown in Figure 5 on the third postoperative day.

A cosmetic glove was not used during the early postoperative period. The electronics and battery were carried in a pouch with a shoulder strap.

The patient operated the prosthesis six hours following surgery, and used it on the first postoperative day for handling mail, for eating, and for other activities of daily living. She continued to use the prosthesis in her room and in physical therapy until her hospital discharge on the fourth postoperative day.

The patient used the hand frequently at home (*e.g.*, holding baby food bottles while opening), and indicated that she got more function from the prosthetic hand than from her original, physiological hand, since there had been considerable pain in the hand due to the presence of the tumor.

The first cast was removed on the ninth postoperative day. Skin healing was good except for a small amount of granulation at the exit site of the Penrose drain. The stump was free of edema. However, deep indentations in the skin were evident at the site of the medial and lateral electrodes. Apparently, the concentrated pressure of the electrodes inside the confining, rigid cast was too great. Consequently, a conventional prosthesis was fitted, incorporating a Dorrance 5XA terminal device, a shoulder harness, and a harness "quick disconnect."

On the twenty-third postoperative day, the second cast was removed. The amputation site had healed well, as had the electrode-pressure reaction sites. The stump appeared to be in good condition. However, postsurgical laboratory tissue tests revealed the presence of tumor cells above the amputation site. A second surgical procedure was therefore necessary. Following this surgery, a second myoelectric fitting was performed, at which time flat electrodes constructed of thin (0.001 in.) stainless-steel foil were used. One of these flat electrodes, the grounding electrode, may be seen at "A" in Figure 6 as it is being inserted beneath the tubular elastic bandage. The ends of the foil electrodes that extend from the openings in the bandage may be taped down together with the extensor electrodes ("B"). The other electrode pair may be seen at "C." The edges of the foil are folded over to eliminate sharp surfaces, and the lead wire is soldered directly to the foil. These electrodes have proven to be satisfactory for this application from both an electrical and a mechanical viewpoint.

The second myoelectric fitting was also successful. In addition to different electrodes, a smaller externally powered hand (Otto Bock), more suited for a woman wearer, was fitted. Again, the patient was discharged from the hospital on the fourth

Fig. 5. Patient on the third postoperative day. The electronics are at her side.

postoperative day. On the eleventh postoperative day, the cast was removed. The operative site was well healed, and the sutures were removed. The stump was in excellent condition, and therefore the myoelectrically controlled prosthesis was reapplied.

COMMENTS

The early and extensive use that the patient made of the myoelectrically controlled prosthesis is very encouraging. If proper electrodes are used, myoelectric immediate postsurgical fitting appears to have significant value for amputees. It appears to be an effective therapeutic tool for early rehabilitation. In the future, it may be practical to fit many upper-extremity amputees in this manner, followed by definitive fitting of myoelectric prostheses.

This approach may be backed up with standard hardware and harnessing. Should the myoelectric system not function properly, the electric hand may be removed and replaced by a conventional terminal device with harnessing. Therefore, many of the advantages of the immediate fitting may be maintained in spite of any malfunctioning of the myoelectric prosthesis.

At present, a major disadvantage of the described procedure is the high cost of the electronic system. Another disadvantage is the lack of variety in the externally powered components that are commercially available. Nevertheless, the use of myoelectric control of externally powered components would seem to have a place in

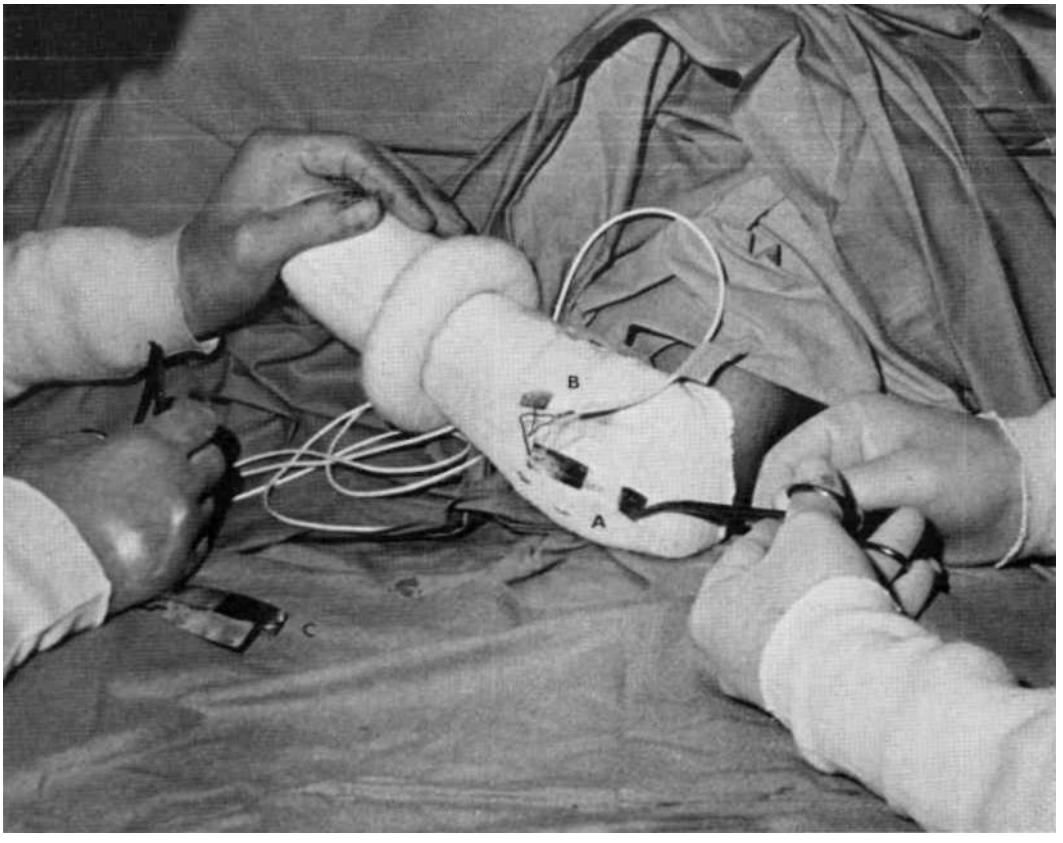

Fig. 6. View showing attachment of the foil electrodes following stump revision. At "A," the ground electrode is shown being pulled through two slits in the tubular bandage. The two extensor electrodes are shown near "B" after they have been taped down. The two foil electrodes for the flexor muscles are shown near "C."

immediate postsurgical prosthetics for upper-extremity amputees.

ACKNOWLEDGMENT

The authors wish to thank Miss Virginia Wilcox for her assistance with the manuscript.

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A Myoelectrically Controlled Powered Elbow[1]

Herbert H. Hartman, M.S.,[2]
David C. Hobart, B.S.E.E.,[3]
Worden Waring, Ph.D.,[4] and
Vernon L. Nickel, M.D.[5]

Since the appearance of the "Russian hand" about ten years ago (3), an increasing number of externally powered prostheses controlled by electrical signals from muscles have been developed. Most of these are built as entire systems, including electrodes, circuitry, motor, and battery. A basic requirement of such systems has been that the user must have two essentially normal muscles in order to operate the motor bidirectionally and so control prehension and release, or elbow flexion and extension.

Because of our concern in fitting patients having greatly reduced muscular function, we have developed circuitry using as control signals the minute electrical activity generated in severely paralyzed muscles. In addition, because of the disabilities of our patients, we have not only circuitry for control from two muscles, but also circuitry which permits bidirectional control from a single muscle site, as does that of Dorcas and Scott (2). In the latter case, when the muscle is relaxed, the motor controlling the orthotic device holds its position. With a small effort, the motor is turned on and the device moves in one direction; a moderate effort operates the motor in the reverse direction. Until recently, all our fittings had been for patients with orthotic devices. The present report describes our first fitting using a prosthesis.

Mrs. S. S. had a traumatic complete avulsion of her right forearm from the elbow. We first saw her nine months post injury, when she was using a prosthesis with two cables, for control of the elbow and the terminal device. The prosthesis was not entirely comfortable, and it required enough force in operation to be rather fatiguing. We decided to fit her with power at one joint; the elbow was selected because it was believed that the sensory feedback of cable control would be more valuable in operating the terminal device than the elbow. Because there was some remaining musculature in the upper arm, it was hoped that electrical signals from the biceps and triceps muscles could be used to control the powered elbow.

On examination, voluntarily controlled electrical signals were obtained from the biceps and triceps areas, but the signals were small and the muscles were not controlled independently. In collaboration with an occupational therapist, muscle strengthening and isolation of control were undertaken. Improvement was noted two weeks later, when the patient was able to operate a test hand splint with a myoelectric control circuit, using her triceps.

[1] This work was supported in part by Grants RD-1751-M and RD-2612-M from the Social and Rehabilitation Service, Department of Health, Education, and Welfare.

[2] Research Physiologist, Rancho Los Amigos Hospital, 7601 East Imperial Highway, Downey, Calif. 90242.

[3] Research Electronics Engineer.

[4] Principal Investigator. Present address: School of Medicine, University of California, Davis, Calif.

[5] Medical Director.

But even after further training exercises, signals from the biceps area were too weak and too highly correlated with triceps signals to be used for control in a two-muscle system. In view of our observations, of the nature of the accident, and of a discussion with the physician who had attended her, it seemed best to use the triceps alone as a control muscle, with the single-muscle, bidirectional control described above.

The powered elbow used is essentially the "Rancho Los Amigos" unit designed by Karchak and Allen (Fig. 1) *(1).* Some modifications were suggested and made by

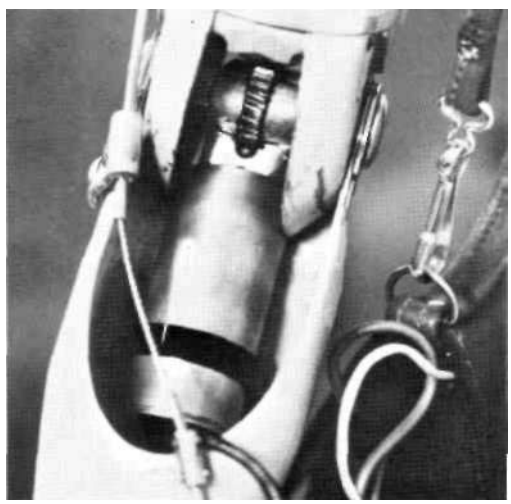

Fig. 1. View of electric elbow designed by Karchak and Allen with motor installed in forearm. Harness snap and strap suspend the battery pack.

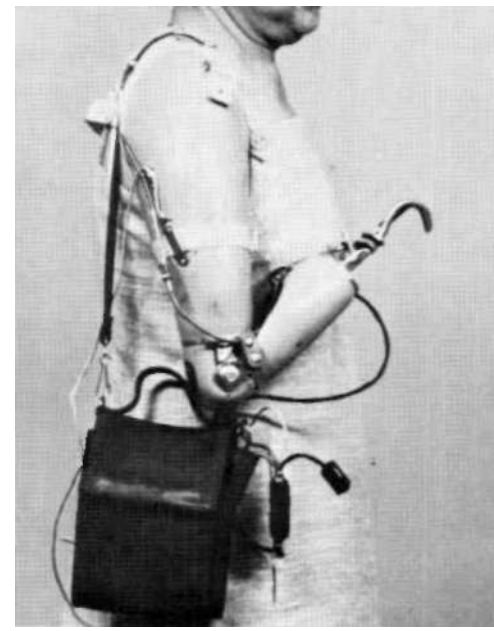

Fig. 3. Patient with the electric elbow controlled by myoelectric signals from the triceps. Note the method of holding the electrode in place.

Kenneth Foshay, of our group. Because of the long length of the stump of the patient, there was no space for parts within the upper arm shell.

The circuit used is shown in Figure 2. It is similar to that described earlier (4), except that an integrated circuit device was substituted for the separate semiconductor components in the front end, and a voltage regulator was added to the power

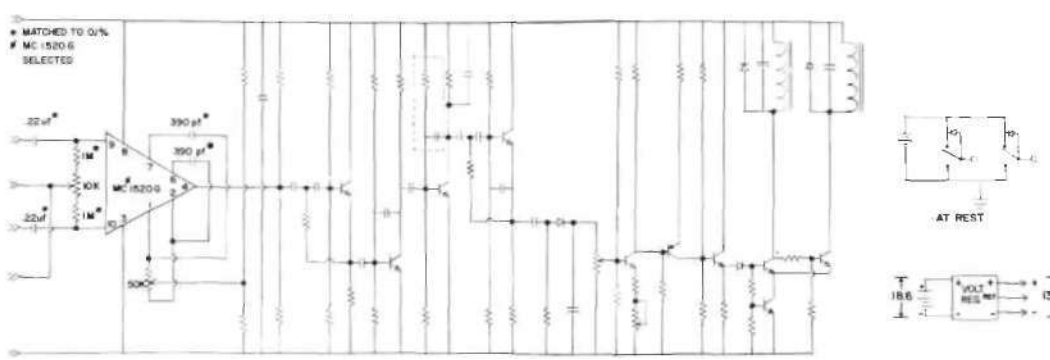

Fig. 2. Circuit used in electric elbow.

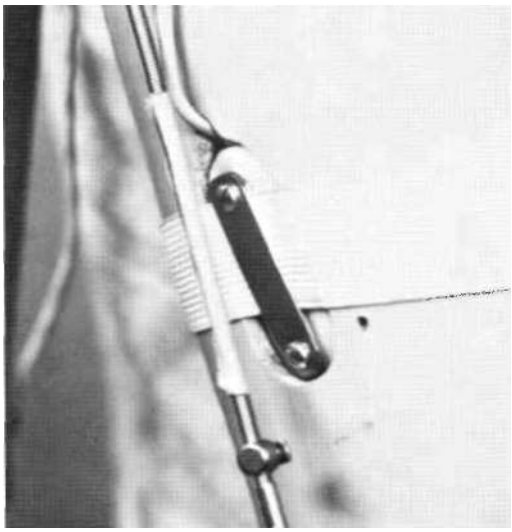

Fig. 4. Close-up view of method of holding the electrode in place.

supply to reduce sensitivity of the circuit to the somewhat varying battery voltage. As indicated in Figure 2, values of three pairs of components should be close to the nominal values shown, and the pairs must be carefully matched so as to minimize common mode interference.

Power for the system is obtained from small, rechargeable, nickel-cadmium batteries. These, together with the electronic circuitry, are carried in a shoulder bag (Fig. 3). An on-off switch is included so that the motor can be disconnected when she puts on or takes off the prosthesis or wishes to lock the elbow for some period of time.

Signals from the triceps area are picked up by surface electrodes fitted into a hole cut into the prosthesis socket and held in place by an elastic band (Figs. 3 and 4). The electrode assembly consists of three domes of textured stainless steel mounted in medical-grade Silastic (5).

The system is insensitive to rather severe challenge by 60 Hz current intentionally brought near to it in the laboratory. In use, there seems to be no significant interference from her car, from an electric sewing machine or iron, or other electrical signal generators. The patient has been using it at home for her various household activities some five to ten hours daily for seven months at the time of writing. Evidence of use is shown by the need to install a new gear after about three months, and recently the elbow joint needed tightening because of increased play from the wear.

ACKNOWLEDGMENTS

We appreciate the work of Donald Colwell, C.P., who made and fitted the prosthesis shells, and we are indebted to the Dow Corning Center for Medical Research for the Medical Silastic 382 used in the electrode assembly. We also express thanks to the Motorola Staff for selecting semiconductor units best meeting our needs.

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A Feeding Device

Sandra S. Rife, O.T. Reg.,[1] AND
Edgar Kennedy, Special Devices Technician[1]

The ability to feed himself not only provides the handicapped individual with a degree of independence in a personal function, but also releases an attendant from a time-consuming task three times a day, seven days a week. Patients who are unable to feed themselves because of limitations of control or movement in the upper limbs may be helped by a feeding device (Fig. 1) that was recently developed at the Ontario Crippled Children's Centre from a design seen in Chailey, England.[2] This report describes the feeder and its use at O.C.C.C.

INDICATIONS FOR USE

Although this feeder is suitable for all ages, our results are based only on trials with handicapped children, particularly those with cerebral palsy, 5 to 18 years of age. Each of these children has learned to manipulate the controls and to feed himself, either independently or with minimal assistance.

There are three physical requirements for satisfactory operation of the feeder:

1. The patient must have sufficient coordination in one arm to depress, push, or pull the knobs. However, functional hand grasp is not essential; a fist, wrist, or forearm can be used to operate the knobs.

2. The patient must be capable of bringing his head forward toward the spoon in a fairly controlled manner.

3. Oral musculature must be sufficient to effect lip closure. Of course, chewing and swallowing should be adequate to ensure proper digestion.

In order to use the feeder properly, the patient must be seated comfortably, with his trunk erect and well supported. The feeder may be placed on a table, wheelchair, or chair tray, and must be positioned correctly so that the elevated spoon is aligned in front of the patient's mouth.

DESCRIPTION OF FEEDER

The feeder (Fig. 2) is mounted on a plastic-surfaced board made from kitchen countertop material. Four suction cups secure the board to a flat surface. The food plate is a standard Corning Ware pie plate, fastened to an adaptor so that it may be quickly secured to a rotary spindle. The plate can be rotated by pushing or pulling a knob *(b)* located near the side of the plate.[3] A special acrylic spoon is mounted with a thumb screw (c) to a linkage arm that suspends it above the plate. The linkage arm is mounted on a spring-loaded hydraulic damper (door closer) (e). When the knob *(d)* located on top of the arm near the spoon is pressed down, the spoon is partly released, so that it hangs downward. If the knob or any part of the linkage arm is further depressed, the spoon contacts the plate and slides forward to scoop up the food. The arm and the spoon remain in this position until released by pressing knob (a). The spring-loaded damper then causes the arm with the

[1] Ontario Crippled Children's Centre, 350 Rumsey Road, Toronto, Ontario, Canada; Special Devices Project funded by the Ontario Hospital Services Comm.

