Autumn 1965

Artificial Limbs

A Review of Current Developments

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Artificial Limbs

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The Score

EUGENE F. MURPHY, PH.D.[1]

THE past twenty years of the Artificial Limb Program comprise predominantly a series of wins, a few losses, and some ties awaiting replays. Participants, coaches, and managers in this prolonged struggle against nature and ignorance have enjoyed some spectacular seasons, but they also have endured grueling practice and frustrating defeats.

Wide interest in artificial limbs accompanies major wars. Ancient armorers made cleverly articulated limbs. The Napoleonic and Crimean Wars stimulated active development in Europe. The American Civil War led to numerous private inventions of prostheses. During World War I vigorous and systematic programs were conducted on both sides. These ended soon after the war, partly because of inflation and other disturbances, and partly because of confidence that limbs had been substantially improved. Everywhere there was a return to "normalcy," but the general impression that amputations are infrequent in peacetime is erroneous. Dr. Glattly's recent survey (*Artificial Limbs*, Spring 1963) corroborates the claim that for a variety of reasons very substantial numbers of civilians face this major operation in peacetime.

In World War II both the Army and the Navy of the United States set up large amputation centers to provide definitive surgery, artificial limbs, and other rehabilitation. Both Services introduced some new materials and mechanisms. To combat severe shortages they used prefabricated, standardized parts and division of labor for fitting and assembling instead of the slow, painstaking custom craftsmanship in very small shops typical of the American limb industry. Dramatic successes occurred. Nevertheless, Service Centers, amputees, commercial limb shops, and, increasingly, the general public were made conscious of the severe limitations of even the best prostheses.

The Surgeon General of the Army, therefore, called a conference in January 1945 which was supposed to agree upon the best available prosthetic components. The principal conclusion was that *none* of the available limbs was really adequate, so research was needed.

The Surgeon General then asked the National Research Council to set up a committee to conduct a research and development program. The resulting

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committee and its descendants have had a variety of designations, membership, organizational structures, and sponsors. Originally the work was supported by the wartime Office of Scientific Research and Development, then by the Army. The Veterans Administration, for many years the sole sponsor of contractual research in prosthetics, still continues important support, but in recent years various agencies within the Department of Health, Education, and Welfare have assumed major financial responsibility.

When the original Committee on Prosthetic Devices asked its surgeons to appraise the artificial limbs available in the summer of 1945, the two chief demands to its engineers were for development of a functional artificial hand that looked normal and for stance-phase stability for above-knee artificial legs, presumably from a lock released during swing phase. Patent files and technical literature were littered with descriptions of inadequate attempts by several generations of inventors.

The surgeons' demands reflected a primary conception of the Committee's role to concentrate on *devices*, susceptible to engineering design. In an era when many orthopaedists still were active in military amputation centers and physical medicine was only emerging, the surgeons were not yet concerned with development of new surgical techniques or with prosthetics education.

Neither were the surgeons primarily concerned with fitting, though its importance was realized. The second subcontract of the Committee, to develop further a saucer socket for the hip-disarticulation case, was with the Research Institute Foundation, a tiny laboratory which had been set up by the Artificial Limb Manufacturers Association. (This project incidentally initiated a number of ideas which later and independently were developed vigorously at larger laboratories.) Both Committee and limb industry a score of years ago considered the fitting of limbs to be a handicraft, often a sculpture-like art, learned by long experience but scarcely susceptible to systematic research.

German studies of alignment principles in World War I had relatively little immediate impact on American practices. Alignment of the above-knee prosthesis in 1945 typically placed the artificial foot far out under the head of the femur "so the amputee would not fall over to the amputated side" and made the axis of the socket bore vertical "so as not to give in to flexion contracture." Thus, while standing on the prosthesis, the amputee leaned against his pelvic band and mechanical hip joint, stressing them severely, in an effort to shift his center of gravity nearer to the foot. Likewise, after exhausting the possibilities of lordosis and unsymmetrical gait in an effort to control a free knee joint after maximum hyperextension of a slightly flexed stump in a straight socket, the recent amputee demanded a mechanical knee lock; a stiff heel bumper or a "long" prosthetic step (caused by inadequate knee friction) only increased instability at heel contact and made the demand for a knee lock more insistent.

The early years of the Artificial Limb Program were dramatic, in some senses wasteful, yet in others very fruitful. Some efforts were lost, but unquestionably

the whole field of upper-extremity prosthetics was changed for the better by fundamental studies, development, and improved management of the individual amputee. Some unilateral amputees found the APRL hand adequately functional, and careful testing proved its cosmetic glove passed unrecognized in a wide variety of social situations. Thus one complaint was at least marginally resolved.

Vigorous study of locomotion proceeded concurrently with numerous development projects. Reintroduction of the suction socket, almost a side activity, forced attention to principles of fitting and alignment, to fostering of cooperation among doctor, limb fitter, therapist, and amputee, and to prosthetics education. Improved alignment as well as added gait training reduced the clamor for knee locks for stance control, and attention shifted toward the swing phase. Several swing-phase mechanisms are now widely used. The Henschke-Mauch Model "A" hydraulic stance-plus-swing-control mechanism has finally been recommended after prolonged development and evaluation. If clinical application studies of the Henschke-Mauch Model "A," including application to recent amputees, prove as encouraging as now seems likely, this device will answer at last the second complaint of the surgeons back in 1945.

But many problems remain. The Program has gradually spread its field of vision beyond the mere development of mechanical components. Fundamental research has provided data on locomotion, biomechanics, muscle action, pain, and other problems. Clinical studies have been made of amputation surgery, cineplasty, myoplasty, and early postsurgical fitting, though further studies of surgery and wound healing are needed. Fitting and alignment now can profit from better anatomical and biomechanical principles, new shop tools, improved materials, clearer analysis of defects, and greater insight into causes. The necessary skill and artistry of the increasingly professional prosthetist can be used more effectively. The team principle has become widely practiced, to the reassurance of all concerned.

Continuing soul-searching has steadily spurred the participants in this battle against ignorance. The best artificial limbs are still crude. Very little has yet been done about orthotics, deliberately kept in abeyance because braces are worn for such a wide variety of conditions that analysis is difficult. The Subcommittee on Sensory Aids, resuming the tasks of the wartime Committee on Sensory Devices, is only beginning its task of reviewing the present VA projects on aids for the blind. CPRD is studying its possibilities and responsibilities in the broad field of bioengineering.

The past score of years has given the Committee an intensive series of encounters, sometimes bruising—but often exhilarating—with problems of mechanisms, their human users, the man-machine interfaces, and the idiosyncracies of the professions concerned.

The Münster-Type Below-Elbow Socket, a Fabrication Technique[1]

HECTOR W. KAY, M.Ed.,[2] KEVIN A. CODY, M.A.,[3] GEORGE HARTMANN, C.P.O.,[4] AND DOMINICK E. CASELLA[5]

THE introduction of the Münster technique into the United States in 1958 generated considerable interest in the prosthetics profession, particularly for the management of amputees with short and very short below-elbow stumps. However, in spite of the enthusiasm for this technique, its application has met with varying success in this country. The dearth of precise instructional material has undoubtedly contributed to the lack of consistent results. Each prosthetist has improvised from the limited information available, sometimes successfully, sometimes unsuccessfully.

The purpose of this article and the manual upon which it is based (*5*) is to present a detailed description of the Münster technique based upon the procedures utilized in the successful fittings performed in the New York University evaluations of 1963–1964 (*1,3*). But there can be no substitute for formal instruction and demonstration in the technique. This point is stressed because at least one critical procedure in the fabrication technique, that of cast taking, is quite difficult to learn by the written word and pictures alone.

The procedures presented do not conform in every respect to those promulgated by the developers, Drs. Oskar Hepp and G. G. Kuhn (*2*). However, it is believed they are a close approximation. For this reason the technique is referred to as the "Münster-type" fabrication technique. In choosing this title, it is intended to give appropriate credit to Drs. Hepp and Kuhn for the original development of the technique, without implying identity with their procedures.

Short below-elbow stumps have always presented fitting problems for the obvious reasons of small attachment area, poor leverage, and a decreased range of useful motion. Split sockets and step-up hinges have commonly been used to provide a full range of elbow flexion (135 deg.) to amputees having very short below-elbow stumps. However, this system is characterized by several features which tend to reduce its over-all acceptability. Step-up hinges decrease the lifting power available to the amputee, increase the bulk of the prosthesis at the elbow and proximal forearm, and historically have lacked durability.

[1] Based upon *A Fabrication Manual for the "Muenster-Type" Below-Elbow Prosthesis*, published by Prosthetic and Orthotic Studies, Research Division, School of Engineering and Science, New York University, New York, N.Y., in April 1965 (*5*). The manual was prepared under the general supervision of Sidney Fishman, Ph.D., Project Director, Child Prosthetic Studies, New York University. The studies that provided the material for the manual are supported by the Children's Bureau and the Vocational Rehabilitation Administration, Department of Health, Education, and Welfare. The publication itself was made possible through a grant from the Children's Bureau.

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Fig. 1. Anterior-oblique and posterior-oblique views of the Münster-type prosthesis.

During the middle 1950's, Drs. Hepp and Kuhn of Münster, Germany, formulated a new approach to the prosthetic management of short upper-extremity stumps. They developed a technique for fabricating sockets for below-elbow and above-elbow amputations which provides a more intimate encapsulation of short stumps (*2*).

Evaluation of Münster Fabrication Technique

New York University Adult Prosthetic Studies became interested in the Münster technique for amputees having short and very short below-elbow stumps, following the favorable experiences reported by amputee clinics in fitting preflexed arms (that is, arms bent to provide a certain amount of preflexion) to children (*4*). Under the auspices of the Subcommittee on Evaluation of the Committee on Prosthetics Research and Development, New York University conducted an evaluation of what was considered the Münster technique in applications to adult amputees (*1,3*). The general characteristics of the below-elbow sockets fabricated in this study were:

1. The forearm was set in a position of initial flexion (average 35 deg.) in relation to the humerus. Because of the reduced range of useful motion, the socket was flexed to position the terminal device in the most generally useful area.
2. The anterior trim line extended to the level of the antecubital fold, with a channel provided for the biceps tendon to avoid interference between socket and biceps tendon during flexion.
3. The posterior aspect of the socket enclosed the olecranon, taking advantage of this bony prominence to provide attachment and stability to the socket. The trim line was just above the level of the epicondyles.

Because of the high anterior and posterior walls of the sockets, the range of motion for

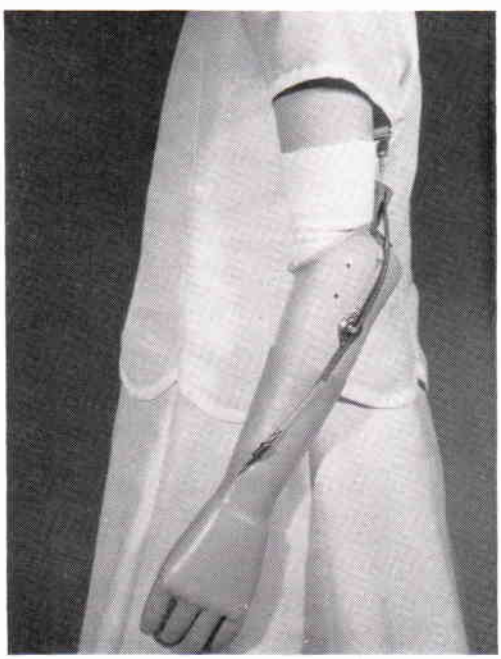

Fig. 2. Maximum extension.

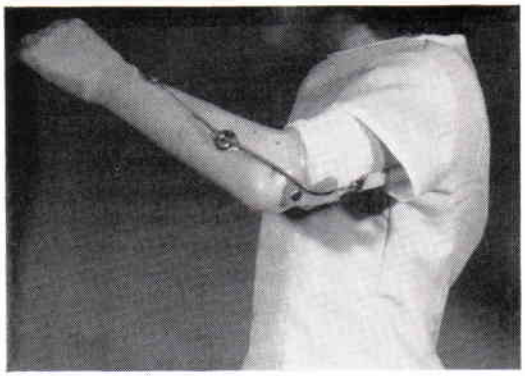

Fig. 3. Maximum flexion.

the average amputee was limited to approximately 70 deg. (from 35 deg. to 105 deg. flexion). The limited range of motion characteristic of Münster-type sockets bears emphasis (Figs. 2 and 3). In current practice, the acceptable checkout standard for maximum elbow flexion with the prosthesis is that it should be within 10 deg. of stump flexion without the prosthesis. This standard is not applicable to the Münster-type prosthesis. Nevertheless, the decreased range of motion available has been found acceptable by unilateral amputees who typically use their prostheses as assistive devices and perform very few activities at the extremes of the flexion-extension range.

The results of the New York University study of Münster-type fittings cited earlier indicated that:

1. Amputees reacted positively to the comfort and security of the socket.
2. The decrease in flexion range had no appreciable effect on the prosthetic functions of unilateral amputees. However, for bilateral subjects, modification of the anterior trim line and the provision of a wrist-flexion device were necessary for the performance of tasks close to the body.
3. Lifting and holding forces available to the amputee were generally superior (Figs. 4 and 5).

Following the favorable results obtained in fitting adult amputees, New York University Child Prosthetic Studies initiated a study of the applicability of these procedures to children with very short, short, and long below-elbow deficiencies. As of March 1965, ten successfully fitted children ranging in age from 20 months to 10 years had worn their prostheses for periods ranging from 4 to 14 months.

Fig. 4. "Live lift"—resisting vertical downward force while maintaining the elbow flexed.

Fig. 5. "Axial load"—resisting vertical downward force with the elbow extended.

Although the study of the children's fittings had not been completed at this writing, the indications are that fabrication procedures for adults, as described in this article, would be equally applicable to children.

Prescription Considerations

A priori, this method of socket fabrication would appear to be of greatest potential benefit to amputees with stumps of the short and very short types. These are patients who, under current practice, would typically be fitted with metal elbow hinges—step-up, polycentric, or, at the longer limits of the range, single-pivot or flexible hinges. Prime beneficiaries might be amputees who normally would be fitted with split sockets and step-up hinges because of the inherent disadvantages in this type of fitting.

In general, this hypothesis has been verified by fitting experience to date. In the NYU evaluations approximately 90 per cent of the stumps fitted fell into the short and very short below-elbow categories. Specifically, nine adults (including one bilateral amputee) with stump lengths ranging from 1½ in. to 5½ in. (18 to 52 per cent) and eight children with stumps 2 in. to 3 in. long (25 to 40 per cent) were successfully fitted with Münster-type prostheses.

The precise limits of applicability of the Münster-type prosthesis (that is, the minimum and maximum stump lengths) must be determined individually for each patient. However, based upon a somewhat limited investigation of these considerations, the following guidelines are offered:

Minimum length: Very short stumps virtually disappear at 90 deg. of elbow flexion. Hence, the maximum prosthetic flexion angle obtainable with stumps in this category is limited accordingly. The shortest stump fitted at NYU was 1½ in. (18 per cent) in length. The maximum flexion angle obtained (with prosthesis) was 80 deg.

Thus, fitting of Münster-type sockets to stumps as short as 1½ in. depends upon the acceptability of a very limited amount of elbow flexion (usually less than 90 deg.).

Maximum length: With regard to maximum stump length, two limiting factors must be considered:

1. Depending on the extent of the anatomical deficiency, stumps of mid-length and longer usually have some degree of residual pronation-supination which may be harnessed in a conventional below-elbow socket with flexible hinges. This active pronation-supination of the prosthesis is eliminated with the Münster-type fitting. The question to be decided is whether other advantages of the Münster-type prosthesis adequately compensate for the loss of rotation in a given case.

2. The configuration of the Münster-type socket (proximal opening at an angle to the socket) presents progressively increasing difficulty in donning and doffing the prosthesis as stump length increases. Absolute stump length rather than proportion of sound side remaining appears to be the prime determinant. The difficulties can be reduced by socket modifications, such as a looser fit or lowered trim line. Such modifications, however, progressively reduce control and retention of the prosthesis.

NYU has fitted several adult and juvenile amputees whose stumps fell into the long classification; that is, 55 per cent of sound side or longer. One adult at the borderline of the long classification (5½ in.—56 per cent) and a child well within this category (4 in.—66 per cent) were not affected by the considerations mentioned above. In both cases residual pronation and supination were minimal, and no difficulty was experienced in putting on and taking off the prosthesis.

However, an adult with a 7-in. stump (66 per cent) required considerable modifications to the proximal brim before the prosthesis could be delivered successfully. The anterior trim line was reduced approximately ½ in. below the cubital fold to facilitate passage of the stump. The subject had about 55 per cent of residual stump rotation; but, since this rotation had not been utilized in the previous prosthesis, no deprivation was imposed by the Münster-type arm.

One child with a 6-in. (92 per cent) stump was also successfully fitted with two different modifications of the Münster-type prosthesis. In the initial prosthesis, the posterior trim line was reduced to just above the olecranon for manageable donning and doffing. In a second fitting, the standard trim lines were maintained, but the socket was made somewhat looser than usual. Both modifications produced sockets with slightly reduced but still very acceptable retention.

Thus, the Münster-type prostheses can apparently be fitted without difficulty to stumps

UPPER EXTREMITY MEASUREMENT CHART

Prosthetist_____ Date_____

Patient's Name_____ Amputation Date_____

Amputation Type_____ Left___ Right___ Race: Caucasian____ Negro____

Height_____ Age____ Sex: Male____ Female____

Socket: Double Wall____ Single Wall____ Split____ "Muenster" Type____

Monolith____ SD Socket____ Section Plate____ Abduction____

Other_____

Hook____ Hand____ Wrist____ Elbow____ Hinge____

Harness_____ Control System_____

Cuff_____ If no cuff is used, indicate attachment point for housing cross bar assembly_____

Range of Motion of Stump: Elbow Flexion_____ Pronation_____
Elbow Extension_____ Supination_____

Condition of Stump (irritation, abrasion, etc.): _____

_____

Special Considerations: _____

_____

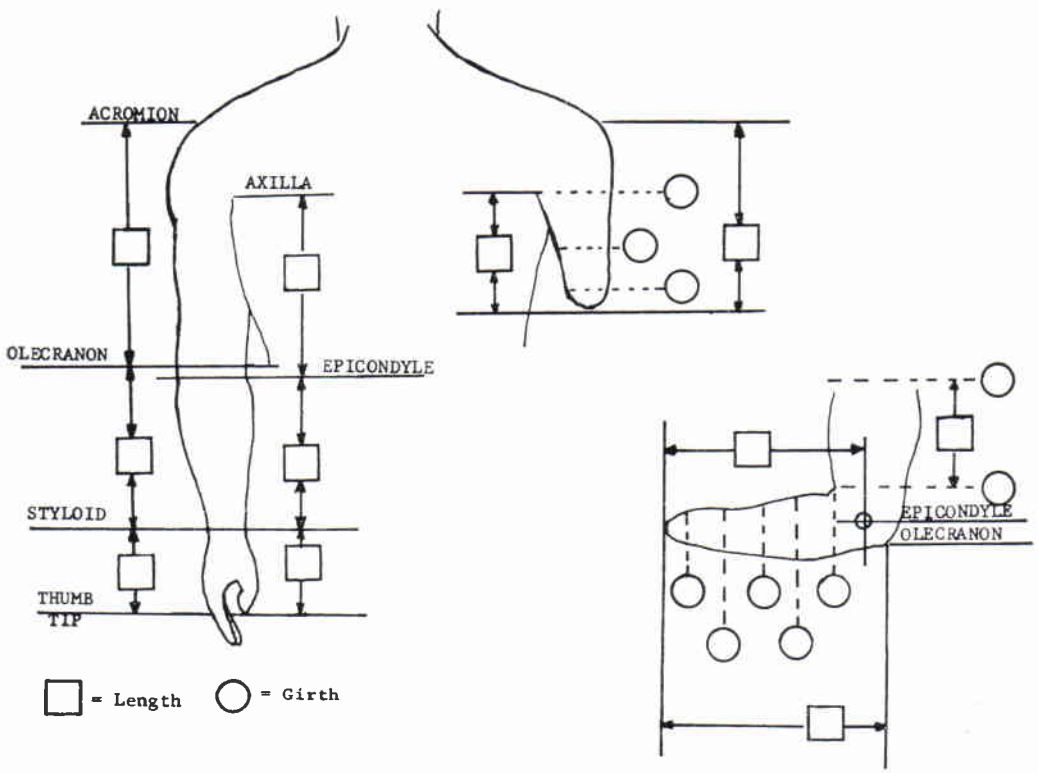

Fig. 6. Measurement form.

up to the limit of the short below-elbow classification (55 per cent). The fitting of longer stumps involves consideration on an individual basis of the factors discussed.

Bilateral Fittings

The question of fitting Münster-type prostheses bilaterally is not fully resolved. Two problems are inherent in such fittings:

1. The difficulty in donning two closely fitting prostheses without assistance.
2. The limitation imposed by restricted elbow flexion, particularly on the dominant side.

NYU has had no experience in fitting children bilaterally but has successfully fitted one bilateral adult amputee (4-in. and 5½-in. stumps). The inherent problems were resolved by:

1. Fitting the sockets less snugly than usual to facilitate donning.
2. Lowering the anterior trim line and providing a wrist-flexion unit on the dominant side for activities close to the body.

It is probable that selected juvenile bilateral amputees might be successfully fitted with similar modifications.

Procedures

Stump Examination and Measurements

Materials required for stump examination and measurements are:

Measuring tape
Ruler
Goniometer
Measurement form (Fig. 6)

A thorough stump examination is an important prerequisite to any prosthetic fitting procedure. In the Münster-type fitting, a stump examination is even more critical than usual because of the intimate socket encapsulation of the stump. Skin irritations, painful scars, abrasions, and sensitive areas must be identified so that necessary socket reliefs may be anticipated and provided.

Consistent with sound prosthetics practice, it is advisable to follow the conventional measurement procedures described in the *Manual of Upper Extremity Prosthetics* (*6*) so that a comprehensive record will be available for future reference. The appropriate below-elbow measurements are recorded on the modified Upper-Extremity Measurement Chart shown as Figure 6. However, it should be noted that, since the plaster-wrap casts are used as check sockets in this technique and stump molds made from the wrap casts are not corrected to measurements, the only measure essential for fabrication is the length of the normal forearm to wrist and thumb tip.

It should also be noted that stump and sound forearm lengths are measured from the olecranon rather than from the epicondyles, since the olecranon is more convenient to use as a reference point on the cast and socket. These measurements are described below.

Stump length: The stump length is measured from the posterior aspect of the olecranon (Fig. 7). If distal redundant tissue is present, the measurement should include the redundancy.

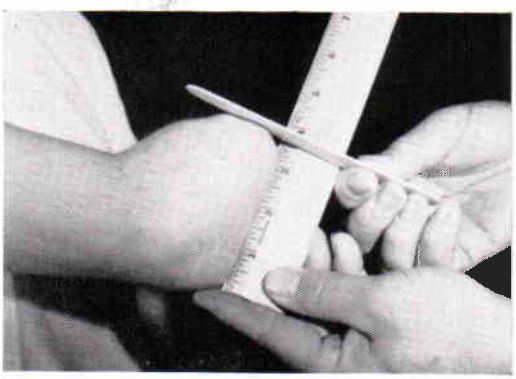

Fig. 7. Measuring stump length.

Forearm length: With the patient's sound forearm flexed at approximately 90 deg., and held midway between pronation and supination, measurements are made from the proximal aspect of the olecranon to the distal aspect of the ulnar styloid, and from the olecranon to a point on the ulnar border of the hand which corresponds to the thumb tip (Fig. 8).

The Wrap Cast

Materials required to take the wrap cast are:

Cotton stockinette (appropriate size for stump)

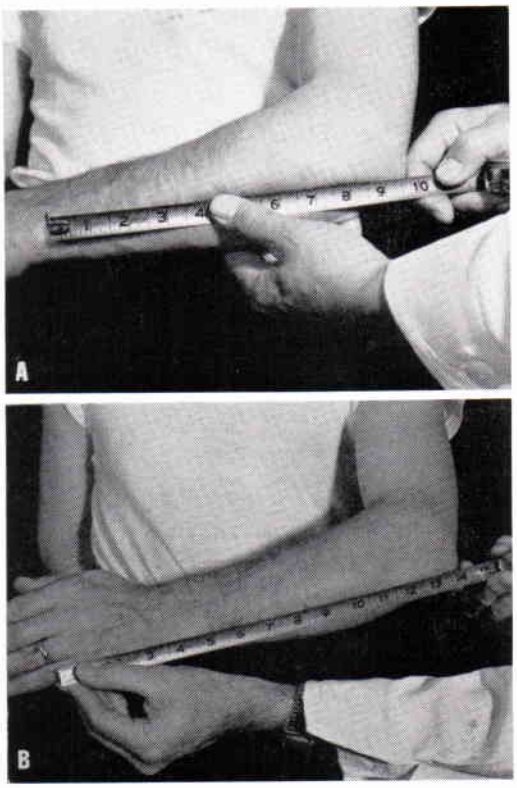

Fig. 8. Measuring forearm length. *A*, Measuring from the proximal aspect of the olecranon to the distal aspect of the ulnar styloid; *B*, measuring from the olecranon to a point on the ulnar border of the hand which corresponds to the thumb tip.

Dacron tape for temporary harness
Yates clamps
Indelible marking pencil
Three rolls of plaster-of-Paris bandage (6 or 8 cm. elastic-type preferred)
Pail of water

A snug, form-fitting cotton stockinette is placed over the stump to insulate the skin and hair from plaster. The assistance of the amputee or a temporary figure-eight harness may be used to keep the stockinette free from wrinkles. The harness method is generally preferable for children.

Application of the proper molding grip is essential to the success of the wrap cast and hence to the final outcome of the fitting. It is important, therefore, that the prosthetist practice this procedure on each amputee prior to the application of the cast. He will thus become familiar with the individual characteristics of each amputee's stump, and the possibility of erroneous molding once the stump is wrapped will consequently be reduced. Furthermore, the amputee will know what to expect during the casting procedure and be better able to cooperate.

It is important to note that the prosthetist will be able to apply the molding grip more conveniently when his arms and those of the amputee are at the same level. It is suggested, therefore, that child amputees sit on a table or stand on a raised platform.

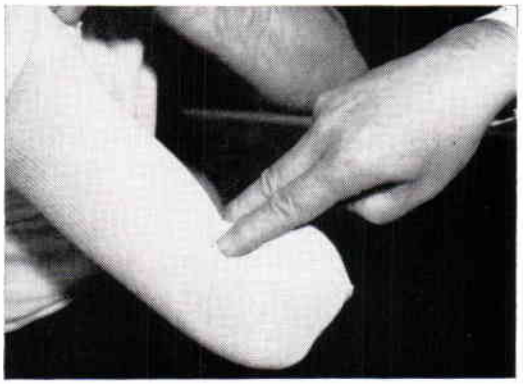

Fig. 9. Practicing the molding grip. The prosthetist exerts moderate pressure on either side of the biceps tendon.

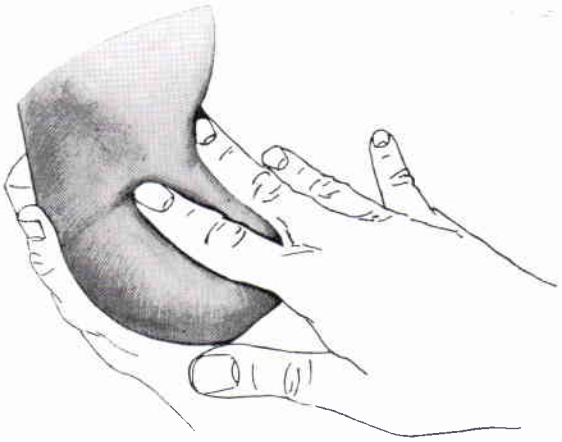

Fig. 10. Another view of the prosthetist exerting pressure on either side of the biceps tendon, simultaneously into the cubital fold and downward on the anterior surface of the stump.

In this article, the specific steps to be followed are described for a right below-elbow amputee (the hand positions are reversed for a left amputee). Because of the fundamental importance of the correct molding grip, this aspect of the fabrication procedure is illustrated with both photographs and drawings.

With the amputee's stump flexed to 90 deg., the index and middle fingers of the prosthetist's right hand are placed on the anterior surface of the stump. The prosthetist's right wrist should be in a neutral or slightly extended position. The two fingers should rest on either side of the biceps tendon and along the ante-

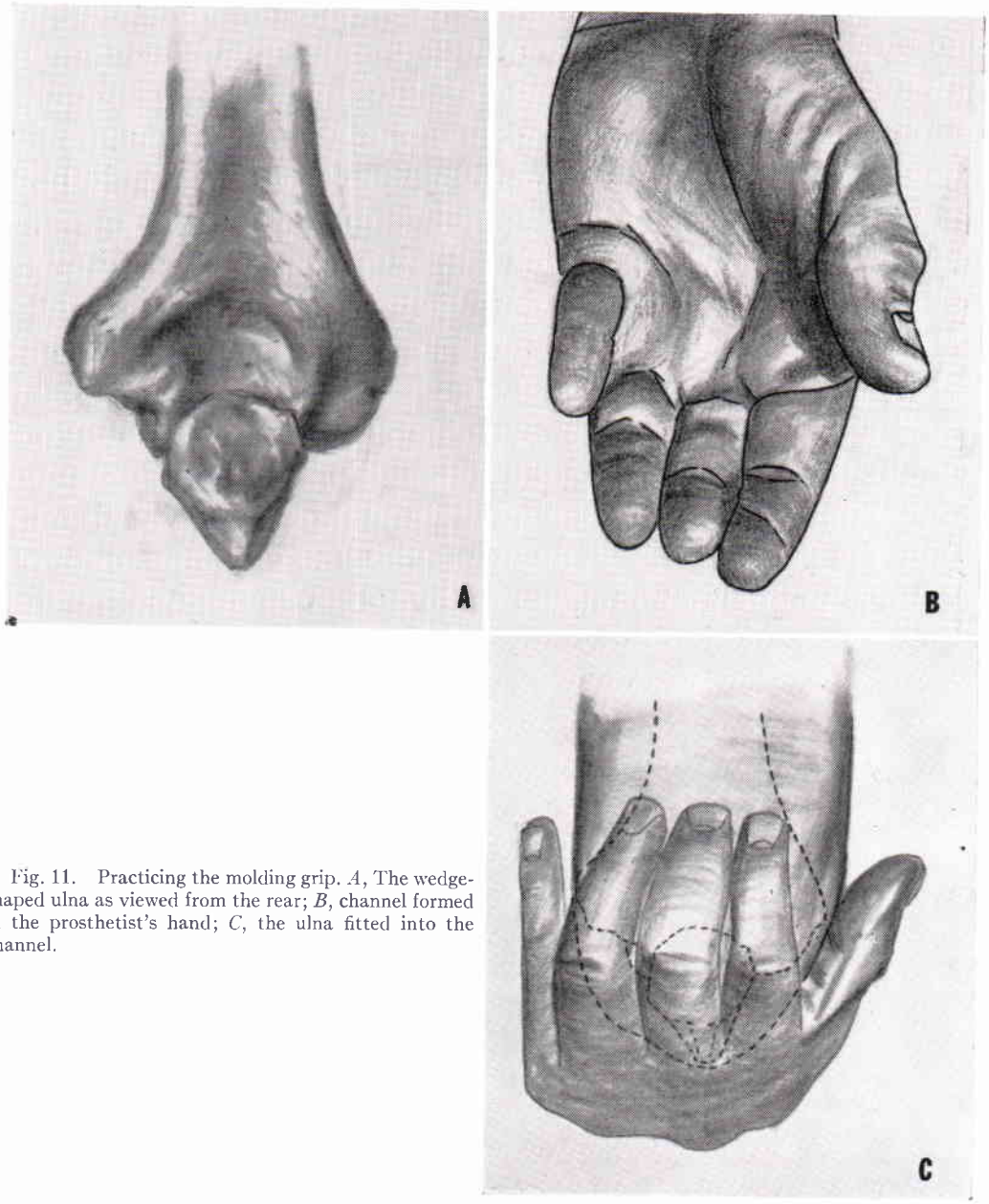

Fig. 11. Practicing the molding grip. *A*, The wedge-shaped ulna as viewed from the rear; *B*, channel formed in the prosthetist's hand; *C*, the ulna fitted into the channel.

rior surface of the stump. Moderate pressure is exerted (to the point of firm resistance) simultaneously into the cubital fold and downward on the anterior surface of the stump, but any concentration of pressure distally is avoided (Figs. 9 and 10).

The dorsal aspect of the proximal ulna is distinctly wedge-shaped. The prosthetist's left hand is shaped so that the thenar and hypothenar eminences form a channel into which this wedge will fit (Fig. 11). The grooved hand is then positioned against the underside of the stump to provide stability and support without distortion. The metacarpal joints of the prosthetist's left hand should be located just below the amputee's olecranon (Fig. 12).

The index, middle, and ring fingers of the prosthetist's left hand are cupped and positioned on the distal posterior surface of the humerus just above the level of the epicondyles (Fig. 13). Gentle downward pressure is applied with the pads of the fingers. Care must be taken to avoid pressure between the palm of the hand and the olecranon. Thus relief is automatically provided for the olecranon. The little finger and the thumb may be curled to make contact with the medial and lateral epicondyles, respectively. However, these digits should *not* exert any pressure.

In view of the intimate fit which characterizes the Münster-type socket, tender areas and bony prominences such as the olecranon and the epicondyles must be clearly defined for the provision of the necessary reliefs. While the stump is flexed at 90 deg., these areas are marked with an indelible pencil so that they may be easily identified on the wrap cast (Fig. 14).

A preliminary trim line is marked on the cast sock by drawing a line posteriorly connecting two points 1 in. superior to the medial and the lateral epicondyle, respectively; and the

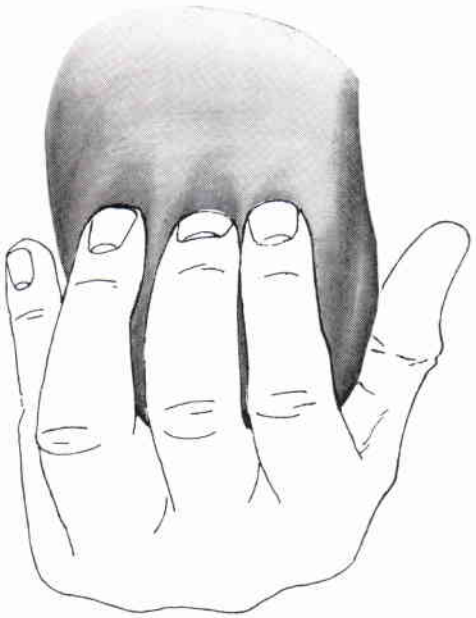

Fig. 13. Practicing the molding grip; gentle downward pressure being applied by the pads of the index, middle, and ring fingers of the prosthetist's left hand.

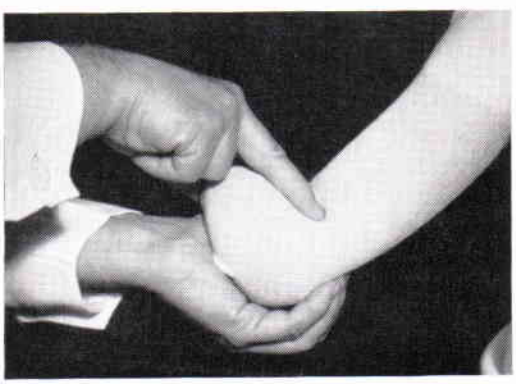

Fig. 12. Practicing the molding grip; positioning the grooved left hand of the prosthetist against the underside of the stump.

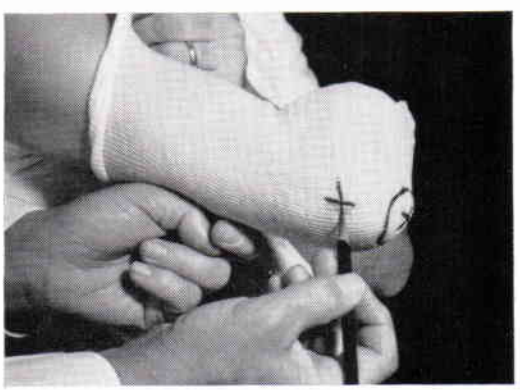

Fig. 14. Marking tender areas and bony prominences.

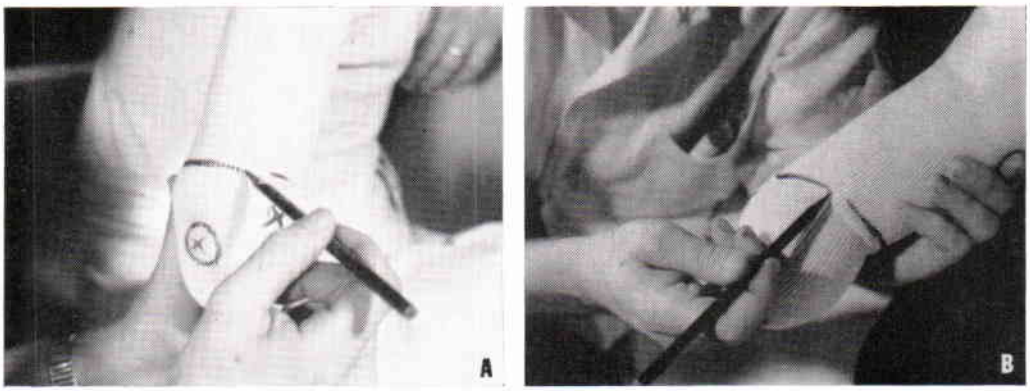

Fig. 15. Marking the preliminary trim line on the cast sock. *A*, A line is drawn posteriorly connecting two points 1 in. superior to the medial and the lateral condyles; *B*, the line is continued to pass anteriorly ½ in. above the mid-cubital space.

line is continued anteriorly so that it passes through a point ½ in. above the mid-cubital space (Fig. 15).