[2] Chailey Heritage Experimental Workshop, Chailey-Sussex, England.

[3] The spindle mechanism can be reassembled so that the knob is pulled to rotate the plate rather than pushed.

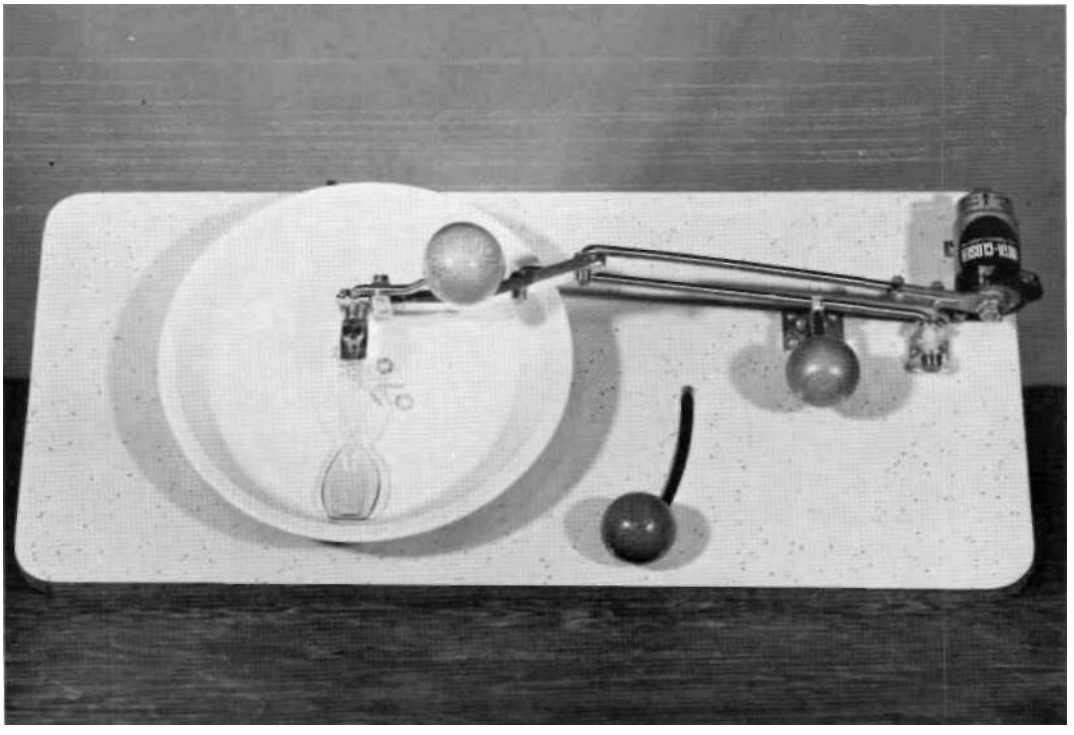


Fig. 1. The feeding device. In some models, a circular hole is cut to the left of the plate to secure a glass.

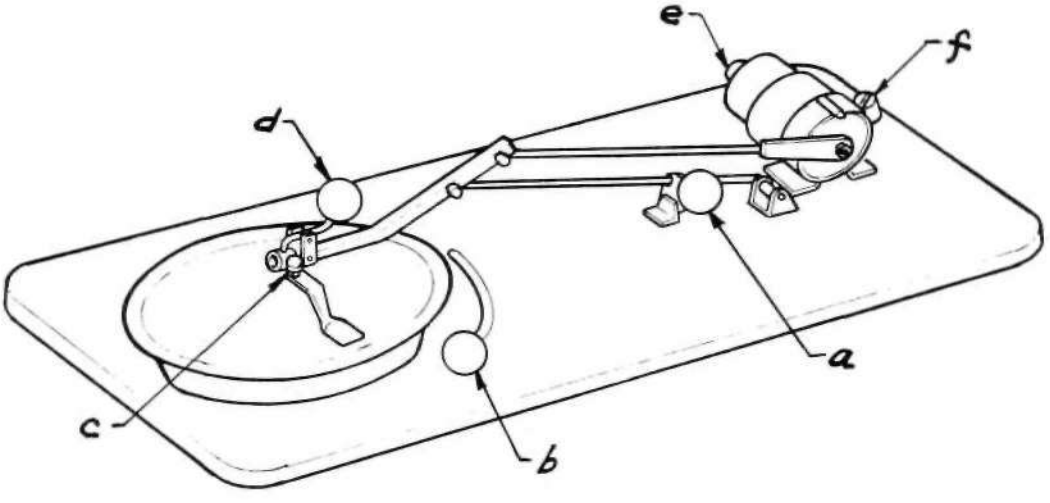


Fig. 2. Components of the feeding device.

Fig. 3. Child is rotating the plate by pushing knob (6) in order to position the food in line with the spoon.

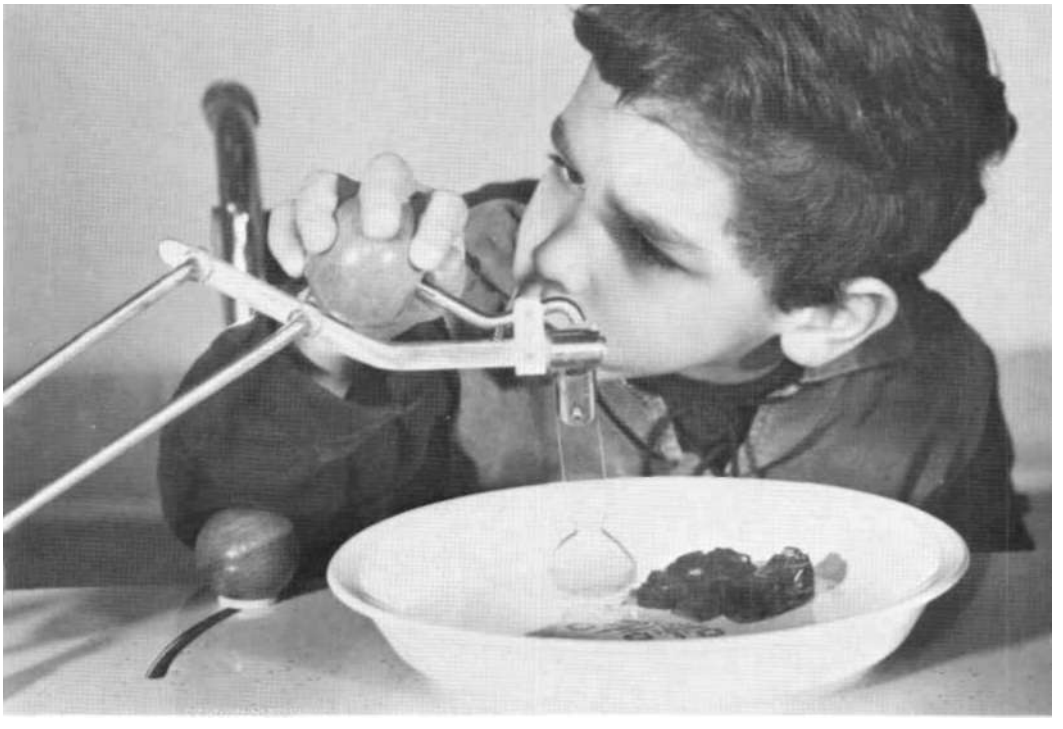


Fig. 4. By depressing knob *(d),* the spoon reaches the plate and scoops the food.

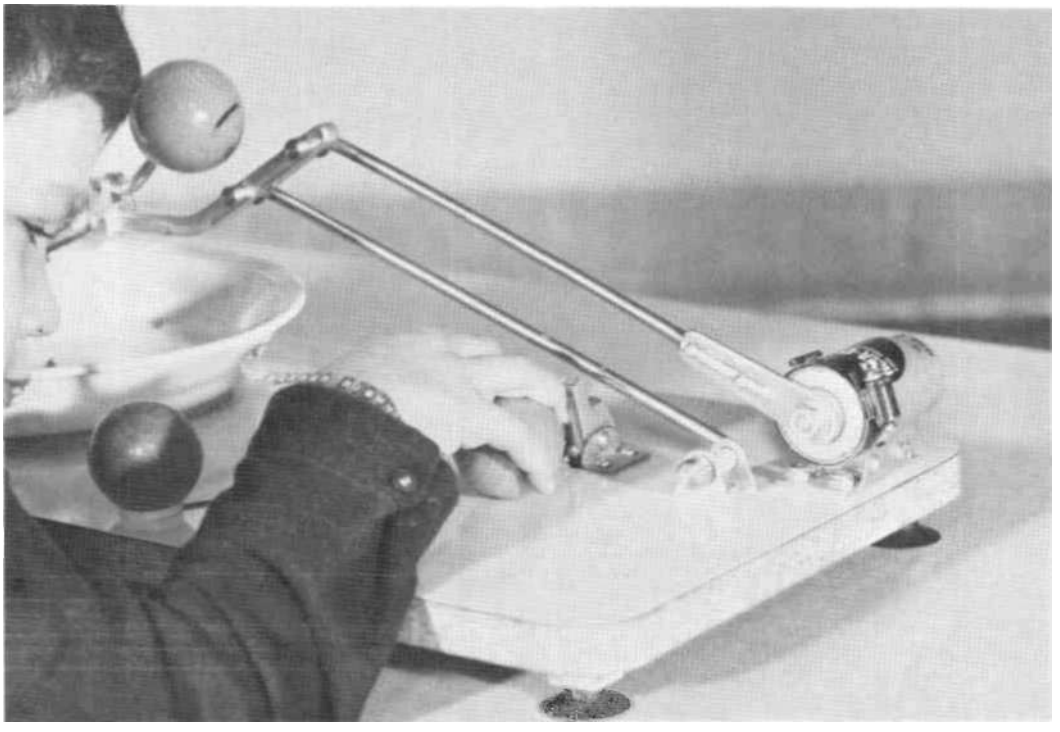


Fig. 5. The spoon is allowed to rise by depressing knob (a).

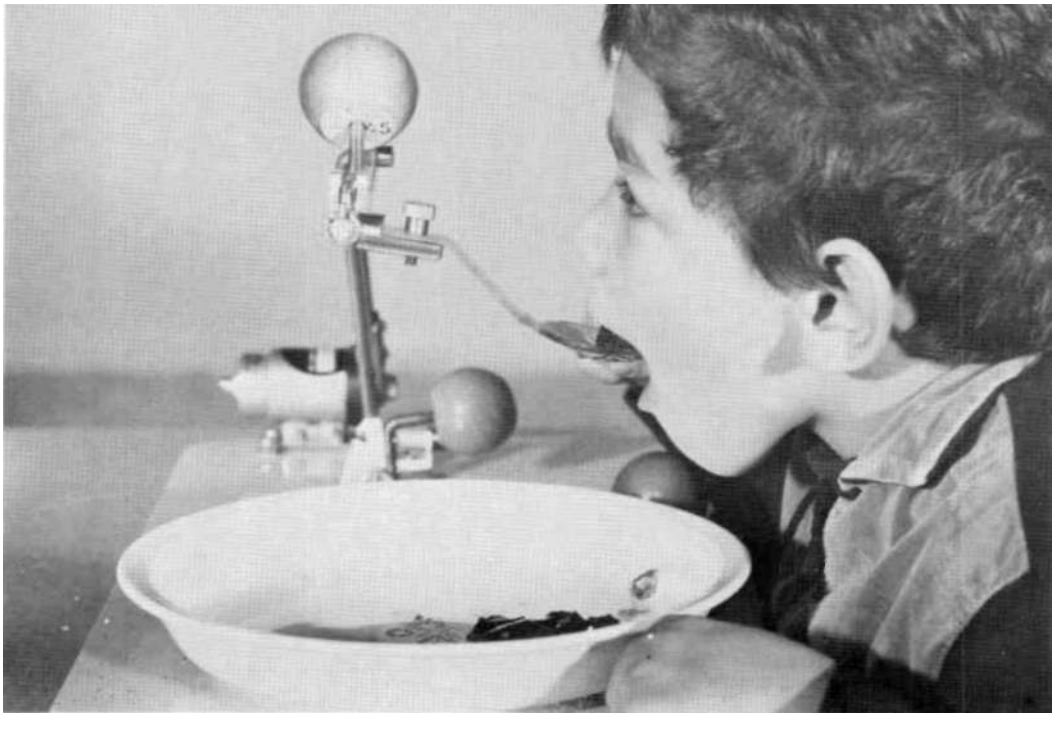


Fig. 6. With the spoon elevated to the correct height, the child is able to take the food into his mouth,

spoon to rise to the appropriate level. The level to which the arm rises can be adjusted (*f*). In some models of the feeder, a hole is provided near the plate for holding a drinking glass. The feeder is available in both left- and right-hand models.[4]

SELECTION AND PREPARATION OF FOOD

The food to be served should be soft *(e.g.,* mashed potatoes, pudding) or in small pieces *(e.g.,* meat, peas, fruit). Foods such as spaghetti or macaroni are only practical if cut up very finely. Soup is not suitable.

To facilitate serving, the plate can be removed from the spindle by rotating about 30 deg while gently lifting it upwards. The food should be placed around the edge of the plate, with each type separated so that the operator may make the desired selection by rotating the plate.

To place the plate back on the feeder, allow the arm holding the spoon to rise by pressing knob *(a).* Center the plate over the spindle so that the adaptor falls into the slot, then rotate the plate about 30 deg in a direction opposite to that produced by knob *(b).* The feeder is then ready for use.

OPERATION OF FEEDER

1. Push knob *(b)* until desired food is in position to be scooped up (Fig. 3).

2. Press knob *(d)* and, in doing so, push the spoon down into the plate (Fig. 4). (Some people may find it easier to push the spoon into the plate by pushing down on the arm.)

3. Press knob (a) to raise the spoon, and bring mouth forward to the filled spoon (Figs. 5 and 6). Continue this cycle until the meal is completed.

[4] The feeder can be obtained from Prosthetic Services, N.H.&W., Sunnybrook Hospital, 2075 Bayview Ave., Toronto, Ontario, Canada.

CARE AND ADJUSTMENTS OF FEEDER

Proper handling and cleanliness will ensure that the feeder remains in good working order. After each meal, the plate should be removed and washed in detergent and water, and the plastic top wiped clean. The thumb screw (Fig. 2, *c*), when loosened, allows the spoon to be removed for washing.

A screw (Fig. 2, *f*) allows adjustment of the height to which the spoon rises. If this must be lowered or raised, the screw is loosened, and the metal stop is pushed closer to or farther from the rod. The screw is then tightened.

RESULTS OF FEEDER TRIALS

Twelve cerebral palsy children, both spastics and athetoids, are successfully using the feeder. Their reactions to the feeder are similar; they truly enjoy feeding themselves. For most, this is the first time they have ever fed themselves, and their feelings of excitement, pride, and independence are very evident.

The parents of these children are similarly very delighted that their child can feed himself. The mother now can perform some of her mealtime chores as well as eat her own meal without having to constantly attend to this child. Some children still must have their mouths wiped after every few bites, but this takes considerably less effort on the mother's part than feeding her child every mouthful.

All in all, the results and the reactions we have observed of the feeder trials have been very satisfactory and promising.

Artificial Limbs, Vol 13. No 2, pp 69-73. Autumn 1969

Review of Visual Aids for Prosthetics and Orthotics[1]

Films

PROSTHETICS (GENERAL)

"Checkout Procedure for Unilateral Below Elbow Prosthesis," Institute of Rehabilitation Medicine, 1968, 3-4 min per cartridge, color, silent, Super 8 mm; requires Technicolor Super 8 projector.

Summary: Six cartridges depict various aspects of the checkout procedure as follows: Part I—Fit; Part II—Function, range of motion; Part III—Function, cable system; Part IV—Function, control system efficiency; Part V—Function, wrist unit; and Part VI—Craftsmanship. An occupational therapist, working with a below-elbow amputee, demonstrates the various procedures. Checkout forms accompany the films.

Evaluation: These films are excellent teaching devices. Procedures are clearly presented, and the separate cartridges can be used by either instructor or student. A special projector is required, however. Only basic routine procedures, as practiced at the Institute of Rehabilitation Medicine, are included. In a few instances, reasons for failure are controversial. These films are recommended for occupational therapists, physical therapists, physicians, and prosthetists.

Distributor: Institute of Rehabilitation Medicine Publications, 400 East 34th St., New York, N. Y. 10016.

Rental Fee: None.

Purchase Cost: $11.00 per cartridge. Film can be ordered in 16-mm continuous reel; cost unknown.

"Controls Training for the Bilateral Amputee," San Jose State College, 1968, 22 min, color, sound, 16 mm.

Summary: The expositor of the film, a bilateral above-elbow, below-elbow amputee, demonstrates donning and removing his prostheses, identifies the prosthetic components, and demonstrates and explains the function of each component. He also describes early training procedures and demonstrates these with the assistance of an occupational therapist.