The critical relationship between the stump and the Münster-type socket cannot be overemphasized. Every effort should be made, therefore, to obtain a properly fitting cast. To this end, it is recommended that at least two, and preferably three, casts be taken so that the prosthetist and the patient together may choose the best of the series. Elastic or nonelastic plaster-of-Paris bandages may be used, but the elastic is preferable since it results in a more accurate configuration.

While the stump is flexed at 90 deg. and the humerus is held midway between internal and external rotation, the wrap is commenced with two circular turns above the elbow joint (over the olecranon and the cubital fold). Only very slight tension should be applied to the plaster-of-Paris bandage (either elastic or nonelastic) in the process (Fig. 16*A*). The wrapping proceeds to the distal end of the stump in a figure-eight or a spiral pattern (Fig. 16*B*). The wrap is continued at least ¼ in. above the reference marks made earlier.

When the wrapping has been completed, the molding grip practiced earlier is applied (Fig. 17). Finger pressure should be sufficient to displace all loose tissue (to the point where firm resistance is reached). Pressure is maintained until the plaster has set.

After the plaster has hardened, the proximal end of the wrap cast is reinforced with several turns of nonelastic plaster-of-Paris bandage in order to minimize distortion. Then the stockinette is pulled down over the cast (Fig. 18*A*). As the cast is gently worked off the stump, upward pressure is applied to the arm to increase skin tension at the proximal end of the cast in order to break the vacuum seal (Fig. 18*B*).

The stockinette is removed from the cast, and the indelible markings which have been transferred from the stockinette to the inner wall of the cast are accentuated (Fig. 19).

These procedures should be repeated until a minimum of two, and preferably three, casts have been taken.

THE CHECK SOCKET

Materials required to prepare the check socket are:

Knife
Scissors
Fresh plaster
Water

All of the wrap casts taken should be prepared in accordance with the procedures described below and used as check sockets. The one agreed upon by both the prosthetist and the patient as providing the most comfortable fit and the greatest range of motion and maximum security is selected for use in the preparation of the positive plaster model.

A hole is cut in the cast, just large enough to allow the passage of a stump pulling sock and as

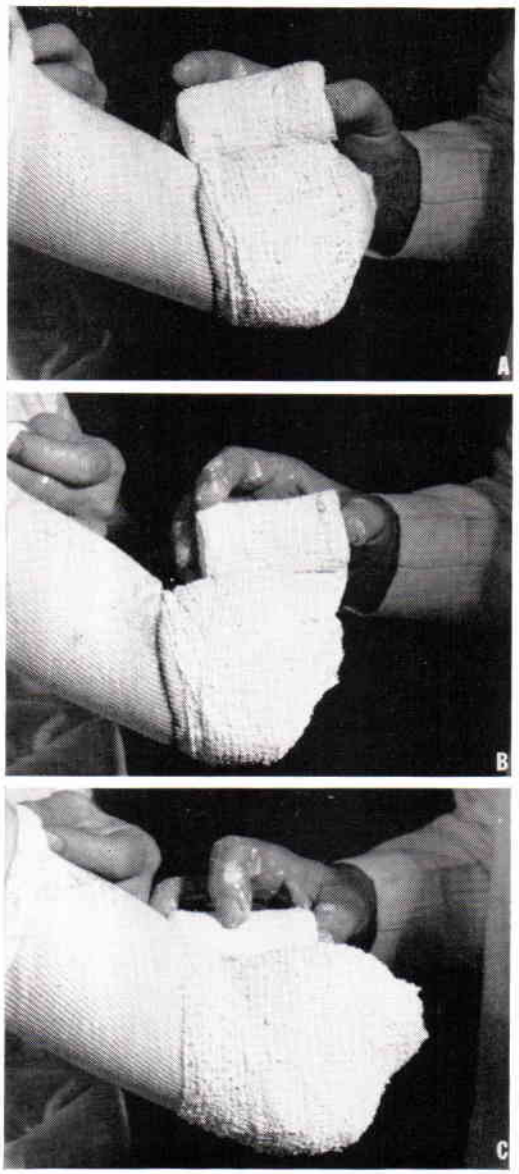

Fig. 16. Wrapping the stump. *A*, The wrap is begun with two circular turns around the elbow joint—over the olecranon and the cubital fold; *B*, the distal end of the stump is included in either a figure-eight or a spiral pattern; *C*, the wrap is continued at least ¼ in. above the reference marks made earlier.

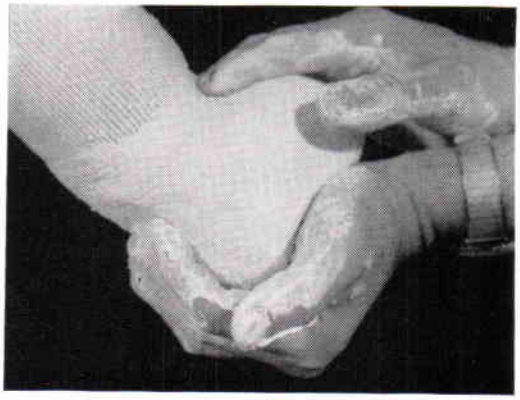

Fig. 17. Application of the molding grip to the wrap cast.

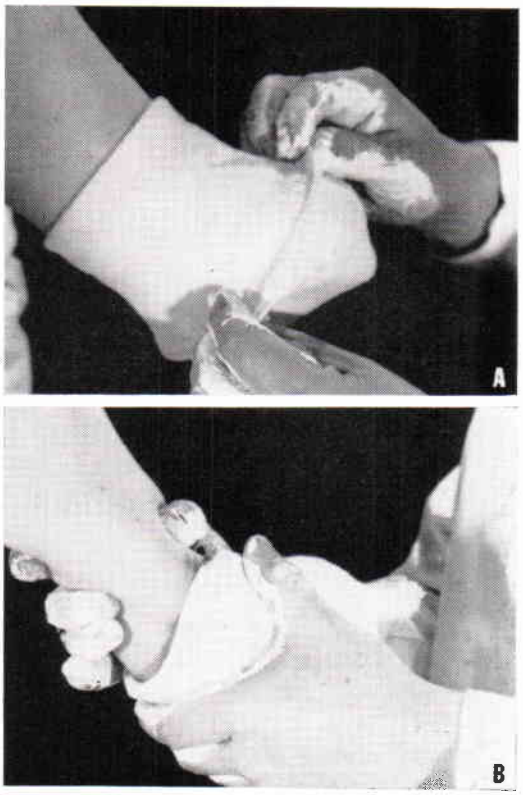

Fig. 18. Removal of wrap cast. *A*, Pulling the stockinette down over the cast; *B*, applying upward pressure on the arm as the cast is gently worked off the stump.

close to the distal end as possible so that shortening of the cast is minimized (Fig. 20*A*). The final trim lines for every socket must be determined individually for each amputee. However, as an initial step, the proximal end of the cast is trimmed to the level of the reference line made earlier (Fig. 20*B*).

The cast is then moistened, and the inside of

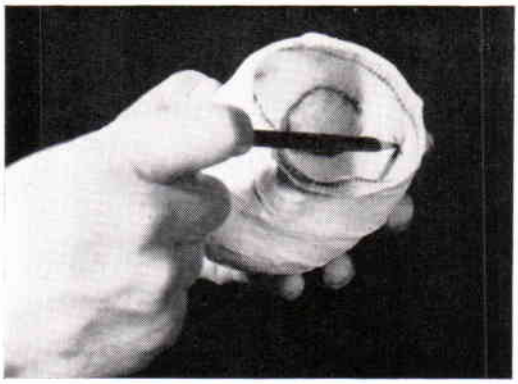

Fig. 19. Accentuating the indelible markings transferred from the stockinette to the inner wall of the cast.

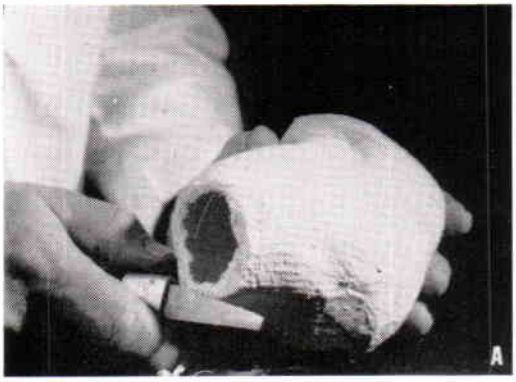

Fig. 20. Trimming the cast. *A*, The hole cut in the distal end should be just large enough to permit passage of a stump pulling sock; *B*, trimming the proximal end at the level of the reference line made earlier.

the cast is smoothed with fresh plaster to remove all gauze marks, except in the area of the epicondyles and the olecranon (Fig. 21). *No* plaster should be added in these critical areas.

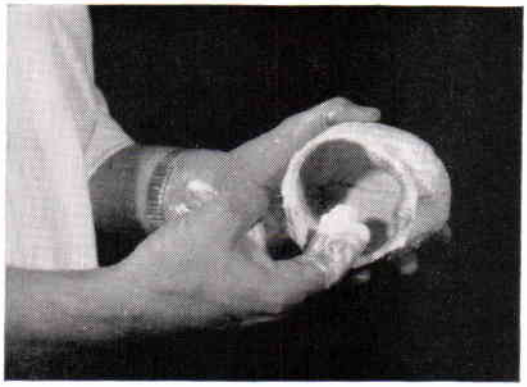

Fig. 21. Smoothing the inside of the cast.

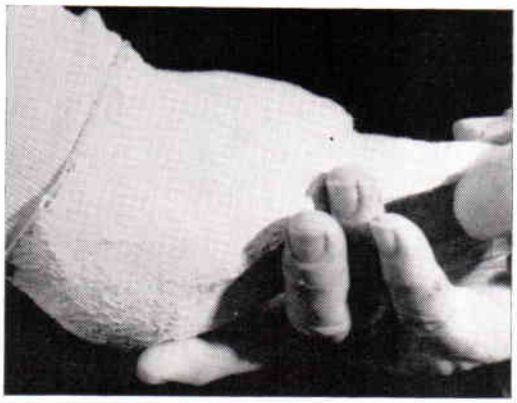

Fig. 22. Pulling the stump into the check socket.

FITTING THE CHECK SOCKET

Materials required for fitting the check socket are:

Cotton stockinette (stump pulling sock)
Indelible marking pencil

A length of stockinette is placed on the amputee's stump, and the distal end of the stockinette is drawn through the hole in the check socket. The stump is pulled into the socket, care being taken that all flesh is drawn inside the cast (Fig. 22).

With the check socket on the amputee, the usual tests are made for adequacy of fit, comfort, and range of motion by having the amputee exert force against resistance in elbow flexion, extension, and rotation (Fig. 23). Although the stump cannot rotate the socket, there may be some undesirable rotation of the stump within the socket. If the fit of the check

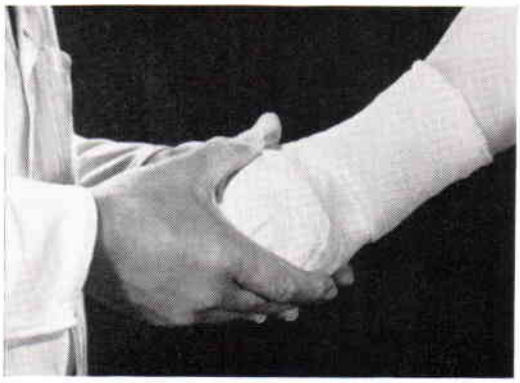

Fig. 23. Determining the adequacy of the fit.

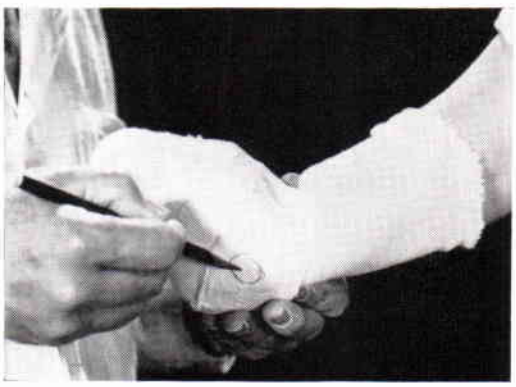

Fig. 24. Marking an area which requires relief.

socket is not satisfactory, the socket should be rejected.

If the check socket causes any pain or discomfort, the appropriate area should be marked on the outside of the socket so that relief can be provided (Fig. 24).

The same procedures are repeated with the other check sockets and the best socket is selected for use in completion of the prosthesis.

ESTABLISHING THE RANGE OF MOTION IN CHECK SOCKETS

The maximum forearm flexion and extension positions attainable with the Münster-type prosthesis will be significantly less than those achieved in conventional prostheses. Experience has shown that the maximum flexion range for the typical short below-elbow stump fitted with a Münster-type socket is approximately 70 deg. (from 35 deg. initial flexion to 105 deg. maximum flexion) (*1,3*). A range of motion of this magnitude is not always achievable but should be the initial goal of the fitting.

The principal factors limiting the range of motion are:

1. Restriction in the maximum flexion angle obtained attributable to one or more of the following conditions:
   - Insufficient relief for the olecranon
   - Too small a channel for the biceps tendon
   - Too high an anterior wall
2. Restriction in extension attributable to too high a posterior trim line.

However, it must be emphasized that lowered trim lines or loose fit will adversely affect the retention of the socket on the stump. Hence, the initial trim lines need to be closely maintained in order to provide maximum socket retention. They should be reduced only when absolutely necessary to provide greater comfort or increased range of motion, or both.

Materials required in establishing the range of motion are:

- Indelible pencil
- Scissors or knife
- Goniometer
- Ruler

A line is drawn on the lateral side of the check socket coincident with its long axis (from the lateral epicondyle to the mid-distal end) to serve as a guide in measuring flexion and extension (Fig. 25).

The center of the goniometer is placed on the lateral epicondyle. The lower arm of the goniometer is placed on the long axis line, and the upper arm of the goniometer is lined up with

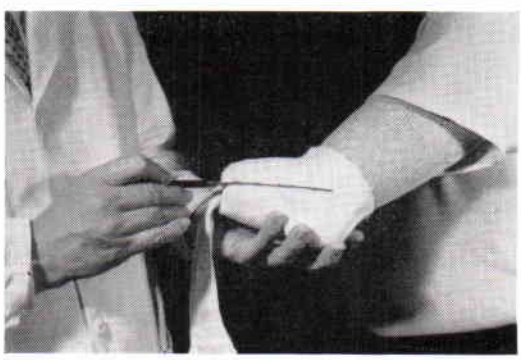

Fig. 25. Drawing a line on the check socket coincident with its long axis.

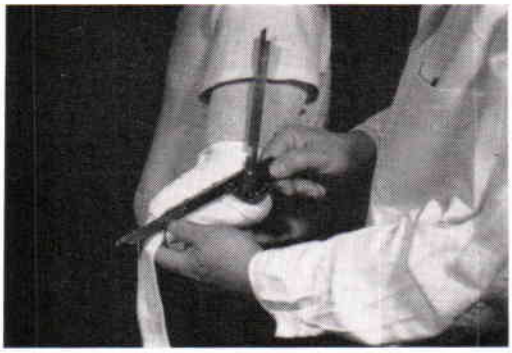

Fig. 26. Placement of goniometer to measure maximum flexion and extension angles.

Fig. 27. Trimming the check socket to provide increased range of motion.

Fig. 28. Drawing a second line at a 35-deg. angle between the humerus and the stump to serve as a guide in aligning the forearm shell.

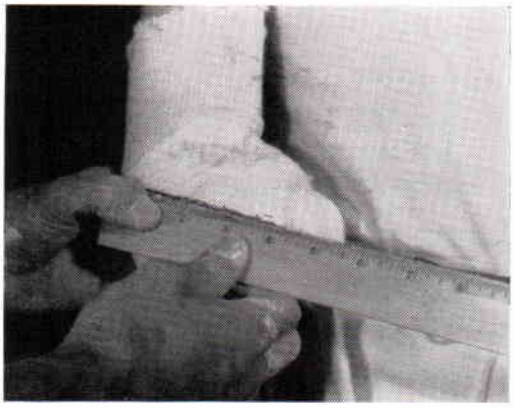

Fig. 29. Placing a ruler along the 35-deg. line to test the adequacy of the proposed angle of initial flexion.

the acromion (Fig. 26). Maximum flexion and extension angles are measured from these points of reference.

If motion is restricted, the specific cause for the restriction should be determined and corrective action should be taken (Fig. 27).

If the amputee cannot achieve the proposed 35 deg. of initial flexion in the check socket, the discrepancy is compensated for in the alignment of the forearm shell. Therefore, while the stump is maintained in an actively extended position, a second line is drawn on the check socket at an angle of 35 deg. between the humerus and the stump (Fig. 28). This line will serve as a guide in aligning the forearm shell.

The adequacy of the proposed initial flexion angle is tested by placing a ruler along the 35-deg. line drawn on the check socket (Fig. 29). The ruler is placed to correspond to the intended length of the finished prosthesis; that is, the olecranon-to-thumb-tip measurement recorded on the Upper-Extremity Measurement Form (Fig. 6).

The amputee should flex and extend this improvised forearm composed of the check socket and the ruler (Fig. 30). Maximum flexion should be about 105 deg., except for very short stumps, where it probably may not exceed 90 deg. Because of the inherent limitation of motion associated with the Münster-type prosthesis, the usual test of having the amputee bring his terminal device to his mouth is not applicable. The goal is to provide the maximum flexion angle possible compatible with a cosmetically acceptable initial flexion position and socket retention.

If the maximum flexion angle obtained with 35 deg. of initial flexion is not acceptable, the angle of the ruler is adjusted to provide greater

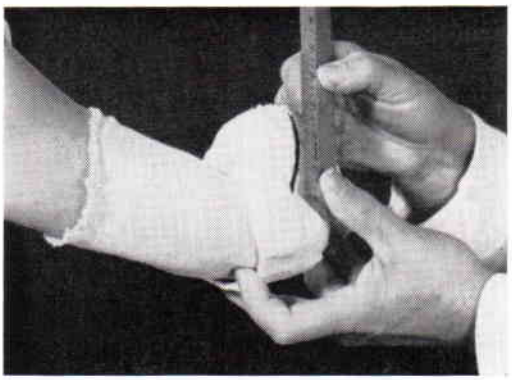

Fig. 30. Checking the flexion and extension of the improvised forearm composed of check socket and ruler.

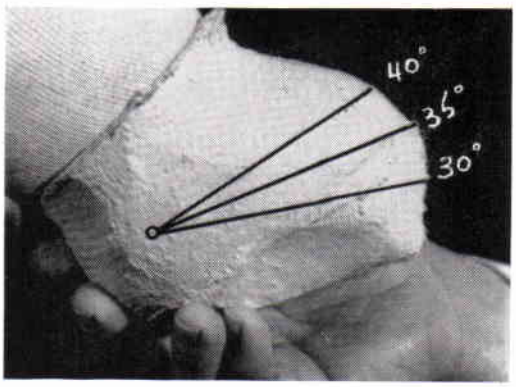

Fig. 31. Alternative angles of initial flexion: 30 deg., increased extension, decreased flexion; 40 deg., increased flexion, decreased extension.

initial flexion. Initial flexion angles to a maximum of 45 deg. have been used, but at the expense of decreased cosmesis (Fig. 31). If less than 35 deg. of initial flexion is desired for cosmetic or other reasons, the angle is decreased accordingly. Such reduction also decreases the maximum flexion angle obtainable. The selected angle of initial flexion is indicated on the check socket.

PREPARATION OF THE POSITIVE MODEL

Materials required for the preparation of the positive model are:

Plaster-of-Paris bandage
Talcum powder
Hollow pipe (approximately 12 in. in length and ½ in. in diameter)
Awl
Two roundhead screws
Fresh plaster
Water
Sanding screen
Indelible marking pencil
Vaseline or other parting agent

The distal end of the check socket is closed with plaster-of-Paris bandage or with masking tape (Fig. 32) and a small extension (approximately 1 in.) is constructed at the proximal end of the check socket (Fig. 33), again with plaster-of-Paris bandage or with masking tape. This extension will provide the prosthetist with a margin of safety in smoothing the positive stump model without disturbing the desired trim line.

After the inner surface of the check socket has been sprinkled with talcum powder, the

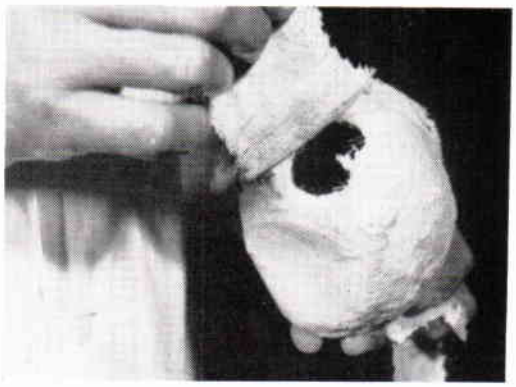

Fig. 32. Closing the distal end of the check socket.

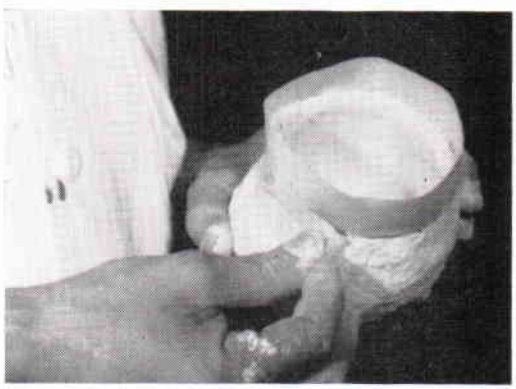

Fig. 33. Construction of extension at proximal end of the check socket.

check socket is filled with liquid plaster of Paris (Fig. 34). Before the plaster hardens, a hollow pipe is inserted into the plaster. A recess approximately 1 in. to 1½ in. deep is made in the plaster at the proximal end of the mold. A small hole, approximately ¼ in. in diameter, should be drilled in the pipe toward the bottom of the recess to facilitate vacuum lamination.

After the positive model has hardened, the check socket is punctured with an awl at the proximal and distal ends of the forearm-extension reference line (Fig. 35). The punctures should penetrate into the positive stump model. An indelible pencil is inserted into the holes to mark the positive model.

The plaster wrap (check socket) is removed, and major irregularities, for example, superfluous plaster, are trimmed from the positive model (Fig. 36). All reference marks should be accentuated on the positive model.

The junction between the positive model of the stump and the mold extension is faired with liquid plaster of Paris to provide a smoothly curved radius (Fig. 37).

The olecranon area on the positive stump model is built up approximately 1/16 in. with liquid plaster of Paris (Fig. 38). This build-up will provide additional relief for this bony prominence.

The distal end of the positive model is built up approximately ½ in. with liquid plaster of Paris. This build-up will increase the length of the socket slightly and provide space for the hole through which the stump sock is pulled (Fig. 39).

The positive model is sanded smooth, and roundhead screws are inserted into the two reference holes made on the lateral side of the

Fig. 34. Check socket filled with liquid plaster of Paris and a hollow pipe inserted into the plaster. The small hole drilled in the pipe will facilitate vacuum lamination.

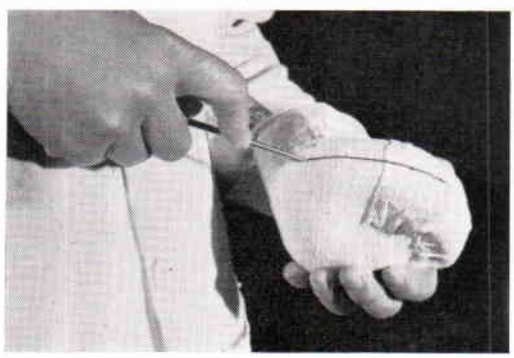

Fig. 35. Puncturing the check socket with an awl in order to mark on the positive model the proximal and distal ends of the forearm extension reference line.

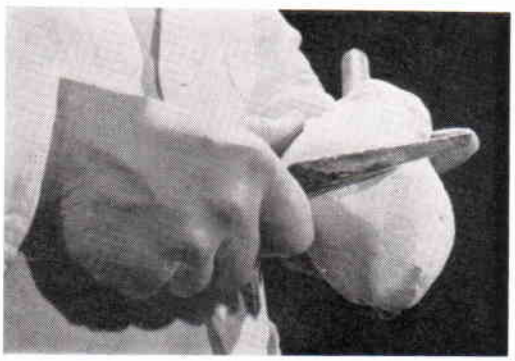

Fig. 36. Trimming irregularities from the positive stump model.

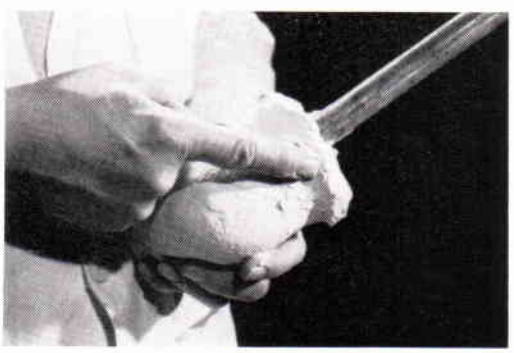

Fig. 37. Fairing the juncture between the positive model and the mold extension.

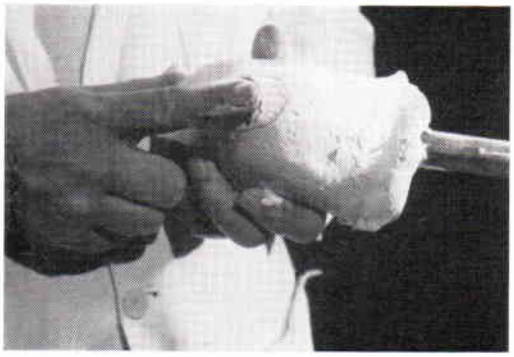

Fig. 38. Building up the olecranon area on the positive model to provide relief for this bony prominence.

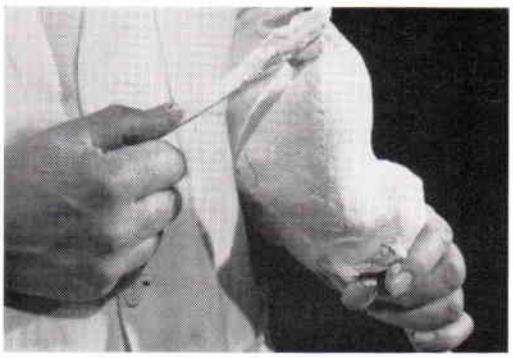

Fig. 39. Building up the distal end of the positive model to increase the length of the socket slightly and to provide space for the hole through which the stump sock is pulled.

model. These screws will produce projections on the laminated socket through which a line will be drawn to align the forearm extension cone.

LAMINATION

Materials required for lamination are:

Drill with ⅛-in. bit
PVA sheets
Dacron blanketing
Nylon stockinette
Polyester resin
Promoter
Masking tape
Vacuum pump
Wrist unit
Manila paper

The socket and forearm shell are laminated in accordance with standard procedures (*6*). Vacuum lamination (*7*) is recommended to provide a truer reproduction of the model.

Holes, ⅛ in. in diameter, are drilled through the undercut areas at the proximal end of the positive model in order to draw the PVA bag into those areas during vacuum lamination (Fig. 40). The holes should exit in the vicinity of the previously mentioned hole in the pipe.

After the stump model has been lubricated, the inner PVA bag, dacron blanketing (for a smoother inner surface), the nylon stockinette, and the outer PVA bag are applied in the usual manner (*6*), under a vacuum pressure of 12 in. of mercury (Fig. 41). (This is equivalent to 5.9 psi.)

Polyester resin is applied in the standard manner (*6,7*). Special attention should be paid to working the resin into the undercut areas (Fig. 42). The layup is oven-cured as usual.

After the socket has cured, an opening is cut in the extreme distal end of the socket (Fig. 43). The hole should be of sufficient diameter to allow the passage of the stump pulling sock.

A reference line is drawn on the outer wall of the socket by connecting the two screwhead projections. A forearm extension cone is applied in the usual manner, with the long axis of the cone coincident with the reference line (Fig. 44).

The lamination procedure for the forearm is the same as for the socket, except that dacron blanketing is not used (Fig. 45). The forearm extension may be laminated as a separate sec-

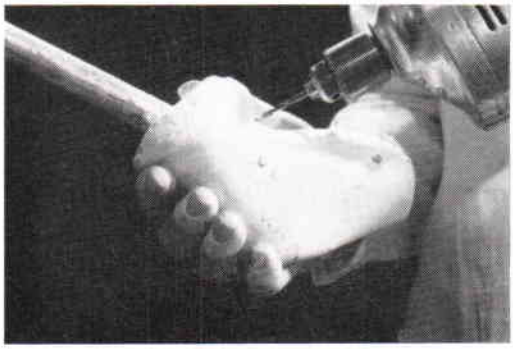

Fig. 40. Drilling ⅛-in. holes through undercut areas at proximal end of the positive model to draw in PVA bag during vacuum lamination.

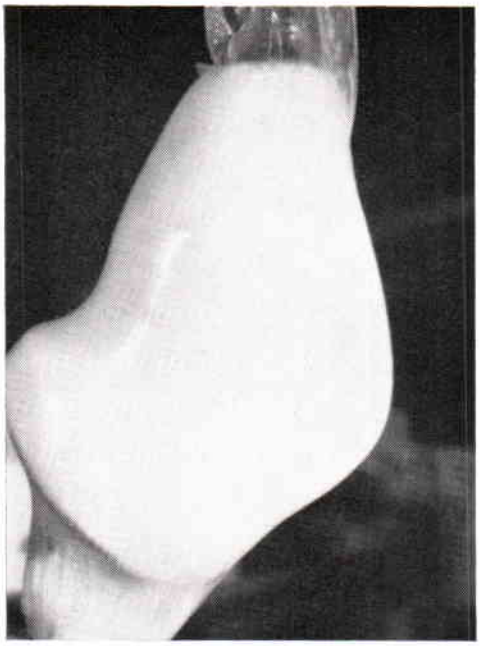

Fig. 41. Inner PVA bag, dacron blanketing, nylon stockinette, and outer PVA bag ready for lamination on lubricated stump model.

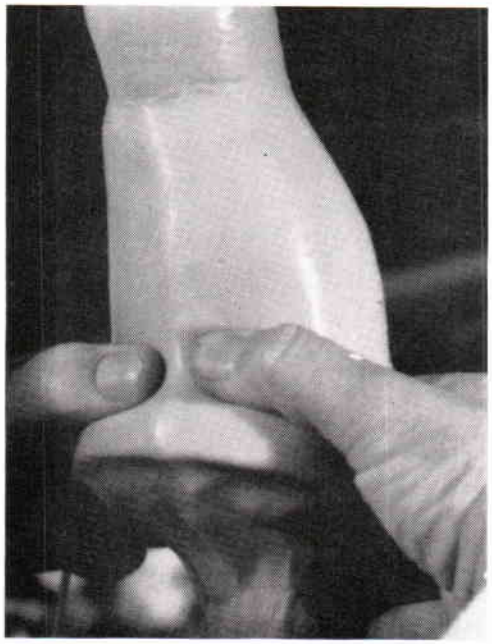

Fig. 42. Working resin into undercut areas.

Fig. 43. Cutting an opening in the distal end of the socket to allow passage of the stump pulling sock.

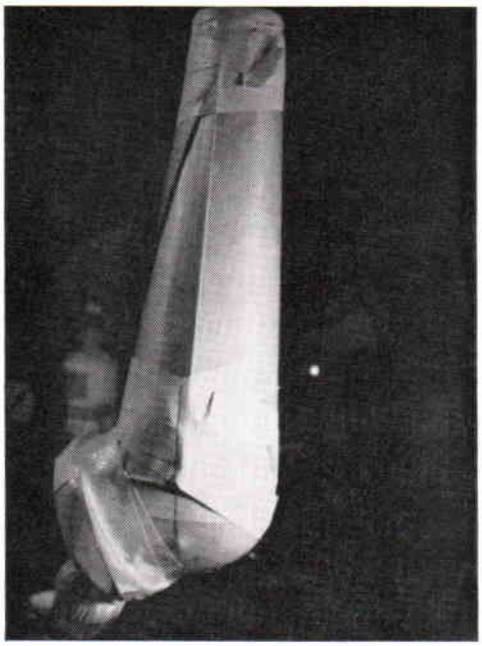

Fig. 44. Forearm extension cone aligned with reference line established by screwheads on socket.

tion or directly over the socket, using a wax melt-out. Both procedures work satisfactorily.

After the forearm laminate has been cured, the prosthesis is cut along the proximal socket brim and the mold is broken out.

FITTING OF THE PROSTHESIS

A 1-in. hole is drilled through the medial wall of the forearm shell close to the distal end of the inner socket to permit passage of the

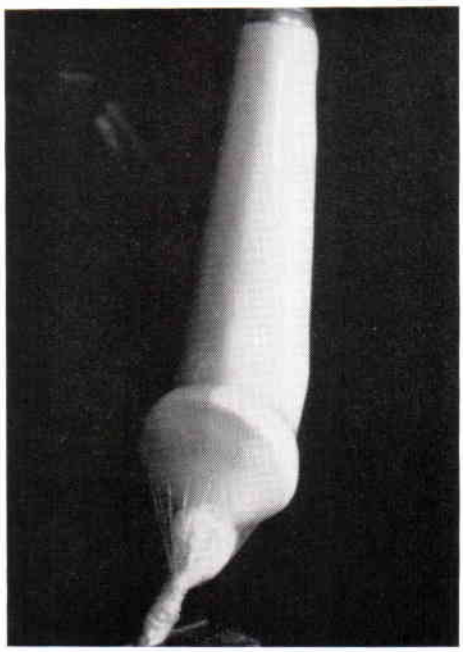

Fig. 45. Forearm extension laminated over socket and cone.

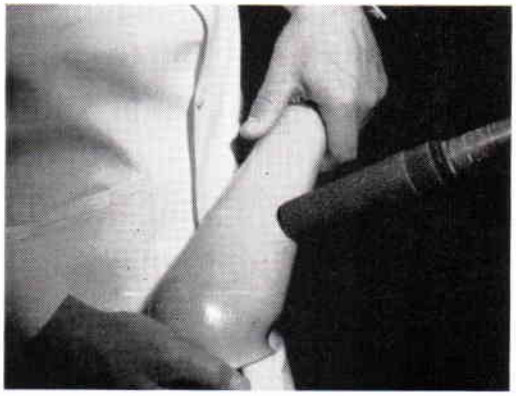

Fig. 46. Polishing the edges of the hole for the stump pulling sock.

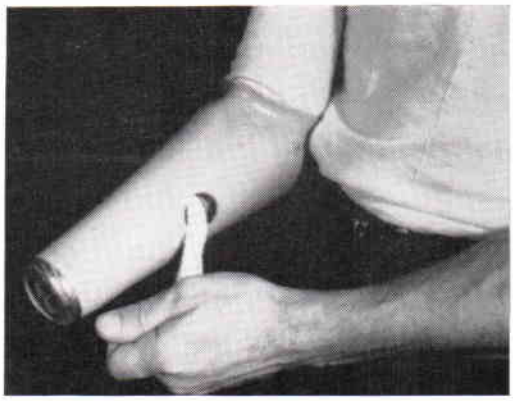

Fig. 47. Application of tension on the stump sock facilitates the complete insertion of the stump into the socket.

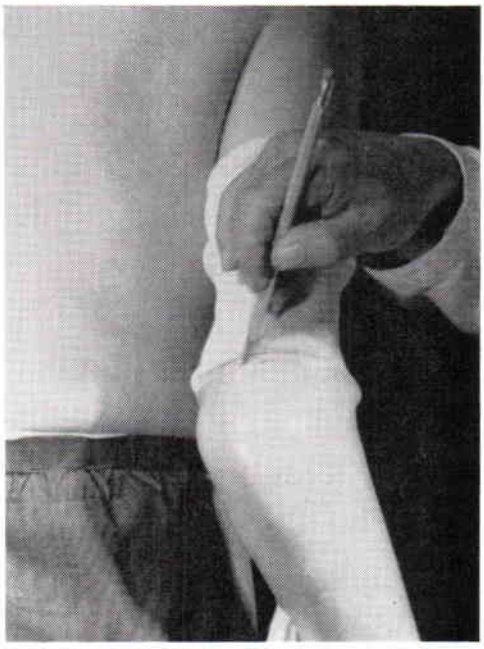

Fig. 48. Checking the adequacy of socket fit.

stump pulling sock. The edges of the hole are polished with a grinding cone (Fig. 46).

Wearing a length of stockinette (approximately 8 to 10 in.) as a stump sock, the amputee inserts his stump into the socket and pulls the distal end of the sock through the hole (Fig. 47). The application of tension on the stump sock facilitates the complete insertion of the stump into the socket. The sock is left on the stump and the end of the sock is tucked into the forearm shell.

The socket is checked for the adequacy of its fit. Reliefs are provided and trim lines are modified (Fig. 48) where necessary for comfort and range of motion.

HARNESSING

Three different harness arrangements have been used successfully at New York University with the Münster-type sockets.

Initially, the arms were fitted with a conventional figure-eight harness with triceps pad, flexible hinges, and inverted Y-strap. However, the intimate stump encapsulation, flexion attitude, and high trim lines of the Münster sockets provide excellent retention and security, and in most cases obviate the need for suspensory apparatus to maintain the socket on the stump. Without harness, the majority of subjects in the New York University study with adult amputees were able to resist high axial loads (in the order of 50 lb.) with negligible socket displacement. In the fitting of child amputees, the same results obtained with axial loads up to one-third of body weight. Hence, the two simplified axilla-loop harness systems which will be described have proved adequate for most patients.