Evaluation: The difficult task of narrating, demonstrating, and explaining is accomplished remarkably well by the expositor, who is thoroughly knowledgeable in all aspects of his subject. The film presupposes considerable knowledge about prosthetics on the part of the viewer. As a teaching film, it would have been enhanced by a slower pace, better organization, and perhaps a professional narrator. Repeated showing of the film would be of value to an amputee in helping him un-

[1]The review and evaluation of prosthetic and orthotic visual aids is a function of the Subcommittee on Educational Materials, Committee on Prosthetic-Orthotic Education. The reviewers of these recently produced films were: Joan Edelstein, Post-Graduate Medical School, New York University; Hazel M. Elliot, Department of Occupational Therapy, Medical College of Virginia; Hans Lehneis, Institute of Rehabilitation Medicine, New York University Medical Center; Jamie Lisle, Department of Physical Therapy, Medical College of Virginia; Phyllis Porter, College of Nursing, University of Bridgeport; Alan Smith, M.D., Veterans Administration Hospital, Brooklyn, New York; Muriel Zimmerman, Institute of Rehabilitation Medicine, New York University Medical Center; Barbara R. Friz, Executive Secretary, CPOE; and Elizabeth Davies, Professional Assistant, CPOE.

A booklet, "Review of Visual Aids for Prosthetics and Orthotics," which includes reviews of 58 films, is available from the Committee on Prosthetic-Orthotic Education, Division of Medical Sciences, National Research Council, 2101 Constitution Ave., Washington, D. C. 20418.

derstand the operation of various mechanisms of the device. For the same reason, therapists involved in training should see and study this presentation.

Distributor: Hosmer, Inc., P. 0. Box 37, Campbell, Calif. 95008.

Rental Fee: None.

Purchase Source: Film Service Laboratories, Inc., 6327 Santa Monica Blvd., Hollywood, Calif. 90038.

Purchase Cost: $101.66.

"Immediate Postsurgical Fitting of the Upper Extremity," University of Miami, 1968, 20 min, color, sound, 16 mm.

Summary: Shows surgical techniques used in wrist disarticulation of a snake-bite victim who suffered complete loss of hand function. Demonstrates the application of a temporary plaster-socket prosthesis immediately following surgery. Thermoplastic material replaces the temporary prosthesis in about *2 1/2* weeks. The patient uses the prosthesis 17 hours after surgery, and a year later he demonstrates skillful use of the hook for writing and other activities of daily living.

Evaluation: The material is well organized and is presented in a clear, concise manner. It is an excellent film, of value primarily to the surgeon and prosthetist, but also of interest as background information for physical therapists, occupational therapists, and nurses.

Distributor: American Academy of Orthopaedic Surgeons, 430 N. Michigan Ave., Chicago, Ill. 60611.

Rental Fee: $5.00.

Purchase Source: Write to Dr. A. Sarmiento, University of Miami School of Medicine, P. O. Box 875, Biscayne Annex, Miami, Fla. 33152.

Purchase Cost: $150.

"Meet Jerry heavy," San Jose State College, 1968, 40 min, color, sound, 16 mm.

Summary: Jerry Leavy, a bilateral above-elbow, below-elbow amputee, narrates the film as he performs many activities of daily living. (He is the same person who appeared in the film, "A Day in the Life of the Amputee," 1955.) Showering, shaving and other activities are accomplished before donning the prostheses immediately prior to dressing. For the rest of the usual day, he wears the prostheses and uses them with unusual dexterity and skill. Portrayal of Mr. Leavy's activities as the president of the Hosmer Corporation and at the controls of his airplane constitute the final part of the film.

Evaluation: This film demonstrates the high degree of skill that can be achieved by a wearer of prostheses who possesses the necessary motivation, perseverance, and coordination. An upper-extremity amputee would profit from observing the "tricks" and short-cuts in performance of activities and would probably appreciate the informal, personal approach. The amputee should have the opportunity to view the film several times because it moves along rapidly, and it would be difficult to pick up all the points in one showing. Besides the amputee and his family, the film would be of special value to occupational and physical therapists and of interest to anyone working with upper-extremity amputees.

Distributor: Hosmer, Inc., P. O. Box 37, Campbell, Calif. 95008.

Rental Fee: None.

Purchase Source: Film Service Laboratories, Inc., 6327 Santa Monica Blvd., Hollywood, Calif. 90038.

Purchase Cost: $201.50.

"Speaking of Nurses—Nursing Care of the Amputee," Rancho Los Amigos Hospital, 1968, 28 min, sound, black and white; requires Ampex 1-in. video tape recorder.

Summary: Presents the role of the liaison nurse in the care of a patient who receives a below-knee amputation and is fitted with a prosthesis immediately following surgery. Shows the patient's presurgical orientation, with the nurse, surgeon, and prosthetist participating. Depicts procedures in treatment, including

surgery and subsequent steps in rehabilitation. Stresses patient-nurse relationships, self-help, and the concepts of prevention, maintenance, restoration, and continuity of patient care.

Evaluation: Although the patient who appears in this film is an amputee, the primary purpose of the film appears to be the presentation of a concept of nursing care, a purpose which is well served. The film does provide a good orientation to the care and management of a particular kind of amputee. The video tape will limit distribution. The film may be of value to nurses and patients, particularly in hospitals where this type of patient-management program exists or is being developed.

Distributor: Acme Film Laboratories, Hollywood, Calif.

Rental Fee: $40.00.

Purchase Cost: $100.00.

CHILD PROSTHETICS

"Congenital Absence of the Lumbar Spine and Sacrum," Area Child Amputee Center, State of Michigan, 1968, 22 min, color, sound, 16 mm.

Summary: This relatively rare condition is well described by use of clinical signs, X-rays, gross and microscopic tissue specimens, pyelograms, and arteriograms. Five male patients were treated at this center, and the film is mostly concerned with the steps in rehabilitation of these patients. Advantages of bilateral subtrochanteric amputation are discussed, and patients are shown ambulating with and without hip-disarticulation prostheses and crutches. Various physical activities are demonstrated.

Evaluation: The material is extremely well organized and clearly presented. The photography is excellent. The film is a good teaching device for professional persons working with these patients and with children who have other congenital limb deficiencies, and could conceivably be of value for viewing by a child's family.

Distributor: State of Michigan Department of Public Health, The Area Child Amputee Program, 920 Cherry St., S.E., Grand Rapids, Mich. 49506.

Rental Fee: None.

Purchase Cost: $136.10.

"Juan Irigoyen Yepez," Institute of Rehabilitation Medicine, 1968, 30 min, sound, black and white, 16 mm.

Summary: This is the story of a bright Bolivian child with severe congenital anomalies of all extremities who was brought to this country to receive intensive habilitation. His physical, social, and emotional problems are discussed by various members of the rehabilitation team, and his progress is demonstrated by dialogue and pictures depicting his activities at various ages. He returns to his own country as an independent young man, able and prepared to contribute to society.

Evaluation: The film's chief value lies in its demonstration of the benefits that may be derived by the severely handicapped person from a well-planned, continuous rehabilitation program. The professional presentation is excellent. The technical quality, although satisfactory, varies because the film is a composite of still and motion pictures taken over many years. The film is recommended for anyone interested in rehabilitation of the severely disabled, and is of particular value to social workers, vocational counselors, and the general public.

Distributor: National Medical Audiovisual Center, Atlanta, Ga. 30333.

Rental Fee: None.

Purchase Cost: Not available for purchase.

"The Nonoperative Treatment of Scoliosis and Round Back by the Milwaukee Brace, Part II," Marquette University, 1968, 30 min, color, sound, 16 mm.

Summary: Presents several patients to demonstrate principles of the Milwaukee brace treatment. Shows the effects of proper and improper fitting of brace components. Discusses all aspects of treatment, including fitting, principles under-

lying component adjustment, methods of adjustment, voluntary correction of posture, rest, therapeutic exercise, and other physical activities.

Evaluation: This is an excellent overall presentation of the nonsurgical treatment of scoliosis and round back. The fact that the patients are followed for long periods of time contributes to the authenticity of the statements. The continuity and organization of the film could have been improved, but generally speaking, the material is well handled, particularly in view of its extensive coverage. Professionally, this is an excellent film, and it would be valuable to physicians, nurses, orthotists, therapists, families of patients, and anyone interested in the treatment of scoliosis and round back.

Distributor: American Academy of Orthopaedic Surgeons, 430 N. Michigan Ave., Chicago, Ill. 60611; or Ideal Pictures, 4431 W. North Ave., Milwaukee, Wis. 53208.

Rental Fee: $5.00.

Purchase Source: Write to Dr. W. P. Blount, 2140 W. Wisconsin Ave., Milwaukee, Wis. 53233.

Purchase Cost: $150.00.

"Swivel-Bar Transfer for the Quadriplegic Patient," Rancho Los Amigos Hospital, 1968, 12 min, color, sound, 16 mm, or Super 8 mm cartridges for either Fairchild or Technicolor sound projection.

Summary: A physical therapist and a patient with high-cervical-cord quadriplegia demonstrate a technique for patient transfer from wheelchair to bed. Describes the equipment needed and the method of attaching it to the bed.

Evaluation: The step-by-step presentation of the transfer technique, the use of repetition, and the well-paced narration contribute to the teaching value of this excellent film. It would be of value in training all levels of health personnel involved in such transfer activities, and would be of interest to public health nurses.

Distributor: Attending Staff Association, Rancho Los Amigos Hospital, 12826 Hawthorn St., Downey, Calif. 90242.

Purchase Cost: $60.00 for 8 mm single-concept cartridge; $81.00 for 16 mm. Film is available for one preview.

Slides

"Nomenclature for Congenital Skeletal Limb Deficiencies," 1967. Approximately 35 cardboard-mounted, 35 mm, 2 in. x 2 in., black and white.

These are slides of the figures used to illustrate the article, "Nomenclature for Congenital Limb Deficiencies, a Revision of the Frantz and O'Rahilly Classification," *Artificial Limbs,* 10:1, Spring 1966.

Distributor: Committee on Prosthetics Research and Development, Division of Engineering, National Research Council, 2101 Constitution Ave., Washington, D. C. 20418.

Rental Fee: None.

Purchase Cost: Not available for purchase; may be borrowed for purpose of duplication.

"Upper and Lower Limb Deficiencies, Congenital Amputees," compiled by Henry K. Taylor, M.D., Institute of Rehabilitation Medicine, 1968, 123 cardboard-mounted, 35 mm, 2 in. x 2 in.

These slides were made from X-rays of 92 cases of limb deficiencies in congenital amputees and are grouped according to patients with a specified number of limb deficiencies. They are accompanied by a booklet that includes definitions of terminology and captions for each slide indicating the Frantz-O'Rahilly classification of the anomaly. The slides are arbitrarily divided into Series No. 10-4, capsule A, and No. 10-4, capsule B.

Distributor: Micro-X-Ray Recorder, Inc., 3755 W. Lawrence St., Chicago, Ill. 60625.

Purchase Cost: $22.00 for each series.

"Project Slides," Second Series, Veterans Administration Prosthetic and Sensory

Aids Service, and Committee on Prosthetic-Orthotic Education, 1968, 100 slides, 35 mm, 2 in. x 2 in., color.

The slides illustrate above-knee, below-knee, above-elbow, below-elbow, and hip-disarticulation prostheses; prosthetic feet, hands, hooks, hinges; immediate postsurgical prosthetics; and lower-extremity braces.

Distributor: Committee on Prosthetic-Orthotic Education, Division of Medical Sciences, National Research Council, 2101 Constitution Ave., Washington, D. C. 20418.

Rental Fee: None.

Purchase Cost: Not available for purchase. May be borrowed for purpose of duplication.

Technical Notes from the Artificial Limb Program

This section of ARTIFICIAL LIMBS *is intended as an outlet for new developments in limb prosthetics and orthotics which, though not deserving of a long feature article, nevertheless ought to be brought to the attention of the readers of this journal. Notes may vary in length from a single paragraph to several pages of manuscript, as appropriate. Illustrations also are acceptable.*

A Prefabricated Brim for the Above-Knee Immediate Postsurgical Rigid Dressing[1]

This paper describes a procedure for the fabrication and application of a quadrilateral, plaster-of-Paris brim. The brim can be used to establish the proximal portion of an above-knee rigid dressing.

The procedure produces a smooth and regular dressing that can be obtained with minimal assistance and a saving of considerable time in the operating room; however, it will not reduce the total time expended on an above-knee immediate postsurgical fitting. It also requires that the prosthetist obtain certain information concerning the patient preoperatively.

Basically, this requirement involves securing before surgery a circumferential measurement at the ischial level and an anterior-posterior (A-P) measurement of the extremity involved. Also, there must be sufficient time for construction of a custom brim following measurement of the patient, or the prosthetist must have on hand a range of sizes of left and right prefabricated brims.

In the development of this procedure, University of California (Berkeley) casting fixtures were used to make a series of rigid plaster-of-Paris positive molds. These molds were modified to provide the special features required of the proximal portion of a rigid dressing; *i.e.*, no attempt was made to secure positive ischial bearing, and restriction at the ischial level or at any level superior to the site of the amputation was to be avoided. Therefore, on these molds the A-P measurements were increased 3/8 in. over that anticipated for a given circumference at the ischial level. The molds were made to produce a brim 3-1/2 in. deep, measured from the ischial seat. The distal aspect of the mold was increased in the A-P dimension so that no restriction would be applied to the bellies of the extensor or quadriceps muscles. The size increase incurred by the previous step was compensated for somewhat by removal of plaster on the medial side of the mold so that an angle of 10 deg from the vertical was established on the medial wall (Fig. 1).

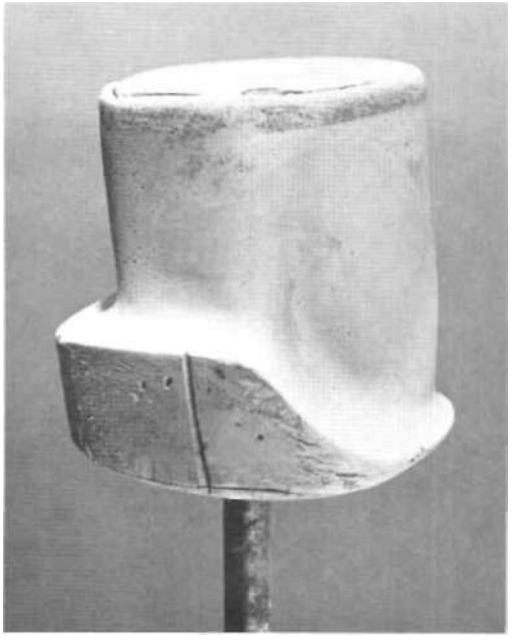


Fig. 1.

The first brims fabricated over these molds were of laminated polyester resin. Two brims were made in succession, one on top of the other, without significant loss of definition, and, consequently, the number of original sizes was doubled. After the brims were removed from the mold, the lateral sides were cut and provided with a leather tongue. A hose clamp

[1] This work was conducted under Veterans Administration Contract No. V1005M-1079.

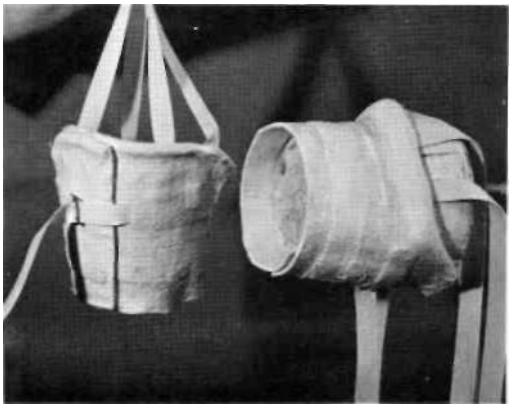


Fig. 2.

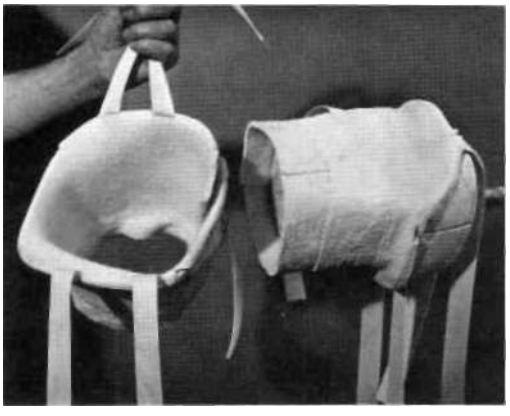


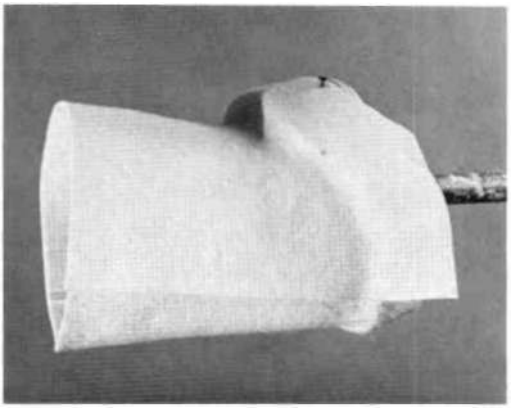
Fig. 3.

closure was put on at the ischial level. These polyester brims were functionally excellent, but deteriorated rather quickly after being used a second time. This drawback prompted a change to a disposable, prefabricated plaster-of-Paris brim with a felt lining. The brim was less expensive to produce, hence, more expendable. The original molds were again used to form these plaster brims. However, many alternative methods of preparing both negative and positive molds could be developed by knowledgeable prosthetists.

The plaster brims, like those made of polyester, are moderately adjustable, in this case by a lap joint on the lateral side secured by a buckle and strap (Fig. 2). In addition, four temporary straps are incorporated into the brim (Fig. 3). These straps extend from the proximal edge and serve to maintain the brim at the ischial level while the distal part of the stump is being wrapped and the permanent cable suspension has been installed in the cast. After serving their purpose, the temporary suspension straps are cut away.