The conventional harness is fabricated according to standard prosthetics practice (*6*). However, because of the integral security of the socket, the size of the triceps pad may be reduced.

In the New York University fittings a triangular triceps pad constructed of light-gauge aluminum covered with leather was used exclusively (Fig. 49). The general pattern of the templates used as a guide in shaping this pad is shown in Figure 50. The exact size of the template for each subject is determined as follows:

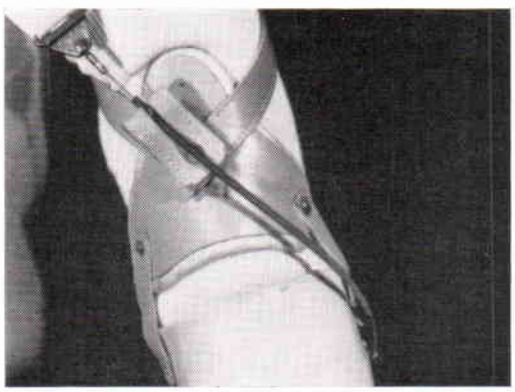

Fig. 49. View of conventional harness showing triceps pad fabricated of light-gauge aluminum covered with leather.

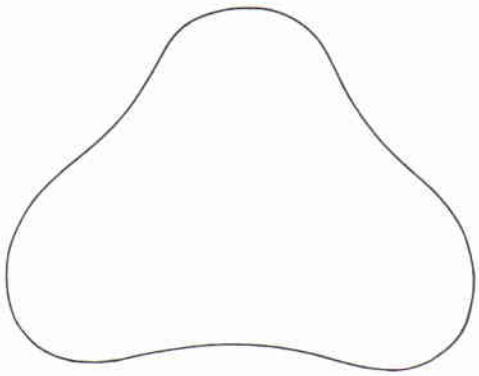

Fig. 50. Pattern of template for triceps pad (not actual size).

1. The width is equal to one-half the circumference of the arm measured just above the epicondyles.
2. The length is three-quarters of the width.

There is no significant functional difference in the two simplified axilla-loop harness systems. In one system the reaction point is located at the proximal socket, while in the other it is located over the triceps. The choice between the two systems depends upon the amputees' preferences regarding the position of their control cables.

To locate the reaction point on the proximal socket, a standard housing crossbar assembly is riveted to the *midline* of the posterior wall of the socket approximately ½ to ¾ in. distal to the proximal brim (Fig. 51). The crossbar portion of the loop is directed upward.

The distal retainer base plate is located on the lateral side of the forearm in the usual manner so that it produces as direct a line of pull as possible between the crossbar and the terminal device.

The cable-housing assembly is attached in the usual manner. The cable should be maintained as short as possible without interfering with function in order to reduce the incidence of the cable rubbing on the flesh or clothing.

The harness is completed with an axilla-loop arrangement (Fig. 51). An additional suspensory strap (that is, a front-support strap) or flexible hinges are not needed.

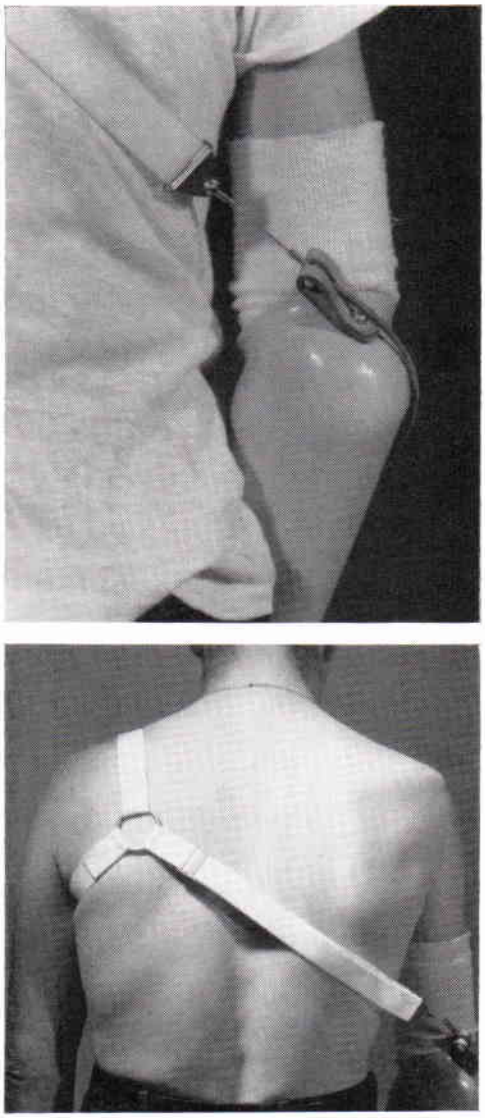

Fig. 51. Simplified axilla-loop harness with reaction point on proximal socket. *Upper*, standard housing crossbar assembly riveted to the midline of the posterior wall of the socket. *Lower*, harness completed with an axilla-loop arrangement.

The simplified axilla-loop system is appropriate for most patients. But some patients will object to the low position of the control cable, which may interfere with the sleeves of shirts or blouses. To meet such objection, the reaction point may be located on a small leather triceps pad (3 in. × 3 in.) (Fig. 52). A small

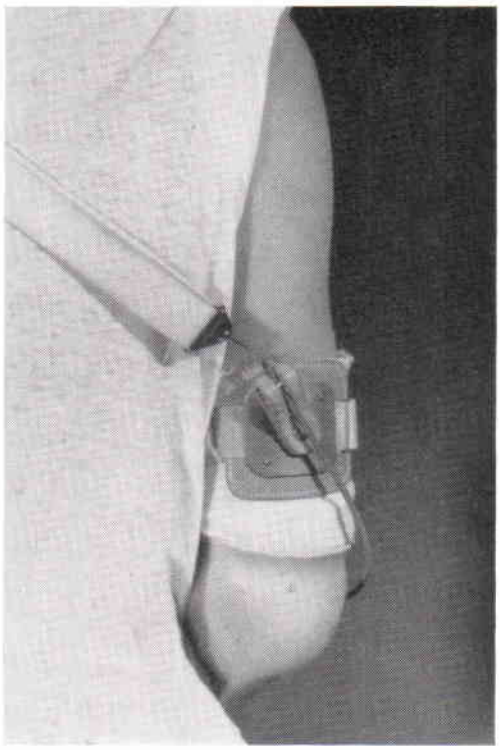

Fig. 52. Reaction point on small triceps pad.

strap, preferably Velcro, is sewn across the middle of the posterior surface of the triceps pad to provide a means of securing the pad to the arm. A standard housing crossbar assembly is attached over the strap and centered on the triceps pad. The distal retainer base plate is placed on the forearm in the same manner as described in the previous system. The cable-housing assembly is attached in the usual manner. The harness is completed with an axilla-loop arrangement.

CHECKOUT PROCEDURES

Standard below-elbow checkout procedures (*1,6*) are applied to the Münster-type prosthesis and the usual requirements should be met except for the following:

1. Since prosthetic forearm rotation is eliminated, the pronation-supination measure is not applicable.
2. Since a decreased flexion range is an integral feature of the socket, the checkout standard of a 10-deg. loss of flexion with prosthesis does not apply. Maximum flexion for most amputees will range between 100 deg.

and 115 deg., which may be approximately 30 deg. less than stump flexion with the prosthesis off.

3. Because of the decreased elbow flexion, the requirement for opening of the terminal device at the mouth may not apply. However, full opening of the terminal device should be available at maximum flexion of the elbow.

In following the checkout procedures, particular attention should be paid to the unique features of these sockets; namely, the critical importance of the fit of the socket around the epicondyles and olecranon and the built-in suspension of the sockets. The application of compression and torque forces (particularly a vertical downward force at the terminal device with the elbow flexed at 90 deg.) should indicate the presence of any pressure areas around the elbow. Additionally the axial-load test (*1,3*)—application of a vertical downward force at the terminal device with the elbow fully extended—should reveal any deficiencies in the suspension feature of the sockets.

It must be recognized, however, that, because of the close fit of the socket over the epicondyles and olecranon, some adults will not be able to tolerate the accepted axial-load standard of 50 lb. (or, for children, one-third of the body weight). Special caution to avoid injury to the amputee should be taken when applying the axial-load force. Failure to meet the 50-lb. standard should not in itself be sufficient cause to reject the prosthesis.

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Special Equipment and Aids for the Young Bilateral Upper-Extremity Amputee[1]

LIESL FRIEDMANN, O.T.R.[2]

CONSIDERABLE information is available concerning the treatment philosophy, prosthetic prescription, and training of the child with a unilateral upper-limb deficiency (*5*). However, there are few published data on adapted equipment for the child with a bilateral upper-extremity deficit. To help remedy this lack, this article presents a brief discussion of the current treatment philosophy at the Institute of Physical Medicine and Rehabilitation in the New York University Medical Center and describes some of the adapted equipment and training procedures that have been found useful for children with congenital bilateral upper-limb deficiencies.

The presentation is essentially confined to children fitted with conventional prostheses. Experience with unilateral and a few bilateral amelic children at the Institute of Physical Medicine and Rehabilitation has led to the conclusion that these patients obtain inadequate benefit from conventional fitting and might do better with externally powered prostheses. However, these prostheses pose their own unique training problems which are not considered here.

[1] This article (*3*) appeared originally in the April 1965 issue of the *Inter-Clinic Information Bulletin*, a monthly publication of the Subcommittee on Child Prosthetics Problems of the Committee on Prosthetics Research and Development, and is being republished in *Artificial Limbs* in the belief that this wider distribution of its useful, practical suggestions will be of interest to readers and will benefit many persons. Preparation of the original article was supported in part by a grant from the Irwin Strasburger Memorial Foundation.

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BILATERAL FITTING RECOMMENDED

The child is fitted as soon as he sits independently. If there are lower-limb deficiencies or other conditions which delay the achievement of sitting balance, assistive devices and training programs are used to facilitate this accomplishment.

It is believed that all children with bilateral upper-limb deficiencies should be fitted bilaterally at the outset for the following reasons:

1. To encourage the performance of bimanual activities and, hopefully, to assist in the development of an appropriate body concept by providing bilateral extremities of equal length.
2. To aid balance and prevent scoliosis.
3. To increase prosthetic tolerance.
4. To prepare for later bilateral prehensile function.
5. To promote eye-hand control of the prostheses.

The considerations listed above outweigh the disadvantages of lack of sensory input from the covered stumps. Since the prostheses are not worn full time by any of these children, ample sensory stimulation of the deficient limbs can be achieved.

TRAINING CONSIDERATIONS

In the training program, the longer stump is developed as the dominant member unless the child shows a strong preference for the shorter limb. If both sides are equal in length, the child's preference is determined by observation.

If the child has lower extremities which can assist in the performance of activities of daily living, use of the feet is encouraged, with loafer-type shoes recommended for easy removal (*4,6*). However, exclusive use of the feet should be discouraged. Pedal skills should be used to assist prosthetic function or in emergencies when the prostheses are not available. Thus,

the feet should be used primarily for activities that cannot be performed with prostheses, although strict rules cannot be applied. The degree to which the lower extremities are used must be a matter of judgment based on the individual case. It should be remembered, however, that if the child becomes too dependent on his lower extremities he will have to learn to reduce foot usage when he reaches the age of social consciousness.

Fitting Modifications

In general, the same standard fitting procedures are used for the bilateral limb-deficient child as are used for the unilateral patient with the following modifications:

1. A 12P hook is fitted immediately but is not activated. Passive mitts are not used.
2. During the passive phase of training (inactive terminal device), a figure-eight harness is used, with a chest strap connecting the two axilla loops added for retention. To prevent the harness from riding up in the back, a vertical strap from the cross of the figure-eight is attached to a waist belt.
3. The usual developmental sequence in a child's perception of the prehensile function of a hook is well known (*6*). In bilateral amputees, the developmental sequence is the same, but is sometimes extended over a longer period. The therapist will usually be able to detect the child's readiness for cable attachment and active use by noting the typical signs of frustration arising from inability to function independently; for example, a sudden, sustained increase in crying, temper tantrums, refusal to wear the prostheses, and similar otherwise unexplainable manifestations. Occasionally, the child will verbalize the desire to do things independently without the prostheses. A reasonable attention span is an imperative requisite.
4. When the child reaches the age of four or five years, bilateral wrist-flexion units are provided.
5. For the very young above-elbow amputee, friction-lock elbow units, which have recently become available, are useful.

Training Procedures

Patients with bilateral limb deficiencies below the mid-humeral level present less of a fitting and training problem than bilateral amelic patients. Nevertheless, they still require specialized training. It is recommended that they be taught the use of one hook at a time and learn pre-positioning of the terminal device by use of the opposite hook, the knee, elbow, chin, or any available hard surface. Training in changing the position of wrist-flexion units by pushing against a hard surface or the opposite prosthesis needs to be given. These patients must also learn to don and remove their prostheses (*5*) and perform the activities of daily living.

Assistive Devices

The pattern of the training program in the New York University Medical Center follows the developmental scale of the normal child as far as possible (*6*). However, it must be remembered that the "child amputee" will eventually become a teen-ager and then an adult. Thus both the physical and psychological aspects of growth should be taken into account in special training programs.

Most of the special training devices used by adults for independence in activities of daily living can also be used by the young teen-ager. However, since training must start at a very early age if independence is to be obtained, devices specifically designed for the very young child must be used initially. The items described in this article are some that have been developed for the patients at the Institute of Physical Medicine and Rehabilitation.

Self-Feeding Aids

The first level of activity training is self-feeding. A swivel spoon[3] possibly with a flat, built-up handle to prevent slipping (Fig. 1) is useful. Initially, the therapist places the

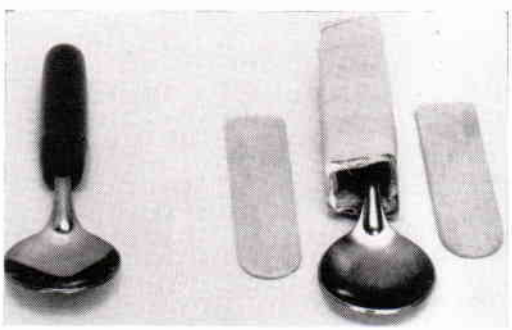

Fig. 1. Straight spoons. The one on the right illustrates a method of building up the handle to prevent slipping when grasped by a prosthesis.

[3] Sta-Level Baby Training Spoon ($1.00); Price Industries, Ltd., 815 East Talmadge Ave., Akron, Ohio.

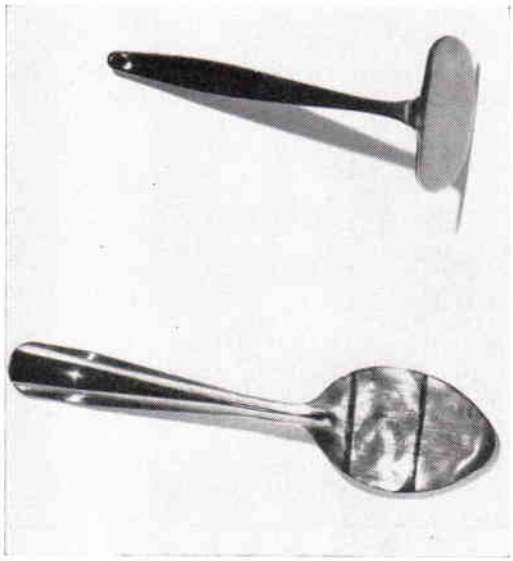

Fig. 2. *Top*, metal pusher formed from flattened spoon. *Bottom*, spoon flattened to make pusher.

spoon into the hook. Later, the child learns to pick up the spoon from the rim of the plate or from the table without assistance. Usually, the child can push the food against the rim of a bowl or against a plateguard. At about four years of age, the child is introduced to the use of a "pusher," a utensil (Fig. 2) commonly used by normal children in Europe. The pusher has been found to be a good pre-knife-and-fork feeding aid. The pusher, which can be made from a flattened and re-shaped teaspoon, is placed behind the "thumb" of the hook on the nondominant side by the therapist. At this stage it is also likely that the child will be able to use a regular teaspoon with a flat handle, bent at an angle which is a compromise between that needed for scooping and the angle needed to get the food to the mouth without spilling.

At six to seven years of age, knife-and-fork usage can be started (Figs. 3 and 4). At first, both utensils are placed behind the "thumbs" by the therapist, but with practice the child learns to do this independently. Bilateral wrist-flexion units are very useful for proper positioning of the utensils as they are maneuvered for insertion into the terminal devices and then for cutting. To prevent plate movement, it is frequently helpful at this stage to

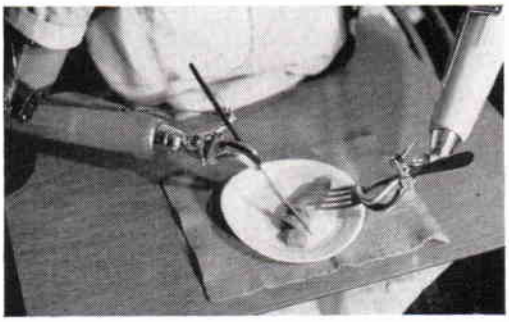

Fig. 3. Use of knife and fork for cutting.

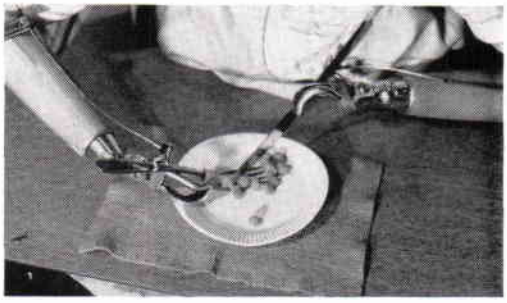

Fig. 4. Use of knife and fork for peas.

use a damp, flat foam-rubber sponge, wet paper towel, or adhesive foam rubber attached to the bottom of the plate. Correct table height is important in reducing shoulder abduction during eating. With the prostheses in complete abduction, the elbows should barely touch the table.

When teaching drinking with a cup, a plastic, flat-handled cup[4] should be used initially. If necessary to prevent spilling when the cup is placed on the table, a lid (Fig. 5) may be provided. At this stage, the child can grasp and release actively but has not yet learned to pre-position the hook. This must be done by the therapist. When the child is able to pre-position the hook (three to four years of age), a regular plastic or paper cup can be introduced. Such cups must be held by the upper rim from above (Fig. 6).

In the public schools of New York City, children are provided soup and a sandwich for lunch. These items are most difficult to handle

[4] Baby Cup, KT5, with flat double handle and lock lid (50 cents); Kayware Corp., 2731 North Crawford Ave., Chicago, Ill.