CONSTRUCTION

In constructing the brim, the mold is first positioned horizontally in a vise. The surface of the mold is covered with 1/8-in. felt, allowing an overlap of 2 to 3 in. on the lateral side and an overhang of 1 in. proximally and 2 in. distally (Fig. 4). By dampening and stretching the felt, it can be made to conform to the contours of the cast without wrinkles. A few tacks through the proximal and distal overhangs into the ends of the cast/mold will hold the felt in place. The lateral felt overlap is reflected to expose the lower extension. Then, starting at the posterior-lateral corner, individual strips of 3-in. plaster-of-Paris splint material are laid onto the surface. Each individual strip is applied so as to overlap the preceding one in order to ensure that a good bond is obtained and the characteristic shape of the underlying mold is maintained (Fig. 5). Application of strips around the cast is continued until the starting position is regained. This portion of the plaster will now be dry enough to allow replacement of the reflected top layer of felt and the continuation of work over its surface to form a lap joint.



From 1-in. wide Dacron or cotton webbing, four 18-in. lengths are cut for the temporary suspension straps. Two anterior and two posterior slits are made through the felt at the proximal brim level in positions that coincide with the location of the attachment buckles on an above-knee suspension belt. The straps are passed through the slits so that 14 in. extend proximally and 4 in. lie over the brim. The lower sections are secured onto the brim with plaster splint (Fig. 6).

The lateral closure straps are made of 1-in. Dacron or cotton webbing. One piece has a buckle attached to it; the second piece serves as a closing strap. These straps are imbedded on the lateral side of the brim at the ischial level.

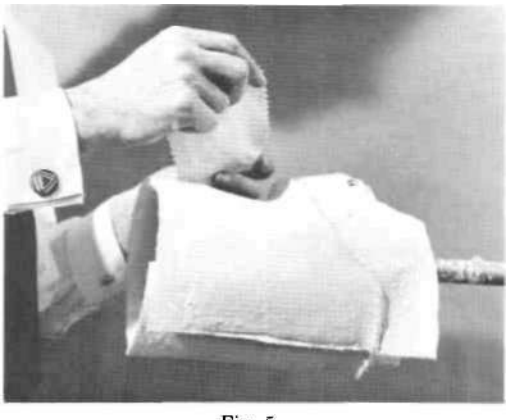


Fig. 5.

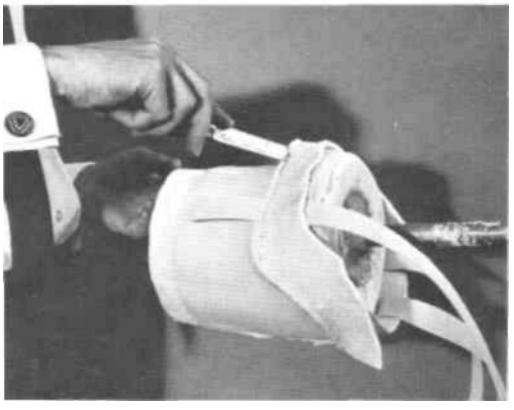


Fig 6.

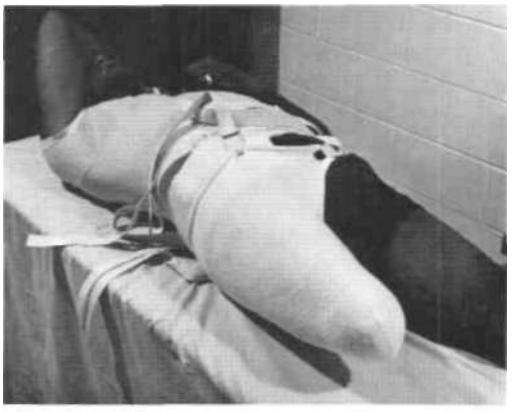


Fig. 7.

The 1-in. felt that was left extending proximally should be skived, folded over, and laid in with plaster, thus producing a very comfortable felt edge at the ischial level. By virtue of the method of construction with the strap inclusions, the proximal area of the brim will be comparatively thicker. In fact, the objective should be to produce a brim that is about 1/4 in. thick proximally with the thickness gradually reduced distally. The felt lining should extend 2 in. below the distal end of the plaster brim.

APPLICATION OF THE BRIM

Following the accepted practice for an above-knee immediate postsurgical fitting *(1),* the suture area is covered with a nonadherent dressing. The suture line and distal-lateral femur are cushioned with sterile lamb's wool or fluffed gauze. A sterile Lycra[2] spandex stump sock is then rolled over the end of the stump and onto the thigh. The sock is split in the perineal area so that it can be pulled snugly. If it is not possible to put the waist belt on the patient preoperatively, it should be positioned at this time with the shoulder strap padded and buckled. The suspension straps of the belt are threaded through holes pierced at a high level in the stump sock and are buckled to secure the stump sock under tension (Fig. 7).

[2] Registered trademark of the Dupont Co.

The prefabricated brim, in the open position, is then pushed up to the ischial level, and the lateral closure strap is tightened (Fig. 8). The straps extending from the proximal brim are tied onto the straps from the belt or secured to any suitable free buckles (Figs. 9 and 10). With the stump sock and the brim securely placed, the distal part of the wrap is ready to be applied using an elastic plaster-of-Paris bandage (Fig. 11). From the moderately firm tension applied on the distal stump, the stretch on the bandage is progressively reduced as the wrap is continued proximally. The wrap is continued over the felt and onto the plaster of the brim.

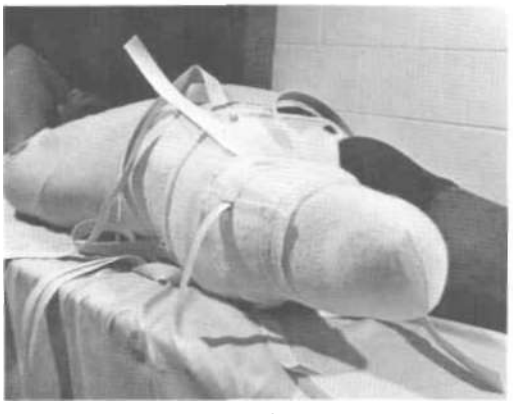


Fig. 8.

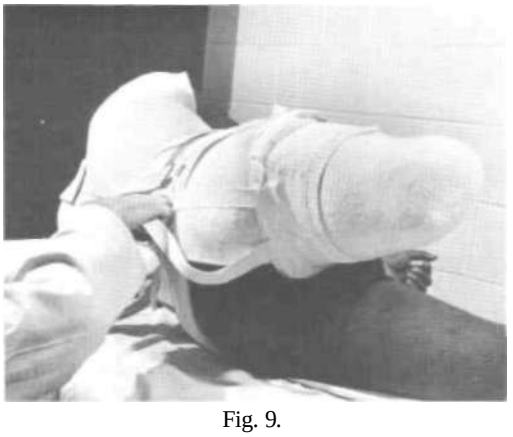


Fig. 9.

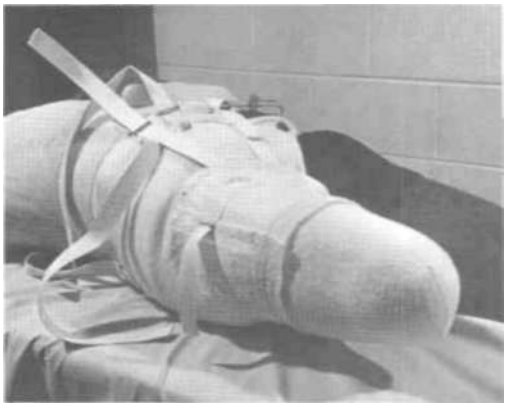


Fig. 10.

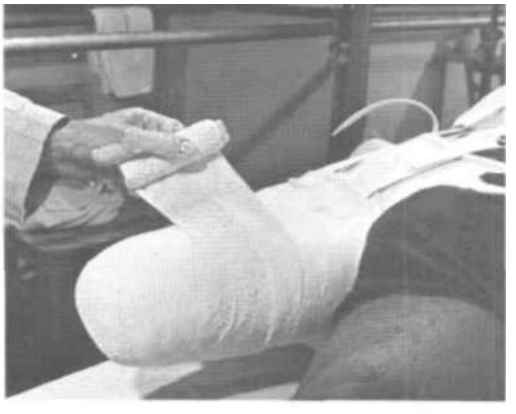


Fig. 11.

With an accurate brim fit and good judgment of bandage tension, a smooth transition will be obtained at the junction of the brim and the distal wrap. If the stump tissues are excessively flaccid, they may tend to fall away from the anterior brim and bulge posteriorly. This situation can be remedied by supporting the tissues with the hands until the elastic plaster of Paris hardens. Relief for the distal femur can be obtained by hand-forming a flat area on the lateral side of the cast slightly superior to the end of the femur. When the elastic plaster of Paris has set, the complete cast should be reinforced with a standard plaster bandage going high enough to support the lateral closure strap. This step is followed by installation

of the cable suspension in the usual manner.

When the suspension cables are securely set in the plaster, the belt straps holding the stump sock and brim can be transferred to the hangers on the permanent suspension cables. The temporary straps in the brim are cut away. The stump sock is reflected and neatly tied in.

The socket attachment plate, knee, and pylon are added following the method described in the Seattle manual (i).

CONCLUSION

Using the procedures that have been described, the need to obtain preoperative patient measurements and the time invested in prefabricating the brim are compensated for by: (a) a reduction in the difficulty of wrapping and maintaining adequate plaster of Paris at the perineal level to form a good ischial seat and a generous anterior flare, *(b)* attainment of a smoother, more comfortable fit at the ischial level, (c) maintenance of constant tension on the stump sock, and (d) a great reduction in the time required for casting the patient, consequently, reduction of the all-important time the patient is anesthetized.

—Ian J. Currell, C.P.
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Prosthetic Research and Evaluation
Chicago, Ill. 60611

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1. Burgess, Ernest M., Joseph E. Traub, and A. Bennett Wilson, Jr., *Immediate postsurgical prosthetics in the management of lower extremity amputees,* TR 10-5, Prosthetic and Sensory Aids Service, U. S. Veterans Administration, Washington, D.C., April 1967.

News and Notes

Prosthetics-Orthotics Education

University of California, Los Angeles

The UCLA Prosthetics Orthotics Program continues to present short-term courses for physicians, therapists, and rehabilitation counselors, and a full-time, one-school-year certificate program for prosthetists and orthotists. The courses for prosthetists and orthotists are conducted by John J. Bray, C.P.&O., Director, Prosthetic-Orthotic Instruction; Charles M. Scott, B.S.M.E., Instructor; Bradd Rosenquist, B.S., Instructor; and Timothy Staats, B.S., Assistant Instructor.

New staff members include: Harry Bradley, M.S.M.E., Engineering Consultant; Florence Conot, B.A., Editor; Laurie Crumplar, Administrative Assistant; Nancy Keating, R.P.T., part-time Instructor; and Arnold Tripp, R.P.T., Consultant Therapist. Keith Vinnecour, C.P., resigned August 1, 1969, to enter private practice.

The course titles, numbers, and dates for this academic year follow.

Physicians
Prosthetics-Orthotics X-482
Sept. 8-19; Nov. 10-21, 1969; Feb. 9-20; Mar. 9-20; May 25-June 5, 1970

Therapists
Prosthetics-Orthotics X-481
Sept. 8-19; Nov. 10-21, 1969; Feb. 9-20; Mar. 9-20; May 25-June 5, 1970

Prosthetists
Upper Extremity Prosthetics X-468
Sept. 15-Oct. 10, 1969
Below Knee Prosthetics X-480
Oct. 27-Nov. 26, 1969
Above Knee Prosthetics X-463
Jan. 5-Feb. 6, 1970
Hip Disarticulation and Symes Prosthetics X-486
Mar. 2-20, 1970

Orthotists
Lower Extremity Orthotics X-485
April 6-May 8, 1970
Upper Extremity Orthotics X-476
June 8-19, 1970

Physicians, Prosthetists, Therapists, and Social Workers
Child Amputee Prosthetics X-469
June 8-19, 1970

Rehabilitation Personnel
Prosthetic-Orthotic Rehabilitation M-480 (not recommended for physicians or therapists)
Nov. 3-5, 1969; Jan. 12-14; May 11-13, 1970

Financial assistance for traineeships is available. *Applications for enrollment must be submitted at least one month prior to the starting date of the desired course.* Address requests for information and applications to: Registrar, Prosthetics-Orthotics Program, Room 22-58 UCLA Rehabilitation Center, 1000 Veteran Ave., Los Angeles, Calif. 90024. (Note: Veterans Administration employees, except Residents at VA hospitals, should direct inquiries to Mr. William M. Bernstock, Coordinator of Prosthetics Education, Veterans Administration, 252 Seventh Ave., New York, N. Y. 10001.)

Bernard R. Strohm, Director of the Prosthetics-Orthotics Program since July 1, 1968, resigned on July 1, 1969, to assume the position of Assistant Director of Hospitals and Clinics of the Health Science Center at UCLA. His new duties will include the coordination of the allied educational programs, including the proposed Prosthetics-Orthotics Degree program.

The UCLA Prosthetics-Orthotics Program now has a functioning biomechanics laboratory. Special equipment installed includes a treadmill, a vital capacities analyzer, a four-channel transistorized telemetry system, the latest pressure transducer equipment, and recording equipment with a twelve-channel capacity. This equipment will enable the research staff, headed by Charles Scott, to do complete force analyses and documentation on the biomechanical function of the UCLA Functional Long Leg Brace (FLLB). Information to date indicates that design changes could make the FLLB less expensive to fabricate and lighter in weight. In addition, this equipment will facilitate studies of pressure at the interface between the skin and the socket of prosthetic-orthotic patients under dynamic conditions. It will also be available for clinical and teaching purposes.

The Certificate Program will have an enrollment of ten students, which includes

At the Prosthetics-Orthotics Biomechanics Laboratory in March 1969, Mr. Lucas of Northern Electric (Canada), Charles Scott of UCLA, and Dr. Edward Peizer of VAPC are shown taking test read-outs on myoelectrically controlled hands for the CPRD U.E.P. research program.

four A.A. and five B.S. students. New Zealand, Puerto Rico, and Canada are represented.

New York University

Bachelor of Science degrees in the field of prosthetics and orthotics were conferred by New York University in June 1969 upon eight graduates: Martha Stibitz Banerjee, Jack Caputo, Peter Delaney, David Forbes, Herbert E. Kramer, Michael Lefton, Ronald Ray, and Richard Roy.

Mrs. Banerjee, who is also an occupational therapist, is married to Dr. Sikhar Banerjee, a physiatrist from India, where the couple plans to practice professionally. She is the first woman to graduate with a baccalaureate degree in prosthetics and orthotics. Her particular interest is upper-extremity orthotics, and she is already active in the design and fabrication of more versatile appliances.

Mr. Caputo had been an orthopedic mechanic prior to his matriculation in the curriculum, where he added a distinguished academic record to his technical skills. In recognition of his excellent academic performance, Mr. Caputo received the second annual J. E. Hanger Award as the outstanding graduate in prosthetics and orthotics. Hailing from New England are Mr. Roy and Mr. Delaney, who had some prosthetic experience before pursuing studies at NYU. The geographically varied class includes Mr. Ray from East Stroudsburg, Pennsylvania, and Mr. Forbes from upstate New York, who intends to emphasize orthotics in his professional activities. Mr. Kramer's degree enhances his record of outstanding contributions in the field, including participation in workshops of AOPA and the National Academy of Sciences-National Research Council. Mr. Lefton had previously been awarded an Associate of Arts degree from Nassau Community College.

Postgraduate prosthetics and orthotics education is now in its fourteenth year at

Mr. Jack Caputo, member of the graduating class of 1968 and winner of the J. E. Hanger award.

NYU. At the end of the 1968-69 academic year, approximately 3,200 physicians and surgeons, 2,200 therapists, 1,300 prosthetists and orthotists, and 800 rehabilitation counselors had attended courses.

Additions to the curriculum during the past year were courses in "Spinal Orthotics for Physicians and Surgeons" and "Recent Developments in Lower Extremity Prosthetics for Therapists." The spinal orthotics course includes instruction on components, design and fit and functions of braces and corsets for the lumbar, thoracic, and cervical spine in relation to the management of various pathological conditions. Review of basic biomechanics, kinesiology, and pathomechanics of the spine provides much of the rationale for clinical practice. Students have the opportunity to evaluate the fit and functions of spinal orthoses in laboratory sessions that feature braces fitted to demonstrator subjects. A substantial portion of the material in the course is based upon that developed for "Spinal Orthotics for Orthotists." The favorable reception given the course warranted the scheduling of three sections for the current year.

"Recent Developments in Lower Extremity Prosthetics" is a two-day, updating course designed especially for therapists who had completed the regular two-week course prior to September 1967. It includes the rationale and procedures for immediate and early prosthetic management, as well as newer designs, components, and materials for below-knee, above-knee, and hip-disarticulation prostheses. Amputees fitted with these more recent devices served as laboratory subjects.

Since a large number of therapists completed the upper-extremity prosthetics course in years when this course concentrated solely on amputees, a new option is being offered this academic year. Therapists may register for a seven-day prosthetics course separate from, or together with, a three-day upper-extremity orthotics course. The orthotics portion features instruction regarding orthotic components, fabrication, fitting, evaluation, and clinical applications to paralyzed and other patients.

Other innovations complement the educational program. Successful trial of an above-knee, mock-up prosthesis, which provides the wearer with sensations similar to those received while walking with a mechanical knee and foot, has paved the way for its general use as a teaching aid. Use of the mock-up should result in improved instruction of amputee patients. Printed materials for most of the courses have been completely re-edited, reorganized, and bound. Instruction has also been upgraded by participation of much of the staff in a clinic-visit program among the numerous rehabilitation facilities in metropolitan New York. The visits have yielded reciprocal benefits already, as the staff members observe a wide range of practical problems in the medical, economic, psychological, and prosthetic and orthotic aspects of care of patients and, in turn, share up-to-date classroom ideas with the local clinic teams.