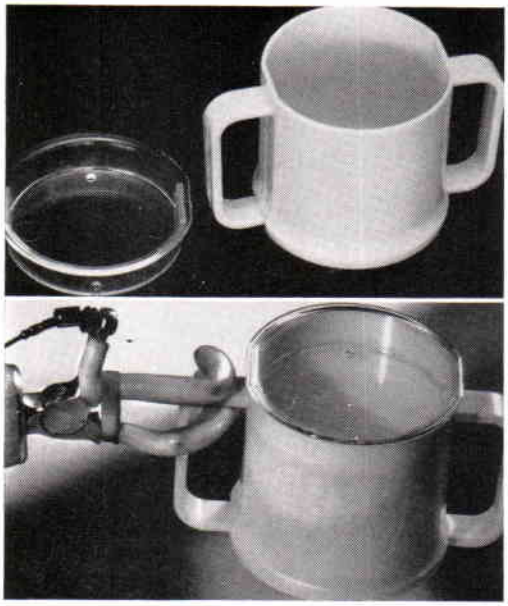

Fig. 5. Cup equipped with cover to avoid spilling.

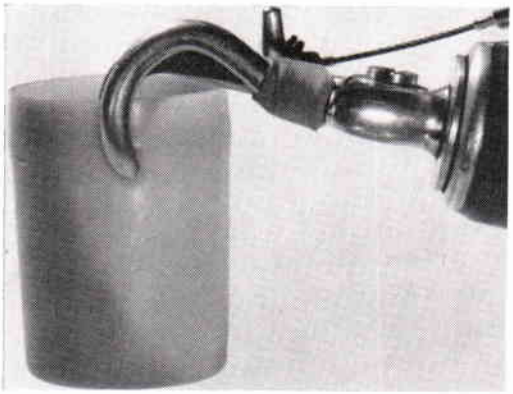

Fig. 6. Plastic cup held at rim.

with a prosthesis. Soup should be sipped from the cup or through a straw, but the child cannot control his prosthesis well enough to prevent mutilation of a sandwich. At the Institute of Physical Medicine and Rehabilitation, a sandwich holder has been devised which is used successfully by some children. The teacher or a parent must insert the sandwich, but the child can then eat it from the holder (Fig. 7).

Dressing Aids and Adapted Clothing

The amount and type of dressing activities performed by the bilateral upper-extremity

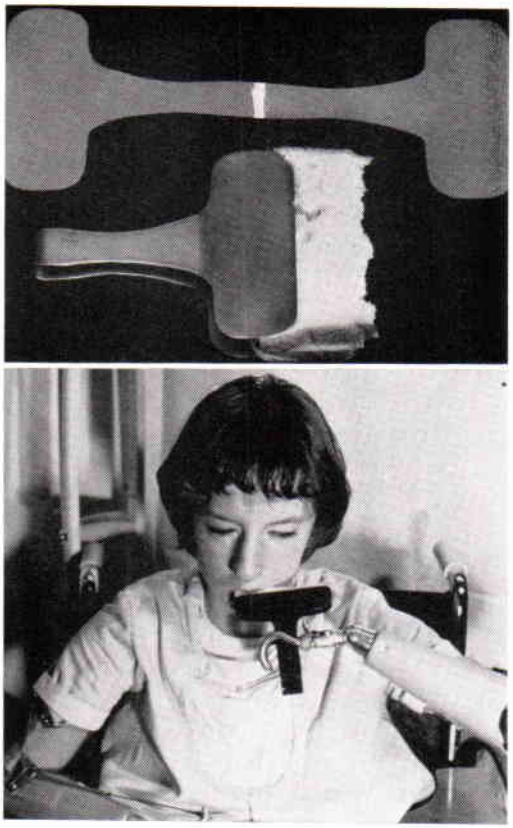

Fig. 7. Sandwich holder.

amputee vary greatly from one child to the next. For these patients the combined use of feet and teeth may be required.

To don his prostheses the child must first put on his stump socks and then maintain them in position as he maneuvers his stumps into the sockets. This feat is not very difficult for the bilateral below-elbow amputee, but if one or both of the limbs are deficient above the elbows, the socks tend to fall off. Others (*6*) have described a bilateral stump sock which is useful. At the Institute of Physical Medicine and Rehabilitation, a connecting piece has been added to this bilateral stump sock to protect the back and axillary skin from irritation (Fig. 8). There is no commercial source for this item at present.

Adolescent girls frequently find a front-opening brassiere useful. The standard item can be easily converted into a front-opening type by sewing up the back, opening the front

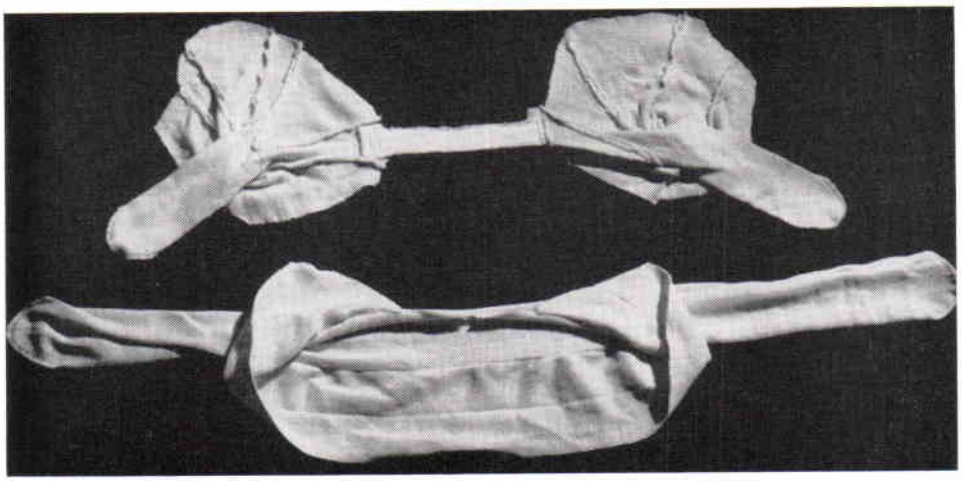

Fig. 8. Bilateral stump socks.

Fig. 9. Front-opening brassiere.

Fig. 10. Modified underpants.

and fastening it with a long Velcro strap and D-ring (Fig. 9). To close the top, a supplementary smaller strap with Velcro or a large hook on an elastic strap may be used. Sleeveless dresses split below the waist and with an open back are helpful.

The major training problem is toileting, which is particularly difficult for females. If a female child does not have normal lower extremities or at least toes able to function sufficiently in grasping clothing or toilet paper at the proper body level, life-long dependency in this function may have to be accepted. In using bilateral upper-extremity prostheses for assistance in toileting, it is a problem to get the prostheses close enough to the body to adjust the underpants while wearing a dress, even with elbow turntables and bilateral wrist-flexion units.

Some children have successfully used modified underpants which do not have to be removed. The crotch of the undergarment is split and refinished with binding (Fig. 10). The opening should close when the child is in the erect position. When the patient sits on the

toilet seat, with the trunk flexed on the thighs and the lower limbs abducted, the opening is sufficiently wide to prevent soiling of the garment. With practice, the use of toilet paper can usually be mastered without special devices. Sometimes, however, the solution of this problem requires the development of special reaching devices which are highly individualized. Female patients usually find tampons much superior to sanitary napkins.

Schoolwork Aids

For the bilateral amputee to function effectively in school, adaptation of equipment is required in many activities. For example, cutting with scissors is an impossible task with the standard item. Figure 11 illustrates a simple and very satisfactory adaptation in which one handle of the child's scissors is embedded in a small piece of wood (1½ in. × 1 in. × ½ in.). The lower handle of the scissors is placed in a groove made with an X-acto knife and held in place with plastic wood. When the scissors are positioned in the wood block, the tip should touch the table. The axis of the two blades should not be tight and the blades should fall open with ease. The child holds the upper handle of the scissors with the hook tines pointing downward. As the handle of the scissors is pulled up and down, the block of wood rides flat on the table surface. In learning to use the adapted scissors, the child should start with straight lines on paper and then include gentle curves and corners and, finally, complex figures. Such scissors are effective only with paper; cloth cutting requires the use of electric scissors (Fig. 12). For cutting thread on a sewing project, a seam ripper is very useful (Fig. 13).

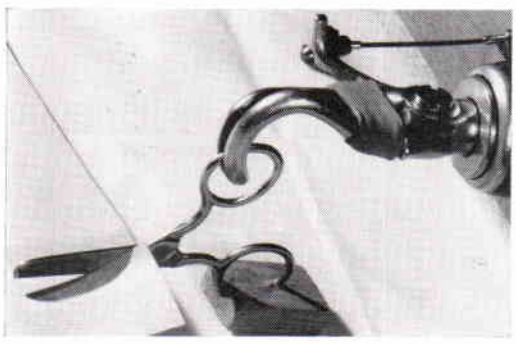

Fig. 11. Scissors with one handle embedded in wood. Plastic wood holds the handle in place.

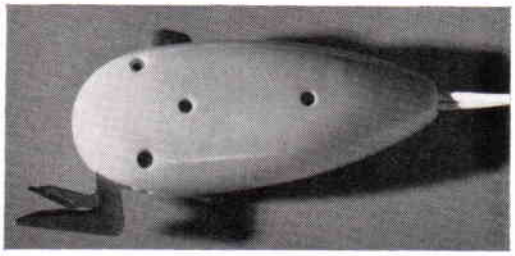

Fig. 12. Electric scissors.

Fig. 13. Seam ripper.

Writing can be facilitated by the use of a clipboard or attaching the paper to the table with masking tape, rather than letting the child struggle to hold the paper steady with his nondominant prosthesis. Chalk holders which prevent the chalk from breaking and improve blackboard writing efficiency are available commercially (6). A pencil holder has also been described (*1*). A simpler crayon-holding device has been used for very young patients at the Institute of Physical Medicine and Rehabilitation (Fig. 14). This holder consists of a wood block (6 in. × 2 in. × 2 in.) with a series of holes drilled at angles to enable the child to withdraw and reinsert the crayon without having to pre-position the crayon. Unless the child presses down very hard, the crayon will not slip from the hook. If a thin layer of foam rubber is glued to the bottom of the wood block, it will not slip on the table. Some older children cannot use their other hook to insert a pencil behind the "thumb" for stability. When clamped to the edge of the table, a simple block of wood with a single deep hole (Fig. 15) is effective in holding the pencil so that it may be properly grasped. In time, the

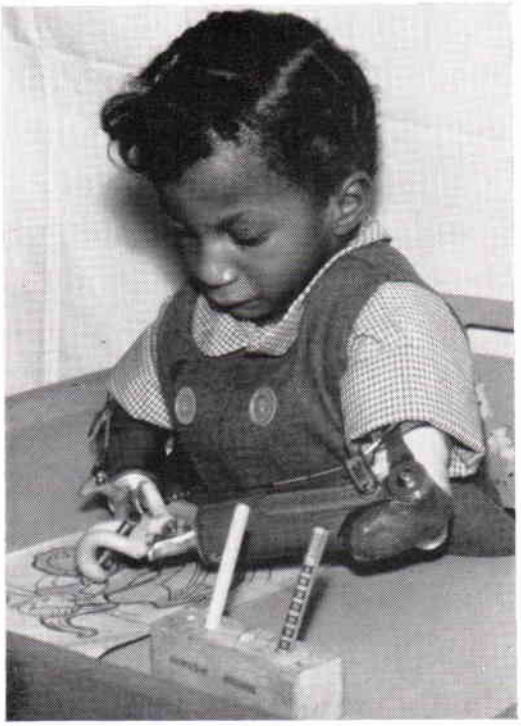

Fig. 14. Crayon holder fashioned from wooden block.

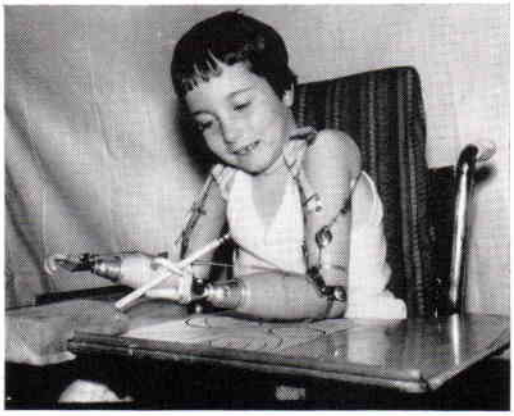

Fig. 15. Pencil holder clamped to edge of tray.

child learns to pick up and position the pencil without special devices.

Sewing and Knitting Aids

It is possible for a bilateral upper-extremity amputee to learn knitting and sewing. One needle with the knitting on it can be inserted in a vise (Fig. 16), while the other needle is held behind the "thumb" in the dominant prosthesis. The wool is laced around the needle by

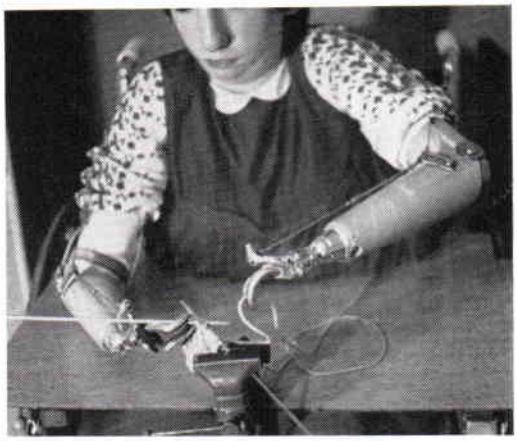

Fig. 16. Small vise used to hold knitting needle.

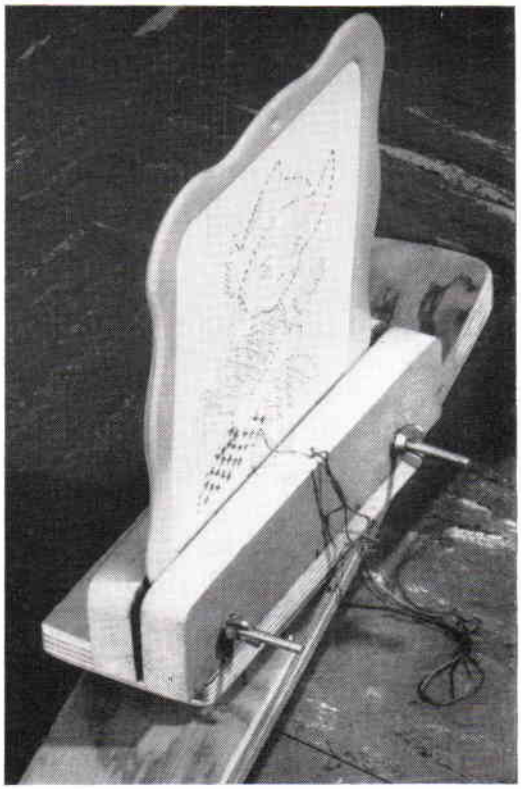

Fig. 17. Frame to hold sewing card, mounted on ball bearings to swing freely on pivot.

the nondominant hook. Thick needles and wool should be used. Sewing can be made easier by use of a frame mounted on a pivot with ball bearings (Fig. 17). Many four- and five-year-old children enjoy sewing cards or doing simple cross-stitch work. This is an excellent activity for training the child to achieve minimal opening of one hook at a time.

Constant Modification Necessary

It is hoped that other therapists will find these suggestions useful and that they will report special devices that they have used successfully. Finally, it should be emphasized that, although a variety of assistive devices, including the feet, are used by young children with bilateral upper-extremity deficiencies in performing the activities of daily living, the problem changes as the child grows older. The physical growth and social consciousness characteristic of the teen-ager may preclude the use of techniques that were acceptable in the younger child. Constant alertness to the need for modification of techniques is required to meet the changing physical and psychosocial needs of the developing child.

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Review of Visual Aids for Prosthetics and Orthotics[1]

Prosthetics (General)

"A Day in the Life of the Amputee," Hosmer-Dorrance, 1955, 26 min., color, silent, 16 mm.

Summary: Presents a bilateral upper-extremity amputee as he performs a number of activities related to self-care, work, and recreation. These include fishing, bowling, gardening, dressing, eating, playing pool, driving a car, and lighting a cigarette.

Evaluation: A technically well-executed film of a man who has acquired unusual skill in the use of the prostheses. It is recommended for upper-extremity amputees and for professional groups who wish to become familiar with the potential accomplishments of this type of amputee. Essentially, its purpose appears to be to encourage upper-extremity amputees to use prostheses and to develop maximal skill in their use.

Distributor: A. J. Hosmer Corporation, P. O. Box 37, Campbell, Calif. 95008.

„A Triple Amputee Steps Out," U.S. Veterans Administration, 1964, 25 min., color, sound, 16 mm.

Summary: Shows the rehabilitation of a male adult with an above-knee amputation on one side, a below-knee amputation on the other, and a unilateral above-elbow amputation. The patient also suffers from heart and kidney complications that add to the difficulty of rehabilitation. Preprosthetic exercises and balancing activities are followed by ambulation with stubbies and, finally, with permanent prostheses and crutches.

Evaluation: The level of rehabilitation for this severely involved patient appears unrealistic; and, although he finally ambulates, the gait is labored and unsteady. Use of the upper-extremity prosthesis, which would seem a more useful activity for this patient, is not discussed. This film has little place in paramedical teaching and would be of interest only to note the accomplishments of this unusual and highly motivated amputee.

Distributor: Central Office Film Library, Veterans Administration, Vermont Ave. and H St., N.W., Washington, D.C. 20420.

"Diary of a Sergeant," U.S. War Department, 1945, 22 min., black and white, sound, 16 mm.

Summary: The story of a soldier (Harold Russell) who, having lost both arms during World War II, wages a determined and successful fight to achieve success in the use of artificial limbs and to establish himself as a useful member of society.

Evaluation: An excellent film for its era. It has lost much of its value, however, through the passage of time and today is primarily of historical interest. It deals with the emotional trauma involved in loss of arms and portrays the courage required by an amputee to achieve his rehabilitation goals. For these reasons, the film may still serve a purpose when used to

[1] This review was compiled by an *ad hoc* committee appointed by the Subcommittee on Prosthetics in Paramedical Education of the Committee on Prosthetic-Orthotic Education. Chairman of the *ad hoc* committee was Mrs. Florence S. Linduff until her appointment as Consultant, Physical Therapy, Division of Training, Vocational Rehabilitation Administration, Washington, D. C. Members are Miss Nancy Ellis, Associate Director, Occupational Therapy Courses, College of Physicians and Surgeons, Columbia University, New York, N. Y.; Miss Jamie Lisle, Director of Physical Therapy, Medical College of Virginia, Richmond, Va.; Miss Lena M. Plaisted, Professor of Rehabilitation Nursing, Boston University School of Nursing, 264 Bay State Rd., Boston, Mass.; Miss Mary Poole, Director, Department of Social Work, University of Pennsylvania Hospital, Philadelphia, Pa.; and Colonel Ruth A. Robinson, Army Medical Specialist Corps, U. S. Army (Ret.), 1325A Worcester Rd., Framingham, Mass. (*ex-officio* member).

The Committee on Prosthetic-Orthotic Education is supported by the Training Division of the Vocational Rehabilitation Administration and by the Prosthetic and Sensory Aid Service of the Veterans Administration.

motivate discouraged upper-extremity amputees or when shown to groups concerned with the emotional impact caused by crippling disease or injury.