Transfer of all shop, classroom, and patient quarters from the old Basic Sciences building at East 26th St. to the present location at 317 East 34th St. has been completed. Better utilization of space in the new quarters has permitted the construction of a third classroom for lecture and laboratory sessions with both undergraduate and graduate students.

The 1969-70 schedule of courses follows. Additional information and application and traineeship forms may be obtained by writing to Dr. Sidney Fishman, Coordinator, Prosthetics and Orthotics, NYU Post-Graduate Medical School, 317 East 34th St., New York, N. Y. 10016.

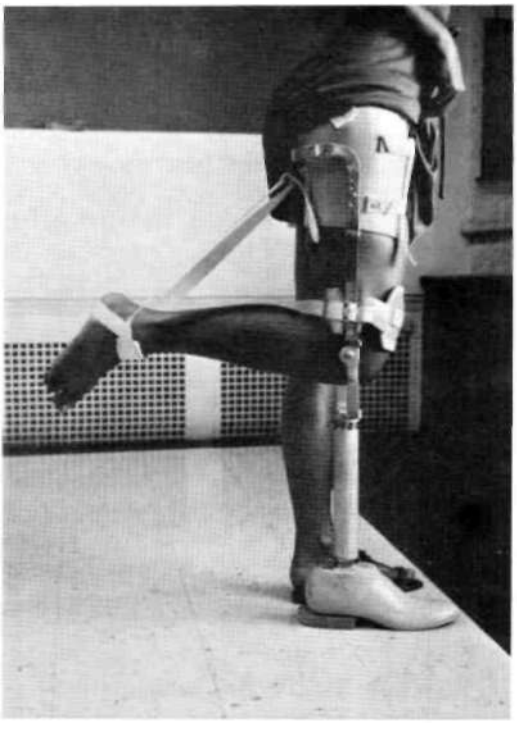
For Physicians and Surgeons

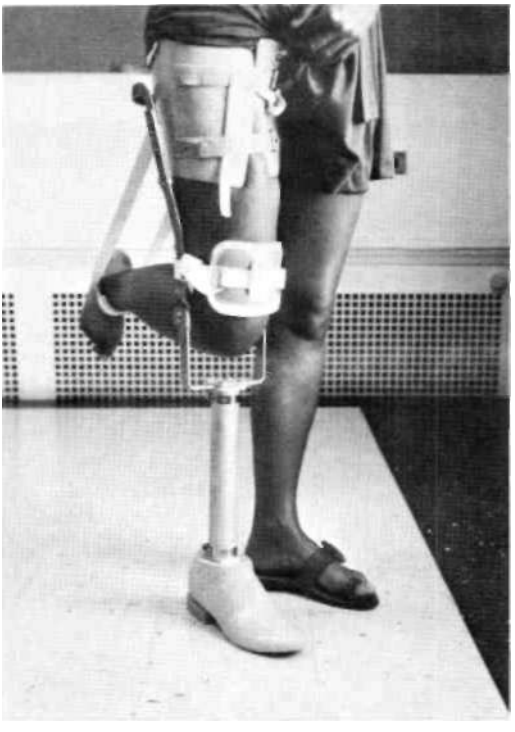
Lower Extremity Prosthetics

741A	September 29-October 4, 1969
741B	November 10-15, 1969
741C	February 2-7, 1970
741D	May 11-16, 1970

Upper Extremity Prosthetics and Orthotics

744A	December 8-12, 1969
744B	March 16-20, 1970





Simulated knee prosthesis.

Lower Extremity Orthotics
751A October 6-10, 1969
751B March 2-6, 1970
751C April 6-10, 1970
Spinal Orthotics
755A November 19-21, 1969
755B January 7-9, 1970
755C April 22-24, 1970
Immediate and Early Postsurgical Prosthetics
7411B March 23-25, 1970

For Therapists
Lower Extremity Prosthetics
742A September 8-19, 1969
742B October 20-31, 1969
742C February 9-20, 1970
742D April 27-May 8, 1970
Upper Extremity Prosthetics and Orthotics
745A December 1-12, 1969
745B March 9-20, 1970
Lower Extremity Orthotics
752A October 6-10, 1969
752B March 2-6, 1970
752C April 6-10, 1970
Recent Developments in Lower Extremity Prosthetics
7421A September 25-26, 1969
7421C April 16-17, 1970

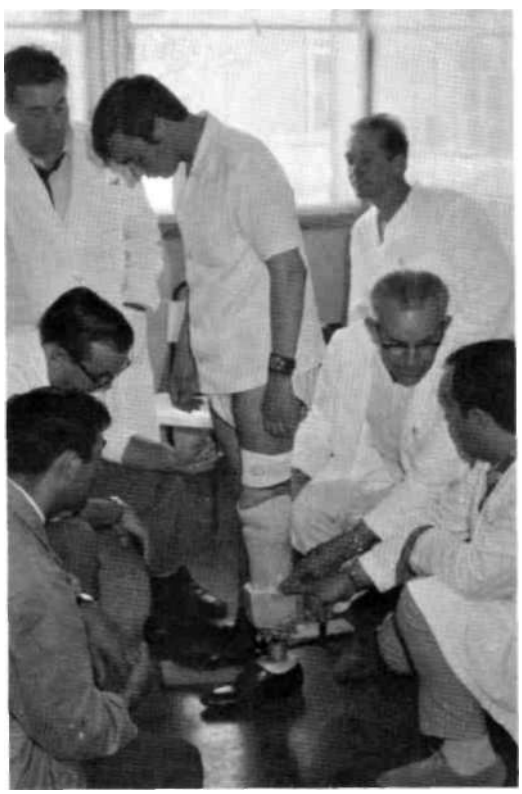
For Prosthetists
Below-Knee Prosthetics
740A September 2-19, 1969
Immediate and Early Postsurgical Prosthetics
7401A January 12-17, 1970
7401B March 23-28, 1970
Above-Knee Prosthetics
743A May 25-June 12, 1970
Upper Extremity Prosthetics
746A July 6-17, 1970

For Orthotists
Spinal Orthotics
756A January 19-30, 1970
Lower Extremity Orthotics
753A June 15-26, 1970

For Rehabilitation Counselors
Prosthetics and Orthotics
750B October 20-24, 1969
750C February 9-13, 1970
750D April 27-May 1, 1970

The faculty has become increasingly involved in international education activities. Cascais, Portugal, was the scene of the Second Annual Course for Pros-

thetists presented at the invitation of the Centro de Medicina de Reabilitacao. The course, which covered below-knee prosthetics, was a sequel to last year's offering in above-knee prosthetics. Dr. Sidney Fishman and Messrs. Warren P. Springer, Ivan A. Dillee, and Clauson F. England conducted the program in cooperation with key members of the professional staff at the Center. Dr. Fishman also consulted in Madrid and Barcelona with Dr. Prim and Dr. Sumoy about the organization of prosthetics and orthotics programs in Spain. Also, in Roehampton, England, he had discussions with Dr. McKenzie, and in Dundee, Scotland, with Dr. Murdoch on matters related to prosthetics and orthotics research and education. On two separate occasions, the faculty participated in programs of the Canadian Interprovincial Association of Prosthetists and Orthotists. Dr. Fishman, Mr. Norman Berger, and Mr. Clyde Dolan addressed the association in Montreal, and Messrs. Berger and Basil Peters addressed the Association in Saskatoon. A course on "Immediate Postsurgical Prosthetics" was presented by Messrs. Dillee and Kramer in Toronto. Mr. Springer participated in a Conference on Priorities in Prosthetic and Orthotic Practice in Dundee, Scotland.



Ivan Dillee and Clauson England of the NYU staff demonstrate a BK adjustable leg to students in the BK prosthetics course at Centro de Medicina de Reabilitacao.

Mr. George Hartmann and Mr. Richard Hanak were instructors in the prosthetic-orthotic technician course at the Inter-American University in Puerto Rico; Mr. Dolan addressed the AOPA national convention at Minneapolis; Mr. Dillee presented programs at the AOPA regional meeting in Hartford, Connecticut; and Mr. Hartmann lectured at Sunnyview Center, Schenectady, New York.

Miss Audrey Schneidmesser and Mr. Dolan left the organization to enter the business field, and Mr. Thomas Grille resigned to resume his studies in the field of industrial design. Two appointments to the professional staff during the year are those of Barbara Gehant, B.S., R.P.T., and Marshall Kaufman, B.M.E. Miss Gehant brings insights from her previous experience as a physical therapist in Denmark, the United States, and England to her new responsibilities as a member of the faculty. Mr. Kaufman has had considerable experience in mechanical design engineering, particularly with electro-mechanical equipment.

Northwestern University

In accordance with the recommendations offered at the December 1968 Below-Knee Prosthetics Symposium (see Artif. Limbs, 13:1:78-79), the Northwestern University Prosthetic-Orthotic Center announced that it will offer a course in "Advanced Below-Knee Prosthetic Techniques for Prosthetists." This intensive, five-day course will include lecture-demonstration and laboratory practice in the

fitting, fabrication, and evaluation of the air-cushion socket, patellar-tendon-bearing supracondylar-suspension socket (PTS), and the patellar-tendon-bearing socket with supracondylar-wedge suspension. A lecture-demonstration on forming sockets using Polysar will also be given.

The course is open to certified prosthetists and those preparing for certification, with a prerequisite of successful completion of a below-knee course at NYU, UCLA, or NU. The tuition for prosthetists is $100 and a laboratory fee of $175.

The classes are scheduled as follows:

Section A	November 17-21, 1969
Section B	December 1-5, 1969
Section C	December 15-19, 1969
Section D	January 5-9, 1970
Section E	January 19-23, 1970
Section F	April 13-17, 1970

Additional sections will be added if enrollment indicates the need.

The complete schedule of courses follows. Requests for further information should be addressed to Charles M. Fryer, M.A., Director, Prosthetic-Orthotic Center, 401 East Ohio St., Chicago, Ill. 60611.

Prosthetists

Prosthetics 601	Above-Knee Prosthetics
Section A	July 7-August 1, 1969
Prosthetics 611	Below-Knee Prosthetics
Section A	July 13-31, 1970
Prosthetics 621	Advanced Below-Knee Prosthetics (see *above)*
Prosthetics 631	Management of the Juvenile Amputee
Section A	November 17-20, 1969
Section B	May 25-28, 1970
Prosthetics 641	Review Course in Prosthetics
Section A	May 18-20, 1970
Prosthetics 681	Immediate Postsurgical Fitting Procedures
Section A	November 24-25, 1969
Section B	March 23-24, 1970

Orthotists

Orthotics 701	Spinal Orthotics
Section A	July 27-August 7, 1970
Orthotics 711	Lower-Extremity Orthotics
Section A	June 22-July 3, 1970
Orthotics 721	Upper-Extremity Orthotics
Section A	July 13-24, 1970
Orthotics 731	Review Course in Orthotics
Section A	April 20-22, 1970

Rehabilitation Counselors

Prosthetics-Orthotics 640	Orientation in Prosthetics and Orthotics
Section A	November 3-6, 1969
Section B	December 15-18, 1969
Section C	February 9-12, 1970
Section D	April 13-16, 1970

Therapists

Prosthetics 622	Lower-Extremity Prosthetics
Section A	September 15-19, 1969
Section B	October 6-10, 1969
Section C	October 27-31, 1969
Section D	November 10-14, 1969
Section E	December 8-12, 1969
Section F	February 2-6, 1970
Section G	March 9-13, 1970
Section H	April 6-10, 1970
Section I	May 4-8, 1970
Prosthetics 632	Management of Juvenile Amputee
Section A	November 17-20, 1969
Section B	May 25-28, 1970
Prosthetics 662	Upper-Extremity Prosthetics
Section A	November 3-6, 1969
Section B	December 15-18, 1969
Section C	February 9-12, 1970
Section D	April 13-16, 1970
Section E	May 11-14, 1970
Orthotics 702	Orthotics
Section A	September 22-26, 1969
Section B	October 20-24, 1969
Section C	February 23-27, 1970
Section D	April 27-May 1, 1970

Physicians and Surgeons

Prosthetics 623	Lower-Extremity Prosthetics
Section A	September 15-19, 1969
Section B	October 6-10, 1969
Section C	October 27-31, 1969
Section D	November 10-14, 1969
Section E	December 8-12, 1969
Section F	February 2-6, 1970
Section G	March 9-13, 1970
Section H	April 6-10, 1970
Section I	May 4-8, 1970
Prosthetics 633	Management of the Juvenile Amputee
Section A	November 17-20, 1969
Section B	May 25-28, 1970
Prosthetics 663	Upper-Extremity Prosthetics
Section A	November 3-6, 1969
Section B	December 15-18, 1969
Section C	February 9-12, 1970
Section D	April 13-16, 1970
Section E	May 11-14, 1970
Prosthetics 683	Immediate Postsurgical Fitting Procedures
Section A	November 24-25, 1969
Section B	March 23-24, 1970
Orthotics 703	Orthotics
Section A	September 22-26, 1969

Section B	October 20-24, 1969
Section C	February 23-27, 1970
Section D	April 27-May 1, 1970

Nurses

Prosthetics 644	Management of the Amputee for Registered Nurses
Section A	November 24-26, 1969
Section B	May 18-20, 1970

Meeting of Visual Aids Group

The Ad Hoc Committee to Review Prosthetic-Orthotic Visual Aids, Committee on Prosthetic-Orthotic Education, met on March 26, 1969, at the Institute of Rehabilitation Medicine, New York City, and on June 4 at the National Academy of Sciences, Washington, D. C, to review films and slides related to prosthetics and orthotics.

The films reviewed were: *Checkout Procedure for Unilateral Below Elbow Prosthesis; Speaking of Nurses—Nursing Care of the Amputee; The Nonoperative Treatment of Scoliosis and Round Back by the Milwaukee Brace, Part II; Immediate Postsurgical Fitting of the Upper Extremity; Congenital Absence of the Lumbar Spine and Sacrum; Juan Irigoyen Yepez; Meet Jerry heavy; Controls Training for the Bilateral Amputee;* and *Swivel-Bar Transfer for the Quadriplegic Patient.*

Ad Hoc Committee on Publications

The first meeting of the Ad Hoc Committee on Publications, Committee on Prosthetic-Orthotic Education, was held at the National Academy of Sciences, Washington, D. C, on April 23, 1969. Members attending were: William M. Bernstock, Chairman; Charles 0. Bechtol, M.D.; Hector Kay; Florence Knowles; Herbert E. Pedersen, M.D., *ex officio;* and Geneva Johnson, *ex officio.* Others attending were: Miles Anderson, Ed.D.; Warren Springer; Robert Thompson, M.D.; Herbert Warburton; A. Bennett Wilson, Jr.; Charles L. Dunham, M.D., Chairman, Division of Medical Sciences, National Research Council; and Barbara R. Friz, Executive Secretary, CPOE. The purpose of the meeting, as stated by Mr. Bernstock, was to explore the problems related to reported shortages of written materials in prosthetics and orthotics and to define the role of the committee in that area.

Current publication activities were reviewed. Representatives of regularly published prosthetics and orthotics journals summarized the salient features of their respective journals. Dr. Robert Thompson, Chairman of the Committee on Prosthetics and Orthotics, American Academy of Orthopaedic Surgeons, discussed a proposal for revision of the *Orthopaedic Appliances Atlas, Vol. 1,* which was first published in 1952.

Dr. Miles Anderson, Director, Division of Vocational Education, UCLA, described plans to develop a series of laboratory manuals that would present step-by-step methods of fabricating orthotic and prosthetic devices. A manual on lower-extremity orthotics is being prepared by a subcommittee composed of members of AOPA and the American Board for Certification in Orthotics and Prosthetics. The project is supported by a grant from the U. S. Office of Education.

Responsibilities of the Ad Hoc Committee on Publications include the review of publications in the fields of prosthetics and orthotics in order to determine the most acute needs for manuals and publications; the exploration of possibilities for meeting these needs; and subsequent encouragement and stimulation in development of pertinent written materials. The committee will act in an advisory and correlative capacity to ensure a controlled and coordinated approach in planning and developing publications, and will serve in an editorial capacity as required.

The group will explore the possibility of establishing a central, automated, information-retrieval system in prosthetics and orthotics. It will also offer to interested textbook publishers its services in arranging for review of prosthetics and orthotics materials prior to publication.

The committee recommended that a network of adult amputee clinics be es-

tablished as a means of facilitating dissemination of information.

Annual Meeting of CPOE

The annual meeting of the Committee on Prosthetic-Orthotic Education was held at the National Academy of Sciences, Washington, D. C, on April 24, 1969. Members attending were: Herbert E. Pedersen, M.D., Chairman; Charles 0. Bechtol, M.D.; William M. Bernstock; Frank W. Clippinger, Jr., M.D.; Clinton L. Compere, M.D.; Roy M. Hoover, M.D.; Geneva R. Johnson; Alvin L. Muilenburg; Lena M. Plaisted; Ruth A. Robinson, Col., AMSC (Ret.); Charles W. Rosenquist; and Walter A. L. Thompson, M.D.

Guests attending were: Quinn H. Becker, M.D.; Audrey Calomino; Michael P. Cestaro; Louise Crunplar; Sidney Fishman, Ph.D.; Charles Fryer; Arthur Guilford; Allen Herrington, M.D.; Hector W. Kay; Florence Knowles; Walter Komiak; Maurice A. LeBlanc; Elwyn C. Saferite, Ed.D.; Augusto Sarmiento, M.D., Joseph E. Traub; Herbert B. Warburton; Martin M. Wilbur, M.D.; Elane Wilcox, Ph.D.; and A. Bennett Wilson, Jr.