Distributor: Central Office Film Library, Veterans Administration, Vermont Ave. and H St., N.W., Washington, D.C. 20420.

"Dynamic Exercises for Lower-Extremity Amputees," U.S. Veterans Administration, 1959, 10 min., color, sound, 16 mm.

Summary: Reviews normal gait and the relationships of body segments during walking. Following the physician's examination of the above-knee stump, the amputee patient demonstrates a series of dynamic exercises to develop balance, coordination, and strength. These exercises are part of a physical-therapy program that prepares the amputee to meet daily functional demands. Several amputee gaits are demonstrated.

Evaluation: This is a large order for a ten-minute film, particularly since it goes beyond the scope of the title. The exercises *per se* are excellent, but the rate at which they are presented limits the use of the film as a teaching device. A patient-to-patient type of teaching contributes to some worthwhile scenes. The film is considered useful for those who are previously oriented in the techniques of dynamic exercises and who are experienced in working with amputees.

Distributor: Central Office Film Library, Veterans Administration, Vermont Ave. and H St., N.W., Washington, D.C. 20420.

"Gait Analysis," Northwestern University Medical School, 1961, 27 min., color, sound, 16 mm.[2]

Summary: Demonstrates the most common gait defects that may be seen in an above-knee amputee, including circumduction, abduction, vaulting, medial and lateral whips, instability of the knee, long prosthetic step, and others. The defects are shown on a subject wearing an adjustable above-knee prosthesis and are described in detail, then discussed as to possible causes, considering the amputee, the stump, and the prosthesis. Demonstrates a normal gait so that comparison between normal and abnormal gait can be made. The narration is conducted by a physician, a prosthetist, and a physical therapist, all faculty members of the Prosthetic-Orthotic Education Program at Northwestern University Medical School. A pocket-size folder that summarizes the material presented has been prepared for use as a handout at showings.

Evaluation: This is a valuable teaching film. Ample time is allowed for the viewer to observe each gait deviation, making it possible for him to correlate the movie sequence with the material presented in the booklet that accompanies the film. Recommended for all medical groups concerned with the management of the lower-extremity amputee, including physicians, physical and occupational therapists, nurses, and prosthetists, at both the student and the graduate levels. The amputee patient would also benefit from seeing this film.

Distributor: American Academy of Orthopaedic Surgeons, 29 East Madison St., Chicago, Ill. 60602.

Rental Fee: $3.00.

"New Geriatric Prostheses Adaptable to Bilateral Amputees," Waterbury Hospital, Waterbury, Conn., 1964, 10 min., color, silent, 16 mm.

Summary: Describes an above-knee prosthesis designed for use by the geriatric patient and points out the advantages of certain modifications over the more conventional "temporary" prosthesis. Demonstrates the use of these prostheses as fitted to a bilateral amputee, a 64-year-old woman.

Evaluation: This film would be of interest only to those who are dealing with the problems of prescribing, designing, or fabricating prostheses for the geriatric patient. The graphic description of the prosthesis is well presented.

[2] Enhancing the value of this film and intended to be used in conjunction with it are 16 loop films, each of which depicts one gait deviation. These loops are 7 ft. in length and can be rerun an indefinite number of times on standard projectors. The set may be purchased for $25.00. When the film is ordered, a check in this amount should be made payable to the distributor: Ideal Picture Co., 417 North State St., Chicago, Ill. 60610.

Distributor: Dr. Sung J. Liao, Director, Department of Physical Medicine and Rehabilitation, Waterbury Hospital, Waterbury, Conn.

"New Legs," National Council for Care of Cripples, South Africa, 1960, 18 min., color, sound, 16 mm.

Summary: Presents the case history of a young railway plate-layer who suffered an accident that ultimately resulted in a bilateral hip disarticulation. He is fitted with a pair of prostheses that incorporate double-action hip joints. Following a training program, he is shown walking with prostheses and crutches and participating in many physical activities with and without the prostheses.

Evaluation: The purpose of this film is to encourage people living in South Africa to support rehabilitation through the purchase of Easter Seal stamps. Perhaps this accounts for the optimistic tone of this technically excellent picture. The amputee is unusually cheerful, physically agile, and well motivated, and his well-planned rehabilitation program is highly successful. This film might be of interest to the patient and family. For paramedical groups it is of interest only to show the potential achievement of one amputee with a bilateral hip disarticulation.

Distributor: Film Library, International Society for Rehabilitation of the Disabled, 219 East 44th St., New York, N. Y. 10017.

Rental Fee: $10.00. (No rental fee for members in good standing with the International Society.)

"Normal Human Locomotion," University of California at Los Angeles, 1965, 3 hr., black and white, sound, 16 mm.

Summary: This seven-reel film reproduces a classroom lecture as presented by Cameron B. Hall, M.D., in the UCLA courses in lower-extremity prosthetics. In his presentation, Dr. Hall graphically describes the normal pattern of human locomotion and explains it in terms of pertinent basic principles, including determinants of gait and mechanical forces. The film is printed at a contrast level that permits it to be shown in a partially lighted room, thereby allowing viewers to write on the illustrated lesson sheets provided with the film.

Evaluation: The film is of special value. It encompasses a difficult subject on the basis of research from voluminous literature, and it is organized in a clear, concise, and understandable manner.

No attempt is made to achieve a technically perfect film; it comes "as is" from the classroom. Dr. Hall's teaching methods, which include skillful execution of illustrations, a keen sense of timing, and—most important—a sequential, organized presentation of materials, combine to make this film an excellent teaching device for both students and instructors.

The film is highly recommended for any professional person engaged in gait training or concerned with any aspect of human locomotion. Its use in undergraduate programs will vary according to the teaching talents of the faculty members and the curriculum content. If the length precludes showing it in one session, it can be shown in two or three sessions. It is recommended that instructors review the film in order to strengthen their own teaching methods and to determine in what way it can supplement or reinforce instruction in their own particular situation.

Distributor: American Academy of Orthopaedic Surgeons, 29 East Madison St., Chicago, Ill. 60602.

Rental Fee: $3.00. (The film may be retained by the borrower for a maximum time of two weeks. Requests for the film should indicate the number of lesson sheets desired.)

"One Step at a Time," Rehabilitation Institute of Montreal, 1963, 15 min., black and white, sound, 16 mm.

Summary: Portrays a unilateral above-knee amputee who is first seen walking with crutches but without an artificial limb. After considerable introspection, this young male decides to be prosthetically fitted. As the story unfolds, it depicts his reaction to the various steps in the rehabilitation program. The three key people responsible for the program—the physician, the physical therapist, and the

prosthetist—are presented, and their roles are briefly explained. The prosthetist plays the major role in this film.

Evaluation: The close-ups, the music, and the general tone of this picture are designed to show the emotional impact on the amputee of the various situations that evolve during the rehabilitation process. The movie is photographically artistic and technically good. Its use to professional people is limited, however, because of the superficial manner in which the material is handled. It appears to be directed toward the layman and especially toward the unfitted amputee.

Distributor: National Film Board of Canada, 690 Fifth Ave., New York, N. Y. 10019.

Purchase Cost: $75.00. (Available for review if viewer is interested in purchasing the film.)

"Physical Therapy Management of a Bilateral Lower-Extremity Amputee," U.S. Army, (PMF 5382), 1964, 32 min., color, sound, 16 mm.

Summary: Illustrates the progression of physical-therapy procedures in the management of the amputee, following the program from the day preprosthetic stump exercises are initiated until the time skillful use of the prostheses is achieved and the amputee—a military officer—is returned to duty as an instructor. The various procedures include bandaging of the above-knee and below-knee stump, joint measurement, stump exercises, stump hygiene, care of the suction socket, body-strengthening and balancing exercises, gait training and analysis, and advanced functional activities. Also, briefly presented are the principles involved in fitting two types of prostheses, the suction socket and the patellar-tendon-bearing socket.

Evaluation: The film is technically superior and professionally sound. Of particular interest and worthy of mention are the well-presented progression of exercises, the clear graphic descriptions, the inclusion of training with the patellar-tendon-bearing prosthesis, and the portrayal of the exacting self-discipline required by the patient.

Although the rehabilitation team is acknowledged, the film is presented entirely from the physical therapist's point of view. Because of the extensive amount of material in this film, its primary value lies in an orientation to a good physical-therapy program rather than its use in teaching skills. It is recommended for viewing by physical therapists and students, and also by any of the allied medical professions who have an interest in the management of the amputee. New amputees would also appreciate this preview of the treatment program.

Distributor: Requests for Army Medical Service motion pictures should be directed to the Commanding General, Attn.: Audio-Visual Communication Center, of the Army Area in which the requesting individual or institution is located, as follows: First U.S. Army, Governors Island, N. Y. (includes Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont); Second U.S. Army, Fort George Meade, Md. (includes Delaware, Kentucky, Maryland, Ohio, Pennsylvania, Virginia, and West Virginia); Third U.S. Army, Atlanta, Ga. (includes Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, and Tennessee); Fourth U.S. Army, Fort Sam Houston, Tex. (includes Arkansas, Louisiana, New Mexico, Oklahoma, and Texas); Fifth U.S. Army, 1660 East Hyde Park Blvd., Chicago, Ill. (includes Colorado, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Wisconsin, and Wyoming); Sixth U.S. Army, Presidio of San Francisco, Calif. (includes Arizona, California, Idaho, Montana, Nevada, Oregon, Utah, and Washington).

"Some Biomechanical Methods for Evaluating Activities," VA Prosthetics Center, 1956, 18 min., color, magnetic sound (requires special projector), 16 mm.

Summary: Shows some of the biomechanical methods used in the laboratory to measure the effectiveness with which both normal and handicapped people can perform various activities. Various photographic, mechanical, and electrical techniques are demonstrated.

Evaluation: This interesting film deals with research methodology and is, therefore, of interest primarily to individuals engaged or interested in research.

Distributor: Research and Development Division, Prosthetic and Sensory Aids Service, Veterans Administration, 252 Seventh Ave., New York, N. Y. 10001.

"Suction Socket Artificial Limb," U. S. Veterans Administration, 1951, 24 min., color, sound, 16 mm.

Summary: Describes the suction-socket prosthesis in terms of the anatomical principles involved in its fabrication and fitting. Presents the indications and contraindications for its prescription, emphasizing the importance of the emotional maturity of the patient. Demonstrates briefly gait abnormalities and training. Also illustrates check-out procedures.

Evaluation: Although made in 1951, this excellent film is valuable in its presentation of a type of above-knee prosthesis that continues to be widely used. This film is of greatest value to physicians, prosthetists, and physical therapists, both staff and students. As background information, it could be useful for anyone concerned with the management of the above-knee amputee.

Distributor: Research and Development Division, Prosthetic and Sensory Aids Service, Veterans Administration, 252 Seventh Ave., New York, N. Y. 10001.

"The Urban Maes Amputation for Peripheral Vascular Disease," U. S. Veterans Administration, 1956, 14 min., color, sound, 16 mm.

Summary: Demonstrates the Urban Maes operative technique of below-knee amputation in a patient with disease of compromised circulations. Shows the healed stump and joint range of motion some weeks later. Also presented are several other patients whose treatment management is similar. Several views of stumps are shown, and the patients are seen ambulating on a temporary pylon as well as on the permanent prosthesis.

Evaluation: Primarily of value to physicians. Because of its relative simplicity, however, the film would be a good selection to illustrate a well-defined surgical procedure to individuals who have not observed actual surgery.

Distributor: Central Office Film Library, Veterans Administration, Vermont Ave. and H St., N.W., Washington, D.C. 20420.

"Total Rehabilitation of a Bilateral High Upper-Extremity Amputee," U. S. Veterans Administration, 1959, 30 min., color, sound, 16 mm.

Summary: Stresses the roles of all members of the rehabilitation team in the management of this amputee. Illustrates the team approach in establishment of the program—examination and supervision by the physician; preprosthetic preparation of the stump and an exercise program by the physical therapist; prosthetic training by the occupational therapist; and vocational guidance by the counselor. Most of the time in this film is devoted to occupational therapy, and the amputee is shown in several learning situations involving functional activities.

Evaluation: The scenes that show how the patient encounters difficulty in performing normally simple chores and how the patient and the therapist work together to find an efficient method of performance are well presented. Although the film does not attempt to present a step-by-step prosthetic training program, the omission of any reference to solving toilet problems, a real concern with this type of amputee, is unfortunate. The team approach is somewhat overemphasized in the film, particularly insofar as the meetings are concerned. This film has teaching value for occupational therapy students and for occupational therapists who have had limited experience in working with patients with upper-extremity amputations. It may also be useful as an orientation for any paramedical group whose members are concerned with the management of the high upper-extremity amputee.

Distributor: Central Office Film Library, Veterans Administration, Vermont Ave. and H St., N.W., Washington, D. C., 20420.

"Upper-Extremity Prosthetics," U. S. Veterans Administration, 1952, 23 min., color, sound, 16 mm.

Summary: Presents two veterans, both of whom are upper-extremity amputees. One

wears his prosthesis successfully; the other keeps his device in his desk. The film explains the dynamics leading to this difference. The successful patient is portrayed as the recipient of services offered in a well-planned amputee management program. The absence of such a program, together with other deterrent factors, is presented as the cause for the second patient's rejection of his original prosthesis. A program designed to correct his reluctance to wear the prosthesis is outlined.

Evaluation: This film succeeds in achieving its objectives, as it clearly demonstrates the importance of good technical and psychological management of the amputee patient. It is not recommended as a teaching film, for it is lacking in its portrayal of the ideal training program. It is recommended as a general type film for paramedical groups and for patients who might be resistant to the intensive effort needed to obtain maximal use of the prosthesis.

Distributor: Central Office Film Library, Veterans Administration, Vermont Ave. and H St., N.W., Washington, D. C. 20420.

"Upper-Extremity Prosthetic Principles," U. S. Veterans Administration, 1955, 29 min., color, sound, 16 mm.

Summary: Demonstrates several interesting activities that were part of a research program aimed at improving upper-extremity prosthetic devices. Of special interest are the demonstration of normal movements of the human hand in a variety of grasping and gripping activities, an analysis of lost movements at various levels of upper-extremity amputation, and the types of upper-extremity prostheses appropriate for specific levels of amputation.

Evaluation: As far as paramedical groups are concerned, this film is of interest to those who would like to be better informed about the development of prosthetic devices. It could be used to illustrate components of prostheses when these are not available, although it should be remembered that only those prosthetic devices in use prior to 1955 are included.

Distributor: Central Office Film Library, Veterans Administration, Vermont Ave. and H St., N.W., Washington, D. C. 20420.

Child Prosthetics

"Adaptation of Children to Prosthetic Limbs," Michigan Crippled Children Commission, 1960, 20 min., color, optical and magnetic sound, 16 mm.

Summary: Presents five children, including upper- and lower-extremity amputees, each of whom demonstrates a wide range of physical activities while wearing his prosthesis. The disability of the child and the indicated prosthetic fitting are also presented.

Evaluation: This film demonstrates well how the artificial limb becomes an integral part of the body image at an early age. The remarkable skill and agility with which these children perform various physical activities are impressive. Some scenes are unnecessarily prolonged and repetitious. The technical quality of the film is not good, and prosthetically it is primarily of historical interest. Of possible interest to parents in demonstrating potential achievement.

Distributor: Michigan Crippled Children Commission, The Area Child Amputee Program, 920 Cherry St., S.E., Grand Rapids, Mich. 49506.

"Child Upper-Extremity Amputee," University of Michigan Medical Center, 1964, 19 min., color, sound, 16 mm.

Summary: Presents ten child amputees and portrays their accomplishments in use of an upper-extremity prosthesis at specified ages, covering a span of several years in some instances. The x-rays of the involved extremities are shown, and a pictorial description of the amputation or limb deficiency is given. In cases of congenital amputees, diagnoses are given in terms of roentgenographical appearance. The type of prosthesis prescribed for each child and the changes necessitated by his growth and development are shown.

Evaluation: A well-presented, informative film that graphically portrays the accomplishments that may be expected of the child amputee who has the advantage of an early treatment program. It points out clearly the disadvantage to the child when prosthetic fitting is delayed. An orientation film of a specialized nature, it should be of interest to any

professional person involved in the care of the child amputee. Parents of child amputees could also benefit by seeing this film. It is recommended for public health nurses who are in a position to refer the young amputee to the amputee clinic.

Distributor: Audio-Visual Education Center, University of Michigan, Frieze Building, 720 East Huron St., Ann Arbor, Mich. 48104.

"Child Prosthetics Project: A Report," University of California at Los Angeles, 1958, 22 min., color, sound, 16 mm.

Summary: Explains the role of each member of a large prosthetics team, which includes the family physician, pediatrician, orthopaedic surgeon, social worker, psychologist, engineer, prosthetist, physical therapist, occupational therapist, and project administrator. Portrays proceedings of a prosthetics conference, during which the patient and parent are presented. The contributions of the social worker, the psychologist, and the engineer are emphasized. At the conclusion of the film, it is explained that one of the principal purposes of the team is to collect research data with a view toward improving training and prosthetic devices and procedures.

Evaluation: At the time the film was made, it undoubtedly served the purpose of showing the UCLA program as well as presenting the concepts of the prosthetics team and the early fitting of the child amputee. Although it might be of some value in demonstrating a research approach, its outdated quality relegates it, for the most part, to the category of "historical interest."

Distributor: Paul L. Brand and Son, 2153 K St., N.W., Washington, D. C. 20001.

Rental Fee: $7.60 plus shipping charges.

"Early Development of Ambulation—Unilateral Below-Knee Amputee," University of California at Los Angeles, 1965, 18 min., black and white, sound, 16 mm.

Summary: Depicts the progress of the child amputee from the time he attempts to stand until he walks independently with the prosthesis, which has become an integral part of his body image. Shown are the changing patterns of rhythm, the gradual narrowing of the base of support, and the increasing stability as motor-kinesthetic development takes place and the child participates in increasingly complex skills and play activities.

Evaluation: Presents well the concept of early fitting, as the child is shown wearing and using the prothesis as effectively as a normal leg. The film should be shown in conjunction with *Infant to School-Age Child—Unilateral Below-Elbow Amputee.*

Distributors: Child Amputee Prosthetics Project, UCLA Rehabilitation Center, 1000 Veteran Ave., Los Angeles, Calif. 90024. Also available for loan from the crippled children's services in all 50 states and in the District of Columbia, the Virgin Islands, Puerto Rico, and Guam through funds supplied by the Children's Bureau, Department of Health, Education, and Welfare.

"Infant to School-Age Child—Unilateral Below-Elbow Amputee," University of California at Los Angeles, 1964, 10 min., black and white, sound, 16 mm.

Summary: Presents the various stages in the motor-kinesthetic development of the child and relates them to the specific times at which the child amputee is ready for initial prosthetic fitting as well as for increasingly complex devices. As skills and physical activities develop in response to demands of daily living, devices are provided that are appropriate to the level of function. The cooperation of the parents in the teaching process is stressed.