Attending from the Division of Medical Sciences, National Research Council, were Charles L. Dunham, M.D., Chairman; Barbara R. Friz, Executive Secretary, CPOE; Elizabeth Davies, Professional Assistant, CPOE; June D. Newman, Secretary, CPOE; and Jean Perrin.

Members and guests were welcomed by Dr. Dunham, after which Dr. Pedersen invited the members to hear reports from representatives of various agencies and organizations concerned with the rehabilitation of disabled persons.

Mr. Bernstock, of the Veterans Administration's Prosthetic and Sensory Aids Service, announced that a new publication on immediate postsurgical fitting had been prepared by the VA-supported Prosthetics Research Study in Seattle and was being made ready in the PSAS Office for printing. He reviewed current PSAS programs and stated that educational efforts in prosthetics for 1969-70 will include emphasis on the field of fluid control mechanisms.

Mr. A. Bennett Wilson, Executive Director, Committee on Prosthetics Research and Development, reported on the activities of his committee, particularly an evaluation program that includes a study of externally powered arms, and one on direct forming of below-knee sockets using synthetic balata. Plans for the coming year include workshops on spina bifida and on cerebral palsy.

Mrs. Florence Knowles, speaking for the University Council on Orthotic and Prosthetic Education, announced that the composition of UCOPE had been expanded to include nine educational programs, ranging from the bench technician to the baccalaureate level. There was considerable discussion about the problems of conducting the needed educational programs for prosthetists, orthotists, and technicians. Mrs. Knowles noted that one of the major difficulties in the technicians' programs is finding permanent faculty. Of increasing concern is the unusually high cost of establishing and conducting the various types of programs. Recruitment and the need to make the public aware of the fields of prosthetics and orthotics also require attention.

The three university programs in prosthetics and orthotics were described by the school directors: Dr. Sidney Fishman, New York University; Mr. Charles Fryer, Northwestern University; and Dr. Charles Bechtol, University of California at Los Angeles. Dr. Fishman reported that, by the end of this school year, NYU will have graduated 25 students with baccalaureate degrees in prosthetics and orthotics. Employment presented no problem for graduates. Regarding enrollments in postgraduate courses, both NYU and Northwestern University reported relatively low percentages of prosthetists and orthotists and high percentages of physicians and therapists.

Dr. Clinton Compere, reporting on behalf of two committees of the American Academy of Orthopaedic Surgeons, stated that the Committee on Orthopaedic Rehabilitation was very active and was concentrating on educational programs concerning spinal cord injuries and other major disabilities. The committee will sponsor a course on "Neuromuscular Skeletal Disorders: Current Concepts in Surgery and Rehabilitation" in conjunction with the University of Miami School of Medicine on December 12-14, 1969. He reported that the Committee on Orthotics and Prosthetics, AAOS, was considering revision of the *Orthopaedic Appliances Atlas, Vol. 1,* and that its members continued to work with the American Orthotic and Prosthetic Association, the VAPC, and CPRD in developing a disability evaluation system to be used as a basis for prescription nomenclature in bracing.

Mr. Herbert Warburton, Executive Director, American Orthotic and Prosthetic Association, reported that AOPA is assuming an expanding role in educational and recruiting activities. He described a proposed recruiting program in which local practitioners would take a more active part by addressing graduating and career-counseling classes and by distributing recruitment materials. He stated that widespread interest in prosthetics and orthotics educational programs was demonstrated by receipt in the national office of approximately seventy-five requests from community colleges and lower-level institutions for assistance in establishing educational courses in prosthetics and orthotics at all levels.

Captain Martin M. Wilbur, M.C., U. S. Navy; Lieutenant Colonel Quinn H. Becker, M.C., U. S. Army; and Major Allen Herrington, M.C., U. S. Air Force, described the prosthetics and orthotics programs of their respective military services. Each spoke of an increased number of amputees in military medical installations, and they agreed that more above-knee bilateral amputees are surviving in military hospitals, attributing this increase to the rapid transportation of casualties away from battle areas.

Highlights of the CPOE subcommittees' annual reports were presented by the chairmen. In the absence of Dr. J. Warren Perry, Mrs. Barbara Friz reported on the results of the manpower survey, an activity of the Subcommittee on Special Educational Projects in Prosthetics and Orthotics.

Dr. Frank Clippinger, Chairman of the Subcommittee on Prosthetics Clinical Studies, requested the submission of suggestions for additional tabulations and correlations from the stored data of the Facility Records Study in order to insure optimum use of these data. He reviewed the results of survey responses from 173 physician-graduates of immediate post-surgical fitting courses and noted that those who had used the procedure reported generally favorable results.

Mrs. Geneva Johnson, Chairman, Subcommittee on Educational Material, stated that the annotated bibliographies of prosthetics and orthotics articles had been completed and were ready for reproduction. She announced that reviews of fifty-nine prosthetics and orthotics films would be available in booklet form.

Miss Lena Plaisted, Chairman of the Ad Hoc Committee on Prosthetics in Nursing Education, discussed briefly the serious lack of communications and instructions to amputees and other patients in the hospital and post-hospital programs.

The following proposed activities were approved:

1. The educational program concerning "the geriatric amputee" will continue, and the papers resulting from the Geriatric Amputee Workshop will be published as expeditiously as possible.

2. The amputee clinic roster will be distributed to various health groups and agencies and to interested persons upon request, and updated annually.

3. The organization of a network of adult amputee clinics will be undertaken, working first with a small group of clinic chiefs.

4. The development of some kind of mechanism to strengthen communications among amputee clinic chiefs will be further studied and pursued.

5. An attempt will be made to identify sources of prescriptions for orthotic devices and to subsequently disseminate available orthotics educational materials, working toward the development of a more definite educational program in this area.

6. The collection of information forms for the Prosthetics Clinical Follow-up Study would be terminated shortly, and the data prepared for analysis.

7. The Ad Hoc Committee on Publications, or a similar group, will be continued on an indefinite basis and will pursue the objectives and activities as presented at that meeting.

UCOPE Meeting

The spring meeting of the University Council on Prosthetic-Orthotic Education (UCOPE) was held at the National Academy of Sciences, Washington, D. C, on April 25, 1969. The council members attending the meeting were: Charles Bechtol, M.D., Chairman; Walter Thompson, M.D.; Sidney Fishman, Ph.D.; Clinton L. Compere, M.D.; Charles Fryer; Walter Komiak; Elane Wilcox, Ph.D.; Elwyn Saferite, Ed.D.; James Steedley; and Henry Nebe. Others attending were: William Bemstock; Miss Audrey Calomino; Michael Cestaro; Mrs. Barbara R. Friz; Knud Jansen, M.D.; Joseph Traub; Herbert Warburton; A. Bennett Wilson; and Mrs. Florence Knowles, Executive Secretary, UCOPE.

Under a new reorganizational plan, it was decided that UCOPE would meet once a year to serve as a forum for any prosthetics or orthotics educational group that wishes to participate. The council has restructured its organization to include a committee on graduate prosthetics and orthotics education, a committee on undergraduate prosthetics and orthotics education, and three subcommittees—prosthetist, orthotist, and examination.

The council recommended that the Committee on Prosthetic-Orthotic Education and UCOPE share a one-day meeting each year to eliminate repetition of reports and to discuss common interests.

Evaluation of new prosthetic and orthotic items by the three university schools was discussed and tentative plans developed. Mr. A. Bennett Wilson reported on the progress in developing a plan for clinical evaluation and suggested that Duke University, Miami University, Rancho Los Amigos Hospital, Vanderbilt University, Fitzsimons General Hospital, and New York University might be used for clinical trials.

The council agreed that advanced courses for prosthetists in below-knee prosthetics should be incorporated in the curriculum of the three university schools; plans for a pilot course to be held at Northwestern University starting August 4, 1969, were discussed. Prosthetists from the industry will cooperate in presentation of these courses.

Dr. Elane Wilcox, Coordinator, Spinal Cord Injury Service, Rancho Los Amigos Hospital, and Mr. Henry Nebe, Administrator, Rehabilitation Division, Delgado College, reviewed the prosthetics and orthotics programs at their respective institutions.

Soaring costs of conducting the prosthetics and orthotics courses have led to the necessity of charging laboratory fees to students. The Committee on Prosthetic Research and Development was asked to participate in a project to explore the possibility of reducing costs of materials used in the laboratories.

Dr. Knud Jansen, Chairman, International Committee on Prosthetics and Orthotics, Orthopaedic Hospital, Copenhagen, reviewed international educational activities in prosthetics and orthotics and discussed the value of the team approach as advocated by the International Committee.

Course for Nurse Educators

Fifteen nurse educators, representing several nursing specialties and widespread geographical locations, attended the first prosthetics course for nurses conducted at Northwestern University, May 25-27, 1969.

This pilot course, sponsored by the Committee on Prosthetic-Orthotic Education, National Research Council, was extremely well accepted by those attending, all of whom agreed that the nurse needs to be well informed in certain specific aspects of prosthetics and should assume more responsibility as far as educational programs are concerned.

Geriatric Amputee Workshop

A Geriatric Amputee Workshop was held in Washington, D. C, on June 9-10, 1969, under the auspices of the Committee on Prosthetic-Orthotic Education. The purpose of the workshop, according to its chairman, Dr. Herbert E. Pedersen, was to develop materials to be incorporated in an authoritative document that would be useful to all who are, or who expect to be, involved with rehabilitation of geriatric amputees.

Twenty-six participants, serving on six panels, developed papers that will be published in manual form. Serving as chairmen of the panels were: Frank Clippinger, Jr., M.D.; Claude N. Lambert, M.D.; Robert Mazet, Jr., M.D., Herbert E. Pedersen, M.D.; Augusto Sarmiento, M.D.; and Richard Warren, M.D.

Other participants were: William Blaisdell, M.D.; Ernest Burgess, M.D.; Frederick L. Hampton, C.P.; Edward T. Haslem, M.D.; John Hermann, M.D.; Ronald Kihn, M.D.; George H. Koepke, M.D.; Alfred E. Kritter, M.D.; Bella J. May, R.P.T.; Wesley S. Moore, M.D.; Mrs. Elinor Pearson; Henry J. Ralston, Ph.D.; Eugene E. Record, M.D.; Allen S. Russek, M.D.; Donald Silver, M.D.; William F. Sinclair, C.P.; Anthony Staros; Robert G. Thompson, M.D.; Bert R. Titus, C.P.O.; and Joseph E. Traub, C.P.

Ad Hoc Committee on Publications

The Ad Hoc Committee on Publications, Committee on Prosthetic-Orthotic Education (CPOE), met in Miami Beach on October 14, 1969. Chairman William M. Bernstock and Mrs. Barbara R. Friz, Executive Secretary, CPOE, summarized activities since the last meeting in April. An interim report on the feasibility of a data retrieval system for prosthetics and orthotics was given, and members agreed that exploration of developing such a system should be continued.

The status of more than a dozen prosthetics and orthotics publications now in various stages of preparation was presented and reviewed. Publication of these manuals and books will add considerably to the prosthetic and orthotic literature. It was recommended that efforts be concentrated on dissemination of information related to the availability of written educational materials, and that such efforts be reinforced by displaying samples of publications at the national conferences of appropriate professional associations.

Publication of a newsletter, directed toward amputee clinic chiefs and their staffs, will be undertaken, the first issue to be distributed in December 1969.

Responses from educators to inquiries on educational materials will be compiled and used as a basis for a selective bibliography applicable to specific areas of instruction. A workshop will be held to review and refine the listing.

Members of the ad hoc committee who attended the meeting were: William M. Bernstock, Norman Berger, Audrey Calomino, Charles Fryer, Florence Knowles, and Augusto Sarmiento, M.D., *ex officio.* Others attending were: Sidney Fishman, Ph.D., and A. Bennett Wilson, Jr., Executive Director, Committee on Prosthetic Research and Development.

Subcommittee on Special Educational Projects

Chairman J. Warren Perry, Ph.D., presided at a meeting of the Subcommittee

on Special Educational Projects in Prosthetics and Orthotics (SEPPO) in Miami Beach on October 14, 1969. The findings of the recently completed Manpower Survey were reviewed in detail, and it was the consensus of the group that the survey had yielded valuable information, useful to educators, supporting agencies, and others involved in upgrading professional and educational standards. The report is to be published in the December 1969 issue of *Orthotics and Prosthetics.*

A number of projects proposed by the members were considered by the committee, and it was decided that priority would be given to a follow-up study on graduates of prosthetics and orthotics degree programs.

The chairman, in a discussion of the present and future status of prosthetics and orthotics degree programs, spoke of the tremendous expansion of allied health programs in community colleges throughout the United States and warned that some are developing new programs with little concern or interest in the goals or objectives of national health organizations. The members of the subcommittee agreed that officers of the American Orthotic and Prosthetic Association should be alerted to the urgency of establishing "essentials" and "standards" for educational programs at both community college and university levels.

Members attending the meeting were: J. Warren Perry, Ph.D., William M. Bernstock, Sidney Fishman, Ph.D., Florence Knowles, and Alvin Muilenburg. Also present were George Lambert, Ronney Snell, and Barbara R. Friz.

Committee on Prosthetics Research and Development

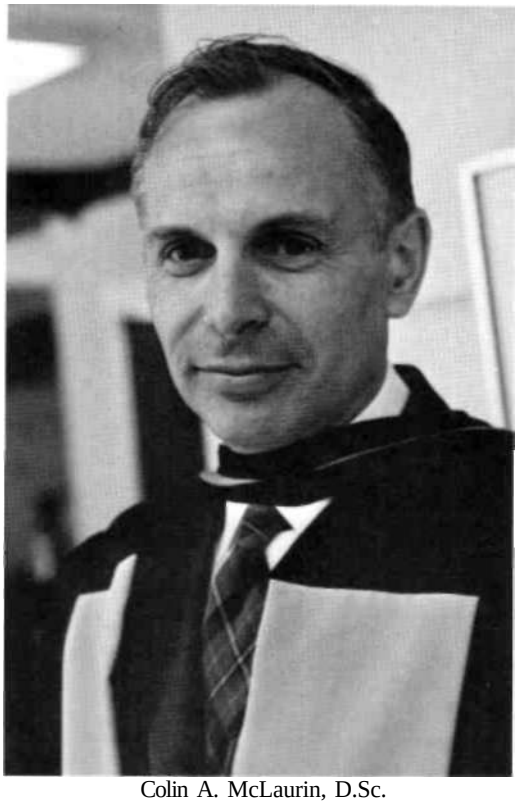
Maurice LeBlanc, formerly on the staff of the Prosthetics-Orthotics Program at UCLA, was appointed Staff Engineer of the Committee on Prosthetics Research and Development in March 1969.

Maurice LeBlanc

Mr. LeBlanc received the degrees of Bachelor of Science and Master of Science in Mechanical Engineering from Stanford University with scholastic distinction. While with the U. S. Navy, he served as a test engineer in the Polaris-Submarine Program.

While with the Prosthetics-Orthotics Program at UCLA, Mr. LeBlanc received a certificate in prosthetics and orthotics, was a major contributor to the revised edition of the *Manual of Upper Extremity Prosthetics,* and conducted a feasibility study, "Endoskeletal Upper Extremity Prosthesis." A report of the research project was presented at the Sixth Workshop on Upper-Extremity Prosthetic Components held in Santa Monica, Calif, in October 1968.

In June 1969, Mr. LeBlanc was qualified as a Certified Prosthetist by the American Board for Certification in Orthotics and Prosthetics. His present duties at CPRD involve primarily the coordinated clinical evaluation of externally powered elbows.



Colin A. McLaurin, D.Sc.

Colin A. McLaurin, Chairman of CPRD, received an honorary degree of Doctor of Science from Queen's University, Kingston, Ontario, at its Convocation on May 24, 1969.

A graduate of the University of Toronto in Aeronautical Engineering, Dr. McLaurin was associated with Sunnybrook Hospital in Toronto and in private industry before moving to Northwestern University, where he organized the research program in prosthetics and orthotics. Now on the staff of the Ontario Crippled Children's Centre, he has been a member of CPRD since 1962.

In the *Queen's Review,* the university alumni bulletin, Dr. McLaurin was described as an engineer who has "applied his skills and knowledge of engineering to alleviate human disability among patients of all ages, and in many nations" and who has fostered "a true partnership between medicine and engineering."

Fracture Bracing Workshop

A workshop on "Fracture Bracing," sponsored by the Committee on Prosthetics Research and Development, was held at the Duke University Medical Center February 28-March 1, 1969. Robert G. Thompson, M.D., served as chairman. The purpose of the meeting was to permit the interchange of information about current work on methods of accelerating the healing of fractures of long bones, and on ways to use prosthetic and orthotic principles to reduce rehabilitation time.

Approximately 20 participants heard reports presented by representatives of the University of Miami, Fitzsimons General Hospital, Rancho Los Amigos Hospital, Vanderbilt University, and New York University. A report of the workshop was published and is available from CPRD.

Medical Orientation Course for Prosthetists, Orthotists, and Engineers

A pilot course sponsored by CPRD was held at the Duke University Medical Center on March 3-4, 1969. The program was introduced by the chairman, Dr. Frank Clippinger, and lectures on the following subjects were presented: "Medical Practice in the Mid-Twentieth Century," "Physiology of Wound Healing," "Reconstructive Techniques in Orthopaedics," "Infection and Antibiosis," "Fractures," "Reconstructive Surgery in the Upper Extremity," "Arthritis-Pathogenesis and Reconstruction," "Paralytic Diseases in Children," "Diabetes Mellitus," "Neurological Diseases and Stroke," and "Circulation and Arteriosclerosis."

All participants agreed that the program was well organized and well presented, and that the lectures were very informative. During the discussion regarding the possibility of presenting similar courses or seminars in the future, it was agreed that meetings of this type would be useful, particularly if they were directed toward small groups of specialists,

with emphasis on clinical application so that working-level information could be exchanged.

Workshop on Spinal Orthotics

A Workshop on Spinal Orthotics, sponsored by CPRD, was held at the University of California Medical Center in San Francisco on March 28-29, 1969. As expressed by the chairman, Dr. James Morris, the purpose of the meeting was to bring together knowledgeable people in the field to review current practices and developments in back bracing as a first step toward improving treatment of patients and determining the direction for future research.

The discussions indicated that an organized approach to the development of spinal orthotics is needed, that research in back bracing should be encouraged, and that additional workshops and communication are necessary before definitive recommendations can be made.

Workshop on Knee-Disarticulation and Hip-Disarticulation Prostheses

On the recommendation of the Subcommittee on Design and Development, a Workshop on Knee-Disarticulation and Hip-Disarticulation Prostheses was held on March 31, 1969, at the University of California Medical Center, San Francisco. Prof. Charles W. Radcliffe presided. The workshop was attended by 15 prosthetists and engineers, among them representatives from manufacturers of special parts required for functional knee- and hip-disarticulation prostheses.

The workshop recommended the preparation of a manual for fabrication of plastic-laminate sockets for the knee-disarticulation prosthesis, acceleration of the development of improved knee joints for the knee-disarticulation prosthesis, and the application of the modular approach to the design of hip-disarticulation prostheses.

A report of the workshop was prepared and is available from CPRD.

International Conference on Prosthetics and Orthotics Research

An International Conference on Research in Limb Prosthetics and Orthotics was held at Cacapon State Park, Berkeley Springs, W. Va., on April 28-May 2, 1969. The conference was sponsored by CPRD and the International Committee on Prosthetics and Orthotics of the International Society for Rehabilitation of the Disabled, and attended by 60 representatives of 19 countries.

Knud Jansen, M.D., Chairman, ISRD, and Herbert Elftman, Ph.D., Professor of Anatomy, College of Physicians and Surgeons, Columbia University, served as co-chairmen.

The conference report is available from the Committee on Prosthetics Research and Development, National Research Council, 2101 Constitution Ave., Washington, D. C, 20418.

Panel on Lower-Extremity Orthotics

The Panel on Lower-Extremity Orthotics of the Subcommittee on Design and Development held its Sixth Workshop in Disneyland, Calif., on May 22, 1969. The participants were Roy Snelson (Chairman), Peter Bulkeley, Roddy Chupurdia, Henry Gardner, Sam Hamontree, Robert Klebba, Alojz Kralj, Hans A. Mauch, Wallace Motloch, Jacquelin Perry, Charles Radcliffe, Bruce Scott, Elmer Skinner, Anthony Staros, and Charles Thompson.

The workshop focussed on the problems of design of knee joints for braces. Following presentations by Dr. Perry on "Function of the Normal Human Knee Joint" and Mr. Gardner on "Location of Single-Axis Knee Joints," Dr. Bulkeley and Mr. Thompson reported on their study of human knee motion. The discussion period centered primarily on the problem of sta-

bilization of the knee, and various possible solutions.

The workshop report, which is available from CPRD, contains a "Partial Bibliography on the Knee Joint as Related to Prosthetic/Orthotic Design."

Subcommittee on Evaluation

The Subcommittee on Evaluation met on May 27, 1969, at New York University. As expressed by the chairman, Mr. Howard Thranhardt, the main purpose of the meeting was to discuss the evaluation program for several externally powered elbows.

The current status of the plans for evaluating the seven elbows that were discussed at the Sixth Workshop on Upper Extremity Prosthetics Components on October 21-23, 1968, in Santa Monica, Calif., was reported as follows:

Rancho Elbow: OCCC Elbow:	Funding has been provided by the Children's Bureau to enable New York University to purchase and evaluate 20 of these child-sized elbows. The Rancho elbow is available, and the OCCC elbow is expected to be available in the fall.
AMBRL Elbow:	The Veterans Administration is buying 25 elbows for clinical evaluation. Availability scheduled August 15, 1969.
AIPR Elbow:	The Social and Rehabilitation Service has funded the purchase of 30 complete AIPR arms for clinical evaluation, and 6 to 10 of the elbows will first be used separately for clinical evaluation. Availability scheduled July 15, 1969.
Boston "Arm":	The Liberty Mutual Insurance Co. and EG&G, Inc. are funding the clinical evaluation of 10 to 12 units. Availability scheduled August 1, 1969.
Gilmatic Elbow:	This is being redesigned and is not included for clinical evaluation at this time.
VAPC Elbow:	The Veterans Administration is proceeding with the development of this elbow. It is not included for clinical evaluation at this time.

The clinical evaluation of the OCCC and Rancho child-sized elbows will be conducted and the results reported by New York University with the cooperation of various child amputee clinics. The clinical evaluation of the AMBRL, AIPR, and Boston elbows will be conducted and the results reported by the CPRD staff under the guidance of the Subcommittee on Evaluation with the cooperation of various clinics.

Mr. Joseph Traub of the Social and Rehabilitation Service, Department of Health, Education, and Welfare, presented the following items for discussion:

1. The probability that the prosthetics and orthotics centers at New York University, Northwestern University, and the University of California, Los Angeles, and several bioengineering centers will soon be participating in the evaluation of prosthetic and orthotic devices and techniques was indicated. It was proposed that Texas Institute for Rehabilitation and Research/ Baylor University, Rancho Los Amigos Hospital, and Jackson Memorial Hospital/ University of Miami be included as participating bioengineering centers for future clinical evaluation studies. The subcommittee concurred with and recommended this proposal.

2. Under the Public Law 480 program, certain foreign countries receive assistance for research and development of artificial limbs and braces, and it is recognized that the United States could derive benefits from evaluation studies of large numbers of patients fitted with prostheses and orthoses. The subcommittee expressed approval of proposed PL 480 evaluation programs and offered its full cooperation and assistance.

Conference on "Priorities in Prosthetic and Orthotic Practice"

From June 16-20, 1969, four Scottish organizations—the Eastern Regional Hospital Board, "Action for the Crippled Child," the University of Strathclyde, Glasgow, and the University of Dundee—sponsored a conference on "Priorities in Prosthetic and Orthotic Practice." The

conference was held at the University of Dundee, with Mr. George Murdoch presiding as chairman.

Approximately 140 lecturers and others participated in an outstanding program. In addition to speakers from Scotland and England, research workers and clinicians from Sweden, Denmark, Czechoslovakia, Yugoslavia, Canada, and the United States presented papers.

The lectures and conference discussions will be published in book form early in 1970 by Edward Arnold Ltd., London, England.

Conference Topics and Contributors

Introductory Lectures	
Opening Address	Mrs. M. B. A. Denny; Scotland
The Concept of Clinical Prescription	George Murdoch; Dundee
Normal and Abnormal Locomotion	Edward Peizer; Veterans Administration Prosthetics Center, New York
"Ideal" Limb Concept	R. M. Kenedi; University of Strathclyde
The Below-Knee Amputation	
Surgery	G. Murdoch
Biomechanics	John Hughes; University of Strathclyde
The Prosthesis	W. Barclay; University of Strathclyde
Recent Variants of the P.T.B. Prosthesis	Erik Lyquist; Orthopaedic Hospital, Copenhagen
Ankle/Foot Mechanisms	David N. Condie; Dundee Limb Fitting Centre
Evaluation of the P.T.B. Prosthesis	A. Bennett Wilson; National Research Council, Washington, D. C.
Syme's Amputation	
Surgery	George Whitefield; Glasgow
Biomechanics, Prostheses and Available Mechanisms	Colin McLaurin; Ontario Crippled Children's Centre, Toronto
The Aesthetic Problem	Dugald Cameron; Glasgow School of Art
Partial Foot Amputations	
Surgery	John Bingham; Glasgow
Biomechanics	D. N. Condie
Prosthesis	W. H. Tuck; Royal National Orthopaedic Hospital, Middlesex
Above-Knee Amputations	
Surgery	George Fulford; Edinburgh
Anatomical Studies of the Stump	Josef Chodera; Prosthetics Research Centre, Prague
Biomechanics	C. W. Radcliffe; University of California, Berkeley
Prosthesis	E. Lyquist
Interface Problems and Possible Solutions	R. G. Redhead and B. J. Alcock; Biomechanical Research and Development Unit, Roehampton
Alternative Solution	J. Chodera
Knee and Knee/Ankle Mechanisms	C. W. Radcliffe
Through-Knee Amputations	
Surgery	Jorgen Kjolbye; Copenhagen
Biomechanics	J. Hughes
Prosthesis	E. E. Harris; Limb Fitting Centre, London
Knee Mechanisms	Gordon Bell; Robert Kellie & Sons Ltd., Dundee
The Hindquarter and Hip Disarticulation Amputations	
Surgery	H. Jackson Burrows; London
Biomechanics	C. McLaurin
Prosthesis	A. W. McQuirk; J. E. Hanger Ltd., Roehampton
General Topics	
The Congenitally Deficient Lower Limb	D. S. McKenzie; Biomechanical Research and Development Unit, Roehampton
Body and External Power in the Leg Prosthesis	T. C. Duggan; Powered Prostheses Research Unit, Glasgow
The Upper Extremity	
The Hand/Arm System	David C. Simpson; Orthopaedic BioEngineering Unit, Edinburgh
Amputation and Congenital Deficiency	Douglas Lamb; Edinburgh
A Specification of Loss	A. B. Kinnier Wilson; Powered Limbs Research Unit, London
Functional Replacement Today	D. S. McKenzie
Control of External Power	A. Bottomley; Biomechanical Research and Development Unit, Roehampton
Types of External Power	S. R. Montgomery; Powered Limbs Research Unit, London

Evaluation and Acceptance	
I.	J. Kronlund; University of Stockholm
	R. Feeney; Swedish Institute for the Handicapped
II.	D. C. Simpson and G. Murdoch
The Limbfitter and Bracemaker	Norman Capener; Exeter
Production Engineering Aspects of Prosthetic Supply	
Interchangeability, Standardisation and the Modular Concept	J. Hughes
Devices	B. J. Alcock
Sockets	E. Peizer
The Viewpoint of a Production Engineer Involved in Prosthetic Design	Donald Ross; University of Strathclyde
Value Analysis and Industrial Production Design	P. Spear; The Owen Organisation
Orthotics	
Clinical Conditions Amenable to Orthotic Management	J. Kjolbye
Present Orthotic Practice	
I. Lower Extremity	James Hutchison; Dundee
II. Upper Extremity	R. D. Muckart; Dundee
Nomenclature, Classification, Prescription Criteria and Standardisation	E. Peizer
The Modular Concept in Orthotics	
I.	E. Lyquist
II.	D. W. Collins; Hugh Steeper Ltd., London
Focus on Priorities	F. Gracanin; Institution for Rehabilitation, Ljubljana, Yugoslavia
Open Topic Session	
The Design of a Research Organisation in Prosthetics and Orthotics	Bo Klasson; Norrbackainstitut, Stockholm
Educational Requirements	J. Kjolbye and E. Lyquist
The Clinic Team-Hopes and Realities	Mirek Vitali; Limb Fitting Centre, Roehampton
The Limb Service	J. H. F. Brotherston; Scottish Home and Health Department

Panel on Upper-Extremity Prosthetics Components

The Seventh Workshop on Upper-Extremity Prosthetics Components was held on July 30-31, 1969, in Santa Monica, Calif. As expressed by the chairman, Dr. Edward Peizer, the purposes of the workshop were to survey currently developed externally powered terminal devices and to make recommendations for development and evaluation.

Nine externally powered terminal devices were presented: the American Institute of Prosthetic Research (AIPR) hand, the Army Medical Biomechanical Research Laboratory (AMBRL) hand, the Belgrade hand, the Instituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro (INAIL) hand, the Northern Electric hand, the Rehabilitation Institute of Montreal (RIM) hand, the Ontario Crippled Children's Centre (OCCC) hook, the Otto Bock hand, and the Viennatone hand. Eight of these devices were demonstrated on amputees, and data on mechanical and performance tests were examined. (The Belgrade hand was too heavy for fitting.)

The panel decided not to proceed into clinical evaluations of these devices, because additional testing *at this time* would not provide much more information, and because finding solutions for the problems of control of externally powered components is of paramount importance. It was therefore decided that the next meeting of this panel should focus on specifications and standards for externally powered terminal devices and on control of externally powered components, including hybrid systems.

Subcommittee on Design and Development Meeting

The ninth meeting of the Subcommittee on Design and Development was held on August 1, 1969, in Santa Monica, Calif. Members attending were Anthony Staros (Chairman), Fred Leonard, John Lyman, Colin A. McLaurin, Charles W. Radcliffe, James B. Reswick, and two new members—Hans A. Mauch and Roy Snelson.

Also present were Albert Colman, David Condie, James Foort, Maurice LeBlanc, Eugene F. Murphy, Edward Peizer, Howard Thranhardt, Joseph E. Traub, and A. Bennett Wilson, Jr.

Reports on the activities of the subcommittee panels during the preceding year were presented: (a) Upper-Extremity Prosthetic Components—Dr. Peizer, (b) Lower-Extremity Prosthetic Fitting—Mr. Foort, (c) Lower-Extremity Prosthetic Components—Professor Radcliffe, and (d) Lower-Extremity Orthotics—Mr. Snelson.

The following panel meetings were scheduled.

1. Upper-Extremity Prosthetic Components: late 1969; on control and terminal devices standards and specifications.

2. Lower-Extremity Prosthetic Fitting: December 14, 1969, Miami, Fla.; on above-knee fitting.

3. Lower-Extremity Prosthetic Components: October 1969, Miami, Fla.; on SACH foot specifications. Follow-up meeting on knee-disarticulation prostheses, May 1970.

4. Lower-Extremity Orthotics: January 1970; on bracing for knee stability.

International Conference on Training Standards for Prosthetists

In July 1969, a United Nations Inter-Regional Seminar on Standards for the Training of Prosthetists was held in Holte, Denmark.

Formal action on recommendations arising from this seminar was to be taken by the International Committee on Prosthetics and Orthotics (ICPO) at its September 1969 meeting in Dublin, Ireland.

Prior to this step, however, ICPO conducted an open forum on the Holte recommendations. This meeting was held at the Imperial College of Science and Technology, London, England, on September 9-10 under the chairmanship of Dr. Knud Jansen.

In preparing for the London forum, the staff of ICPO broke down the recommendations into a series of questions and distributed these questionnaires to interested parties throughout the world. Responses were received from some 58 individuals and organizations, and these responses provided the background for the London discussions. A feature of the returns was their overwhelming support of the proposed standards, ranging on individual items from 85% to unanimous approval.

The various sections of the recommendations dealing with the role, the responsibilities and training, and the certifications of the prosthetists-orthotists were introduced by selected panelists (Wilfred Kragstrup, Denmark; Werner Wille, United Nations; George Murdoch, Scotland; Miles Anderson, U.S.; and Sidney Fishman, U.S.). In the discussion from the floor, participants were able to present material on educational programs and plans in various countries.

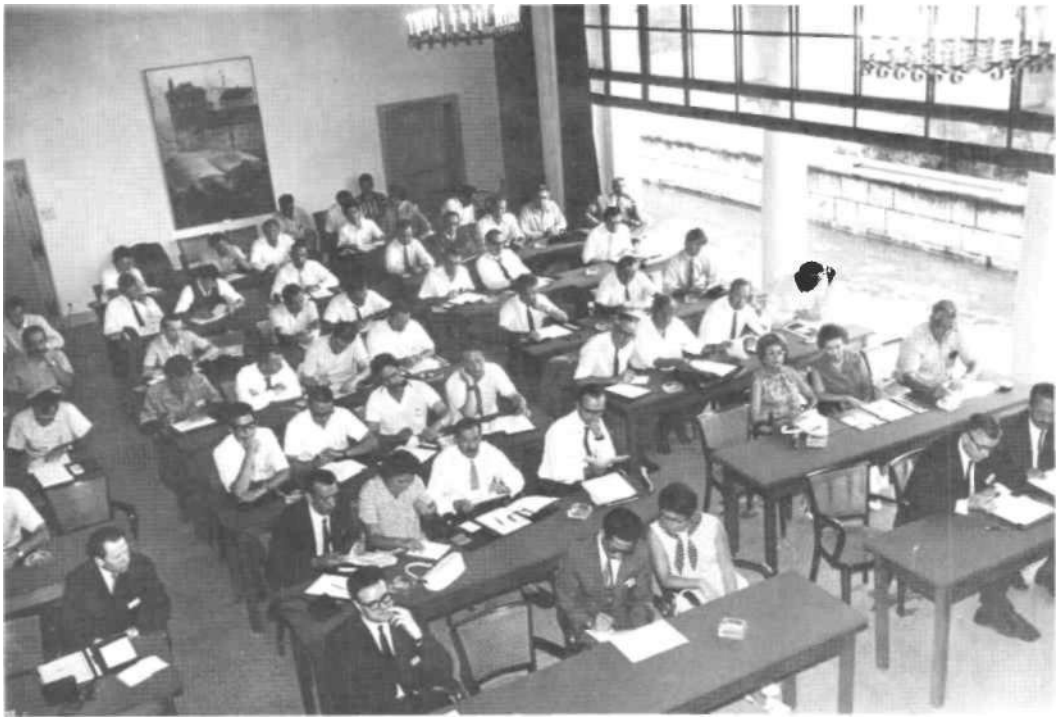
Approximately 80 people attended, including sizable delegations from England and Scotland, and representatives from Australia, Denmark, Germany, Greece, Sweden, Switzerland, the United States, and other countries.

Third International Symposium on External Control of Human Extremities

Almost 100 persons attended the Third International Symposium on External Control of Human Extremities held in Dubrovnik, Yugoslavia, August 25-30, 1969. The United States and the host country were most heavily represented, but delegations from England, Germany, Holland, Israel, Japan, Poland, Sweden, the Union of Soviet Socialist Republics, and several other countries also attended.

The majority of the participants were engineers, although a number of physicians and representatives of other disciplines were also in attendance.

The symposium was sponsored by the Federal Council for Scientific Research of Yugoslavia and organized by the Yugoslav Committee for Electronics and Automa-



Interior of the Dubrovnik Art Gallery, site of the Symposium on External Control of Human Extremities. Hector W. Kay, Assistant Executive Director of CPRD, is at the second table in right foreground.

tion. All meetings were held in the Dubrovnik Art Gallery, which overlooks the old fortress town and the beautiful Adriatic coastline.

In all, some 60 papers were presented, covering a wide range of topics. Some representative presentations were:

1. Sensory Feedback—"Sensory Substitution and Limb Prosthesis," by Paul Bach-y-Rita and C. C. Collins, U.S.

2. Analysis of Biped and Quadruped Locomotion—"On the Stability of Biped Locomotion," by M. Vukobratovic, Yugoslavia, and A. A. Frank, U.S.; "On the Dynamic Stability of Legged Locomotion Systems," by R. B. McGhee and M. D. Kuhner, U.S.

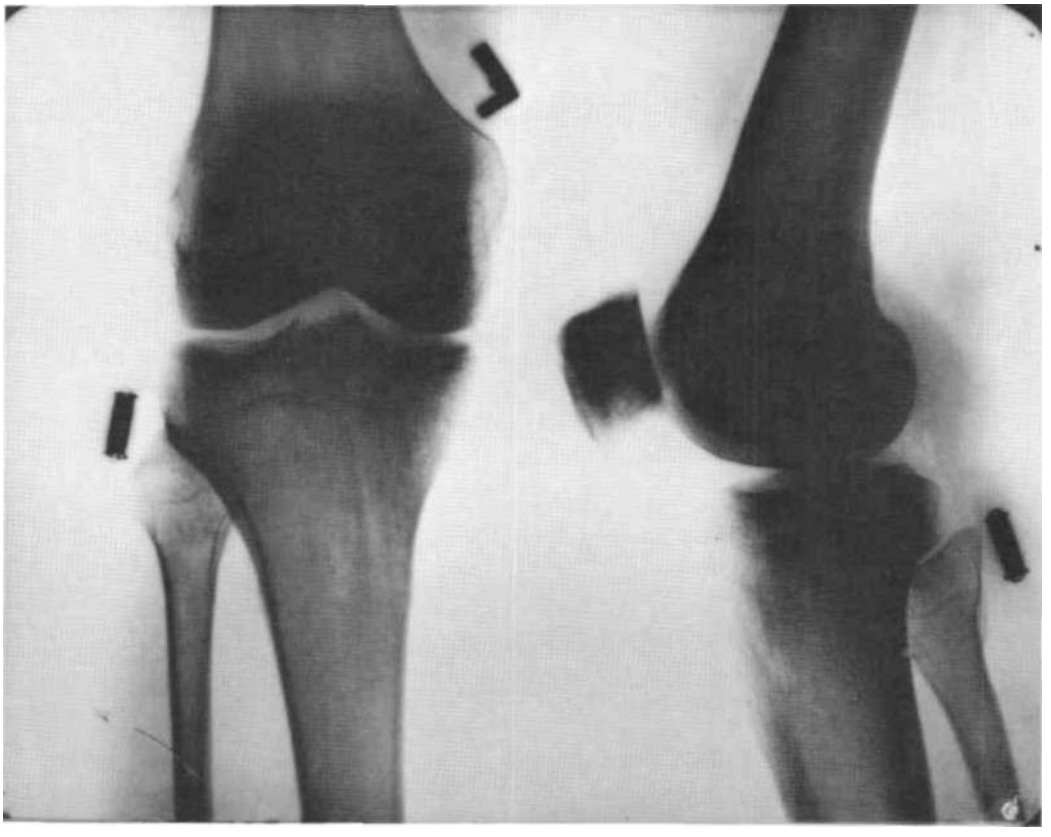
3. Control of Arm Prostheses and Orthoses—"A Multilevel Approach to Orthotic/Prosthetic Control System Design," by H. B. Apple and J. B. Reswick, U.S.; "Distribution of Multilevel Control in Arm Prostheses and Orthoses," by A. Freedy and J. Lyman, U.S.; "Myoelectric Control of Upper Extremity Joint Motion," by H. Hartman, W. Waring, D. Hobart, and V. L. Nickel, U.S.

4. Manipulators—"Performance Criteria of Manipulators," by A. E. Kobrinskii, USSR; "Optimal Control of Manipulators," by Y. A. Stepanenko, USSR; "Supervisory Control of Computer-Manipulators," by T. B. Sheridan, U.S.

5. Actuators and Transducers—"Intraoral Control Systems," by E. L. Bontrager and V. L. Nickel, U.S.

6. Functional Stimulation—"Advanced Version of 'The Ljubljana Functional Electronic Peroneal Brace' with Walking Rate-Controlled Tetanization," by F. Gracanin, A. Kralj, and S. Rebersek, Yugoslavia; "Implantable Muscle or Nerve Stimulator as a Part of an Electronic Brace," by A. Jeglic, E. Vavken, and M. Benedik, Yugoslavia.

Some of the papers which related di-



Muscle stimulator imbedded in leg of A. Jeglic, an engineer in the Ljubljana Research Group.

rectly to prosthetic/orthotic hardware, its applications, and evaluation were: (a) "The Belgrade Electronic Hand"—a series of papers by Hector W. Kay, U.S.; and M. Kajganic, M. Rakic, N. Ivancevic, D. Jaksic, and R. Tomovic, Yugoslavia; (b) "Multifunctional Myoelectric Hand Prostheses with Pressure Sensory Feedback System—Waseda Hand 4P," by I. Kato, S. Yamakawa, K. Ichikawa, and M. Sano, Japan; (c) "A New Limb for Thalidomide Children," by D. Bousso, Israel; (d) "Evaluation of EMG-Controlled Hand Prostheses," by R. J. Feeney and I. Hagaeus, Sweden; and (e) "Development of a Multiple-Axis Myoelectrically Controlled Prosthetic Arm," by R. W. Wirta and D. R. Taylor, Jr., U.S.

An editorial board composed of M. Gavrilovic and M. Marie of Yugoslavia, and A. Bennett Wilson, Jr., Executive Director of CPRD, is currently preparing the proceedings of the symposium for publication. It is anticipated that the material will go to press early in 1970.

Meeting of Subcommittee on Child Prosthetics Problems

The CPRD Subcommittee on Child Prosthetics Problems met on May 7-8, 1969, in conjunction with the Conference of Child Amputee Clinic Chiefs. Members attending were: George T. Aitken, M.D., Chairman; Charles H. Epps, Jr., M.D.; Sidney Fishman, Ph.D.; Leon M. Kruger, M.D.; Claude N. Lambert, M.D., Colin A. McLaurin; and Yoshio Setoguchi, M.D. Guests attending were: Clyde M. E. Dolan; Charles H. Frantz, M.D.; Barbara

R. Friz; Barbara Gehant; Hector W. Kay; Ernst Marquardt, M.D.; D. S. McKenzie, M.D.; and Clifton Mereday.

Leon M. Kruger, M.D., of the Shriners Hospital in Springfield, Mass., was introduced as a new member of the subcommittee.

Mr. Hector Kay reported on the recent additions to the Cooperative Clinic Program, which now includes 28 members, and the progress toward increasing the membership. Of particular interest in that respect is the large number of child amputee clinics (137), as revealed by the Survey of Amputee Clinics conducted by the Committee on Prosthetic-Orthotic Education.

Detailed discussions centered on evaluation projects and on possible clinical application studies of various terminal devices and wrist units, elbows, controls, and coordinated units. Particular interest was expressed about the NYU terminal device, the Viennatone hand, the Myobock hand, the Ontario two-prong hook, the ABP hand with wrist unit, the OCCC Model II elbow, the Rancho Los Amigos Hospital (Electro-Limb Company) elbow, and the Ontario coordinated arm. Field trials on these items will be arranged, if possible.

The chairman was authorized to appoint an *ad hoc* group to explore the possibility of including problems of children's orthotics within the operations of the Subcommittee on Child Prosthetics Problems.

The next meeting of the SCPP was scheduled in conjunction with the fall CPRD meeting.

Conference of Child Amputee Clinic Chiefs

The annual meeting of the Child Amputee Clinic Chiefs was held at the National Academy of Sciences in Washington, D. C, on May 8-9, 1969. George T. Aitken, M.D., conducted the program, which was attended by more than 100 persons.

Representatives from 27 of the 28 participating clinics attended, together with representatives from 12 clinics that are not yet affiliated with this program. Approximately 20 visitors from Australia, Ceylon, England, Germany, India, Morocco, Pakistan, Poland, Sweden, Tunisia, and Yugoslavia were participants. In addition, several orthopedic surgeons, prosthetists, orthotists, and therapists from nearby treatment centers were present.

The program started on an international note with presentations on "The Treatment of the Child with Severe Limb Deficiencies" by Dr. Ernst Marquardt and Dr. Gotz Gerd Kuhn of Germany, Dr. D. S. McKenzie of Great Britain, Messrs. Bo Klasson and Gunnar Holmgren of Sweden, and Dr. Claude N. Lambert of the United States.

Following a review of the cooperative research program, new products for the child amputee were discussed, including: (a) an electrically powered cart for transportation of the severely handicapped child, (b) a lightweight, all-nylon wrist unit, (c) a "passive" lightweight elbow, and (d) a new design of a terminal device.

On May 9, a symposium was held on "The Surgical and Prosthetic Management of Lower Extremity Anomalies." Papers were presented by Charles H. Frantz, M.D.—"Sacral Agenesis;" Leon M. Kruger, M.D.—"Fibular Hemimelia;" George T. Aitken, M.D.—"Tibial Hemimelia;" and Frederic W. Brown, M.D.—"Fibula Transplant in Tibial Hemimelia." The conference concluded with a presentation of patients with lower-extremity anomalies and a discussion of their treatment by Charles H. Epps, M.D., Chief of the Child Amputee Clinic at D. C. General Hospital.

The next meeting will be held in late May or early June, 1970.

Workshop on Adapted Activities for the Physically Handicapped Child

A postgraduate training course and workshop in "Adapted Physical Education and Recreation Therapy Techniques for the Physically Handicapped Child" was held at the Children's Rehabilitation Cen-

ter, University of Virginia Hospital, Charlottesville, on May 12-15, 1969.

Leaders of the course were Ronald Adams, Director of Adaptive Physical Education and Recreation Therapy at the Center, and Lee Rullman, Director of Recreational Activities at Gillette State Hospital, St. Paul, Minn., assisted by Alfred Daniel, Coordinator, Developmental Physical Education, Cherry Hill Public Schools, N. J.

Guest speakers included Warren G. Stamp, M.D., Professor and Chairman, Department of Orthopedics, University of Virginia Hospital, who spoke on "Medical Aspects of the Child with a Spinal Cord Injury," "Non-Operative Treatment of Scoliosis with the Milwaukee Brace," and "Classification of the Child with Congenital Limb Deficits." William F. Stanek, M.D., Chief, Amputee Clinic, Children's Hospital, Denver, Colo., presented papers on "Treatment of the Child with Congenital Lower-Limb Anomalies" and "Amputee Skiing." Hector W. Kay, Assistant Executive Director of CPRD, spoke on "The Child with an Acquired Amputation." Other speakers were: Ira L. Hemmings, M.D., on "The Child with Asthma," and Alfred C. Sparrow, M.D., on "The Child with Rheumatic Fever."

The adapted physical education activities covered in the course were wheelchair bowling, archery and crossbow shooting, table tennis, target tennis, rifle shooting, precision javelin, putt-putt golf, spin and bait casting, canoeing, skiing, mountain climbing, and billiards. The majority of these activities were demonstrated by physically handicapped children.

Many of the activities featured specially developed assistive devices such as a trap suspension system for trap shooting, various mobile "bridges" for billiards and pool, special paddles for table tennis, an archery adaptor device, "outrigger" skis, and an adaptor pusher device for wheelchair bowling.

The speaker at the banquet held for more than 50 participants was Julien Stein, Ph.D., Consultant, Programs for the Handicapped, American Association for Health, Physical Education, and Recreation, whose topic was "Developmental Physical Education Activities in the Elementary School."

Two additional workshops were presented: "Posture Screening," conducted by Alfred Daniel; and "Developmental and Physical Education Activities for the Mentally Retarded and Blind," conducted by Walter Hambrick of the University of South Carolina.

Proceedings of PFFD Symposium Published

A feature of the 1968 annual meeting of Child Amputee Clinic Chiefs was the presentation of a series of papers on PFFD (proximal femoral focal deficiency). Sponsored by the Subcommittee on Child Prosthetics Problems of the Committee on Prosthetics Research and Development, the meeting, held June 13, 1968, attracted an attendance of approximately 110, including representation from 39 clinics and 20 guests from abroad.

Contributors to the symposium and the titles of their papers were:

"Proximal Femoral Focal Deficiency—Definition, Classification, and Management"—George T. Aitken

"Some Concepts of Proximal Femoral Focal Deficiency"—Richard E. King

"The Morphology, Natural History, and Treatment of Proximal Femoral Focal Deficiencies"—Harlan C. Amstutz

"The Surgical and Prosthetic Management of Proximal Femoral Focal Deficiency"—John E. Hall and Dietrich Bochmann

"Proximal Femoral Focal Deficiency—A Review of Treatment Experiences"—G. Wilbur Westin and Finn O. Gunderson

George T. Aitken, M.D., served as editor of the publication. Copies are available at $5.75 from:

Printing and Publishing Office
National Academy of Sciences
2101 Constitution Ave.
Washington, D. C. 20418

Engineering Foundation Conference on Prosthetic and Sensory Aids

A research conference entitled "Introduction to Prosthetic and Sensory Aids" will be conducted by the Engineering Foundation on August 17-21, 1970, at Proctor Academy, Andover, New Hampshire. The chairmen will be Dr. Eugene F. Murphy, Chief, Research and Development Division, Prosthetic and Sensory Aids Service, Veterans Administration; and Mr. A. Bennett Wilson, Jr., Executive Director, Committee on Prosthetics Research and Development, National Research Council.

The purpose of the conference is to present to industries, laboratories, and engineering graduate schools a realistic view of the field, including past achievements, relevant literature, current developments and problems, potential markets for prostheses, braces, and sensory aids, and sources of research funds.

In the tradition of the Engineering Foundation Conferences, the meetings will be conducted rather informally, with opportunities for questions and frank discussion.

Further information may be obtained from the Engineering Foundation, United Engineering Center, 345 E. 47th St., New York, N. Y. 10017.

NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL

THE NATIONAL ACADEMY OF SCIENCES is a private, honorary organization of more than 700 scientists and engineers elected on the basis of outstanding contributions to knowledge. Established bv a Congressional Act of Incorporation signed by Abraham Lincoln on March 3, 1863, and supported by private and public funds, the Academy works to further science and its use for the general welfare by bringing together the most qualified individuals to deal with scientific and technological problems of broad significance.

Under the terms of its Congressional charter, the Academy is also called upon to act as an official—yet independent—adviser to the Federal Government in any matter of science and technology. This provision accounts for the close ties that have always existed between the Academy and the Government, although the Academy is not a governmental agency and its activities are not limited to those on behalf of the Government.

THE NATIONAL ACADEMY OF ENGINEERING was established on December 5, 1964. On that date the Council of the National Academy of Sciences, under the authority of its Act of Incorporation, adopted Articles of Organization bringing the National Academy of Engineering into being, independent and autonomous in its organization and the election of its members, and closely coordinated with the National Academy of Sciences in its advisory activities. The two Academies join in the furtherance of science and engineering and share the responsibility of advising the Federal Government, upon request, on anv subject of science or technology,

THE NATIONAL RESEARCH COUNCIL was organized as an agency of the National Academy of Sciences in 1916, at the request of President Wilson, to enable the broad community of U. S. scientists and engineers to associate their efforts with the limited membership of the Academy in service to science and the nation. Its members, who receive their appointments from the President of the National Academy of Sciences, are drawn from academic, industrial, and government organizations throughout the country. The National Research Council serves both Academies in the discharge of their responsibilities.

Supported by private and public contributions, grants, and contracts, and voluntary contributions of time and effort by several thousand of the nation's leading scientists and engineers, the Academies and their Research Council thus work to serve the national interest, to foster the sound development of science and engineering, and to promote their effective application for the benefit of society.

COMMITTEE ON PROSTHETICS RESEARCH AND DEVELOPMENT
COMMITTEE ON PROSTHETIC-ORTHOTIC EDUCATION

The Committee on Prosthetics Research ami Development and the *Committee on Prosthetic-Orthotic Education,* units of the Division of Engineering and the Division of Medical Sciences, respectively, undertake activities serving research and education in the lields of prosthetics and orthotics, when such activities are accepted by the Academy as a part of its functions. Activities of the Committees are presently supported by the Department of Health, Education, and Welfare and the Veterans Administration, Information or reports developed by activities of the Committees are officially transmitted and published through the National Academy of Sciences.