Evaluation: The concept of fitting the child amputee with the appropriate device at a specific time in his motor-kinesthetic development is well presented. The film has value, not only in demonstrating the progress of the child amputee, but also in teaching the basic principles of growth and development in the young child. Although the film is specialized in nature, it is recommended for undergraduate students in paramedical fields to present the principles of growth and development. It is highly recommended for professional groups working with child amputees. It should be shown in conjunction with the film *Early Development of Ambulation—Unilateral Below-Knee Amputee.*

Distributor: Child Amputee Prosthetics Project, UCLA Rehabilitation Center, 1000

Veteran Ave., Los Angeles, Calif. 90024. Also available for loan from the crippled children's services in all 50 states and in the District of Columbia, the Virgin Islands, Puerto Rico, and Guam through funds supplied by the Children's Bureau, Department of Health, Education, and Welfare.

"Juvenile Amputee with Congenital Skeletal Limb Deficiencies," Tulane University School of Medicine, 1964, 20 min., color, sound, 16 mm.

Summary: Presents ten patients treated at a child-amputee clinic. As each case is presented, the limb deficiency is described on the screen in the terminology of the recently developed roentgenographic classification. The deficiency is further described by x-ray plates and by pictures of the child before surgical procedures. Scenes filmed at a later date show the patient wearing and using a prosthesis fitted to the surgically revised limb. The history of the child is outlined rather fully and, in some instances, the history is pictorially depicted at intervals over a number of years.

Evaluation: This film would be helpful in reinforcing use of the classification of limb deficiencies as developed by O'Rahilly and Frantz. The results obtained in fitting severely involved children are impressive. The information presented is too extensive for the time allotted, making it difficult to stay with the narrator and detracting from the technical quality of the film. This film is recommended for professional groups interested in orientation to this particular type of patient and program. It could also benefit parents of the congenital child amputee.

Distributor: American Academy of Orthopaedic Surgeons, 29 East Madison St., Chicago, Ill. 60602.

Rental Fee: $3.00.

"Lower-Extremity Amputees—Toddlers," Michigan Crippled Children Commission, 1957, 22 min., color, magnetic sound (requires special projector), 16 mm.

Summary: Presents briefly the motor development of the child as it relates to the upright position and ambulatory progress. Describes anomalies and stumps, both pictorially and roentgenographically. Discusses the prosthetic fitting and the child's ambulatory program. Changes in gait patterns over a number of years are demonstrated.

Evaluation: The development of the gait pattern over the years is especially interesting. Because of advances in design, fabrication, and the fitting of prostheses since the film was made, it has outlived its period of optimal value.

Distributor: Michigan Crippled Children Commission, The Area Child Amputee Program, 920 Cherry St., S.E., Grand Rapids, Mich. 49506.

"Prosthetic Training of the Very Young Child Amputee—Upper Extremity," Michigan Crippled Children Commission, 1959, 20 min., color, optical and magnetic sound, 16 mm.

Summary: Demonstrates the training technique used in teaching three upper-extremity child amputees to use their prostheses. It shows a child-sized APRL hand that was in the experimental stage at that time.

Evaluation: This film shows good beginning training technique, outlining three different areas of training—basic body-control motions, development of prosthetic control, and functional prosthetic use. The training situations shift abruptly, causing the film to lose continuity. Technically, it is not a high-quality film. Occupational therapists might find this film of value because some of the techniques of training are still acceptable, although the prostheses are outdated.

Distributor: Michigan Crippled Children Commission, The Area Child Amputee Program, 920 Cherry St., S.E., Grand Rapids, Mich. 49506.

"Upper-Extremity Amputees—Toddlers," Michigan Crippled Children Commission, 1956, 22 min., color, magnetic sound (requires special projector), 16 mm.

Summary: Presents type, diagnosis, and prosthetic fitting of several upper-extremity child amputees. Demonstrates the performance of skills and activities while wearing the prosthesis.

Evaluation: This film, made at the Mary Free Bed Guild Children's Hospital in Grand

Rapids during the earlier years of the child-amputee program, serves to demonstrate how readily children adapt to early prosthetic fitting. Advancements in the prosthetic field, however, cause the film to be outdated. It should be noted that the sound, which is magnetic, is cut off for about the last ten minutes.

Distributor: Michigan Crippled Children Commission, The Area Child Amputee Program, 920 Cherry St., S.E., Grand Rapids, Mich. 49506.

Orthotics

"Assistive Devices for the Physically Handicapped," National Foundation for Infantile Paralysis, 1957, 12 min., sound, color, 16 mm.

Summary: Illustrates many assistive devices and their use by postpoliomyelitis patients. The devices include mouth sticks, overhead slings, feeders of various types, automatic page turners, hydraulic lifts, and several others.

Evaluation: This very comprehensive film is useful to show the kinds of devices used to increase the functional capacity of the post-poliomyelitis patient with severe residual paralysis. Credit is due those whose ingenuity resulted in the improvised equipment demonstrated here. While the film is photographically excellent, its content in terms of emphasis on certain devices, such as the mouth stick, is questionable. The film, made prior to the poliomyelitis vaccines, is necessarily outdated in some aspects, but the devices shown would still be of interest to personnel working with the severely disabled.

Distributor: Film Library, International Society for Rehabilitation of the Disabled, 219 East 44th St., New York, N. Y. 10017.

Rental Fee: $10.00. (No rental fee for members in good standing with the International Society.)

"Kinetics and Orthotics for Function," Institute of Physical Medicine and Rehabilitation, New York University Medical Center, 1963, 25 min., black and white, sound, 16 mm.

Summary: Presents the basic principles in the selection and the use of orthotic devices to achieve as normal function as possible in the presence of upper-extremity weaknesses. The basic normal motions of the upper extremity in the performance of several everyday activities are carefully depicted. The subject, a quadriplegic patient, is introduced as he is undergoing a manual muscle test. The test, which reveals severe weakness in the musculature of the upper extremities, also serves as a basis for determining the degree and nature of the mechanical assistance required to supplement the existing strength. Periodic evaluations are made; and, as strength increases, the appliances are adjusted or replaced. Finally, the amount of assistance is reduced to the minimum required by the patient, who is shown performing a number of activities. Before discharge from the hospital, the patient is equipped with a flexor-hinge hand and is planning to return to his former occupation.

Evaluation: An excellent analytical presentation of the prescription and use of orthotic devices for severely involved upper-extremity patients. Outstanding in this picture is its adherence to the practice of sound teaching principles. As each new step is presented, the principle underlying the selection of orthotic devices is applied and illustrated. The analysis of normal motion serves as a basic approach to the problem. The film gives a feeling for the long time involved and is realistically hopeful in terms of patient accomplishment. This film is highly recommended for all paramedical groups; for occupational therapists it is of value in teaching specific techniques of training.

Distributor: Film Library, New York University Medical Center, 342 East 26th St., New York, N. Y. 10016.

Rental Fee: $5.00.

"Spinal Cord Injury," Rancho Los Amigos Hospital, 1961, 25 min., color, sound, 16 mm.

Summary: Depicts eight levels of spinal-cord injury and demonstrates the degree of independence that the average patient can attain after injury. Independence is accomplished through a program of maximum strengthening of the remaining active muscles, combined with appropriate assistive devices, such as short leg braces, long leg braces, overhead slings, artificial muscles, special splints, crutches, hydraulic lifts, etc., and training.

Evaluation: This well-organized film discusses clearly and precisely each level of injury in terms of specific pertinent information, such as key muscle groups involved, functional loss, and orthotic devices. It points out that the prognosis of the patient is not constant with the level of injury, but is based on demonstrable muscle function. Limitations are carefully noted, and goals are realistic. The film is highly recommended for any professional person working with the paraplegic or quadriplegic patient and for inclusion in the undergraduate curriculum for therapists and nurses. Patient and family would benefit from seeing this film, provided they have accepted a realistic attitude toward rehabilitation.

Distributor: American Academy of Orthopaedic Surgeons, 29 East Madison St., Chicago, Ill. 60602.

Rental Fee: $3.00.

"The Heather Hand," U. S. Veterans Administration, 1960, 10 min., color, silent, 16 mm.

Summary: Describes a light-weight, wrist-extension, hydraulic orthosis. Shows the patient putting it on himself and performing several activities.

Evaluation: Although this film illustrates the device very well and graphically demonstrates its function, it is of practically no value for paramedical groups because it is not accompanied by any explanation, either written or auditory.

Distributor: Research and Development Division, Prosthetic and Sensory Aids Service, Veterans Administration, 252 Seventh Ave., New York, N. Y. 10001.

Amputation Surgery and Fabrication of Prostheses

The compilers of this review did not consider themselves qualified to evaluate films on amputation surgery or the fabrication of prostheses.

Titles of films on surgery may be found in the *Film Reference Guide for Medicine and Allied Sciences*, U. S. Department of Health, Education, and Welfare, Public Health Service, Communicable Disease Center, Atlanta, Ga. 30333.

For those interested, the following films on the fabrication of prostheses are listed.

Available from the Research and Development Division, Prosthetic and Sensory Aids Service, Veterans Administration, 252 Seventh Ave., New York, N. Y. 10001: *Above-Knee Prosthetics—Stump Casting with the Use of a Casting Stand; Below-Knee Prosthetics—Stump Casting with the Use of a Casting Stand; Fabrication Technique for Medial Opening, Polyester Nylon, Syme Prosthesis; Plastic Finishing of an Above-Knee Socket; The Total-Contact, Soft-End, Plastic Laminate Above-Knee Socket.*

Available from Hydra-Cadence, Inc., 623 South Central Ave., P. O. Box 110, Glendale, Calif.: *Hydra-Cadence, Reel 1; Hydra-Cadence, Reel 2.*

L'Attelle Monotubulaire, a Review

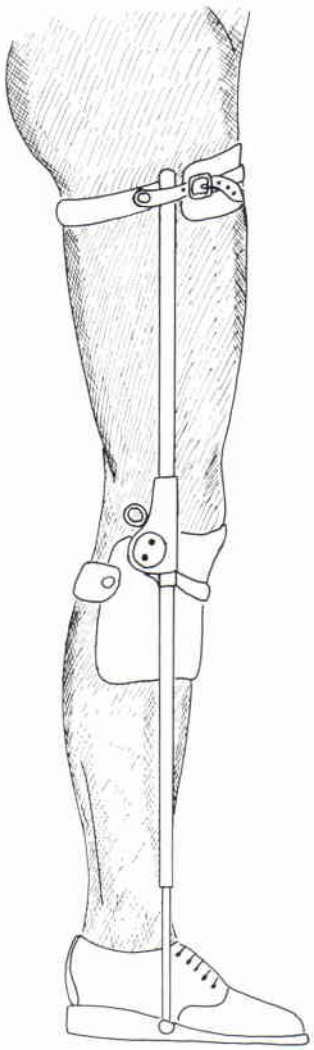
L'ATTELLE MONOTUBULAIRE (The Monotubular Brace), by Louis Pierquin, Guy Fajal, and J. M. Paquin, March 1964. Illustrated. Obtainable from Monsieur G. Fajal, 20 Rue d'Alsace, Vandoeuvre-les-Nancy, Meurthe et Moselle, Nancy, France. 84 pages. Price: 15 francs.

L'Attelle Monotubulaire is the second fascicle, or increment, of the *Atlas d'Appareillage Prothètique et Orthopédique* (Atlas of Prosthetic and Orthopaedic Appliances) being published under the direction of Professor Louis Pierquin of the Faculty of Medicine of Nancy (*Artificial Limbs*, Spring 1964). *L'Attelle Monotubulaire* describes a lower-extremity brace of novel design and function—the monotubular brace. This interesting departure in French orthotics utilizes a single straight tubular upright to provide lightness and strength. The conventional medial upright is eliminated.

Additional departures include a round caliper shoe attachment placed anterior to the ankle joint as well as below it. Geometry is accommodated during ankle movement and spring action is added to the joint by the use of a telescoping lower leg piece which inserts into an upper tube below the calf band. Stops and additional springs can be attached to the stirrup piece.

Thus there has been developed a brace that uses a straight upright anterior to the axis of the leg, which has a moderate posterior offset of the knee joint, which varies in length with ankle motion and is easily adjusted to the torsional alignment of the leg. Patellar-tendon-bearing-type leg bands and quadrilateral sockets can be utilized in place of narrow leg and thigh bands. Wide, contoured plastic bands are attached by metal bands soldered to the brace.

To evaluate such a novel device, one must determine whether construction would present significant problems, whether fitting and alignment procedures can be standardized, and whether utilization corroborates the claimed attributes. Unfortunately, the publication does not provide sufficiently detailed infor-



"When viewed laterally, the monotubular brace is straight; it does not show even the slightest curve at the level of the knee. It rests on a forward pin; that is, on a pin located in front of the axis of the limb." From *L'Attelle Monotubulaire.*

mation to answer these questions. This work is presented in broad terms for the general information of the physician-therapist-orthotist team. It does introduce the device but does not describe the metals used or the fabrication methods. Alignment procedures are not discussed, although two errors—improper depth of the thigh and leg bands and improper rotational alignment due to faulty positioning of the shoe piece—are demonstrated. No analysis of failure rates or comparison of the effectiveness of this brace versus that of standard braces is given.

Considerable thought and work have obviously been expended to bring this device to its present state. Thus it is unfortunate that one can only speculate concerning possible limitations or advantages that might be inherent in its design.

POSSIBLE LIMITATIONS

Difficulties in using this brace might be encountered if deformities of the knee in the frontal plane, for example, genu valgum or genu varum, are present. In addition, the management of any flexion contracture of the knee would apparently be most difficult.

Ankle instability would not be controlled by this device. While drop foot could be managed, varus and valgus deformities, both fixed and functional, might exceed the capacities of the brace. It is not apparent whether or not a calcaneal deformity could be adequately stabilized.

The report notes the critical nature of the depth of the leg band, indicating that proper alignment and fit are vital factors in the application of this orthosis and that careful supervision by the physician would be required.

POSSIBLE ADVANTAGES

Certain advantages of the monotubular brace are apparent. The simplicity of the single-bar fabrication, the lightness of the device, and its potential for control of bilateral disorder without clearance problems are all positive values.

CONCLUSIONS

Since the monotubular brace appears to have potential value and its limitations can be only assumed, the device should be the subject of a controlled evaluation to identify problem areas and to demonstrate the usefulness of the device. This evaluation should include the training of others in fabrication, alignment, and fitting of the brace, and its utilization by a representative group of patients under controlled conditions.

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Late Sequelae of Amputation, a Summary

LATE SEQUELAE OF AMPUTATION, an article on the health of Finnish amputated war veterans, by Kauko A. Solonen, H. J. Rinne, M. Viikeri, and E. Karvinen in Annales Chirurgiae et Gynaecologiae Feniae, Volume 54, Supplementum 138, 1965.

Late Sequelae of Amputation reports an extensive investigation of the late effects of amputation on the general health of the amputee. The subjects in the present series were Finnish war veterans disabled during the 1939–1945 wars and made available for the study while attending a government-sponsored three-week course of rehabilitation at the Kaskisaari Rehabilitation Center in Helsinki.

The amputees participating in the study were chosen at random and considered to be representative of the average war disabled. Of the 311 subjects, 48 were upper-arm, 24 forearm, 65 thigh, and 157 lower-leg amputees; 17 were disabled men with two stumps, not identified as to limb. The average time elapsed since amputation was 18½ years, and the average age of the amputee was 45 years.

The control series consisted of 90 nonamputated persons who had fought during the wars and whose average age was also 45.

The orthopaedic examination was given the amputee immediately upon his arrival at the Center, while the medical, radiological, and physiological examinations were carried out during the three-week period of the course. The team of investigators consisted of an orthopaedist, an internist, a radiologist, and a physiologist. Each specialist performed all the examinations in his particular field himself, thus ensuring evaluation of results on a uniform basis.

A surprisingly large number of amputees, 62 per cent, were engaged in heavy or medium heavy labor. Two of the 17 persons with two amputated limbs had undertaken heavy labor. None was reported as unemployed.

The general condition of the amputees was described as "very good" and of the same level as that of nonamputated persons in the control group. This observation was based on the state of nutrition, arterial pressure, the incidence of specific diseases, and the results of routine laboratory tests and miniature radiography of the chest. Also considered was the number of "healthy" persons in each group as determined by the absence of disease referable to internal medicine, mental disorder, and pathological radiographic or laboratory findings apart from the original injury.

The only statistically significant difference in the series of examinations pertaining to general condition was reflected in the greater number of overweight persons among lower-limb amputees as compared with the control group or with upper-limb amputees who had both legs intact. The authors attributed this finding to the limited mobility of the above-knee amputee and proposed further pursuit of this study, taking into account the constitutional differences of individuals.

The investigation showed that back pain constituted the most frequent complaint among amputees. Pain in the lumbar spine was reported by 65 per cent of the above-knee amputees; by 73 per cent of the below-knee amputees; and by 35 per cent of the control group, reflecting a highly significant difference between the lower-limb amputees and the control group. Pain in the cervical spine was noted by 8 per cent of both above-elbow and below-elbow amputee groups and by 1 per cent in the control group.

Scoliosis of the thoracic spine must be considered a characteristic deformity in upper-limb amputees, based on the investigators' findings in which 92 per cent of the above-elbow amputees and 67 per cent of the below-elbow amputees presented this condition clinically. Radiologically, the frequency of

thoracic scoliosis was significantly greater in upper-limb amputees than in other groups ($P < 0.05$). In all above-elbow amputees and in 87 per cent of below-elbow amputees, the thoracic curve was convex toward the side of the stump.

Clinically, the frequency of lumbar scoliosis was significantly higher in lower-limb than in upper-limb amputees and more common in all groups of amputees than in the control group. Radiologically, the difference was not significant, although a greater percentage of lumbar scoliosis was found in thigh amputees. This greater percentage held true in all groups of amputees as compared with the control group.

Changes in the degree of anteroposterior curves of the spine were frequent in all groups of amputees and more so in amputees than in the uninjured group. No clear correlation could be made between these findings and other factors such as type of amputation, the stump, the use of a prosthesis, or the occupation; nor could the significance of these changes that affected the whole chest be determined in terms of function of the organs of the chest.

The frequency of spondylosis deformans of the lumbar spine was found in 27 per cent of the upper-arm, 50 per cent of the forearm, 31 per cent of the thigh, 34 per cent of the lower-leg, and 35 per cent of the double amputees compared with 14 per cent of the control group. Statistically significant differences between the different groups are not demonstrated in osterchondrosis of the lumbar spine, flattening of the disc, kyphosis, and spondylarthrosis.

In above-knee amputees, flexion contracture of at least 10 deg. at the hip joint on the amputated side occurred in 15 per cent of cases.

Radiographic examination revealed that arthrosis of the hip joint in the intact limb of thigh amputees was significantly higher than in the hip joint of persons in the control group. Chondromalacia patellae was found in the intact limb of 75 per cent of the above-knee group, 62 per cent of the below-knee group, and 53 per cent of the control group.

The incidence of periarthrosis on both the intact and amputated side in the upper-limb amputees was significantly higher than in the lower-limb amputees and the control group.

"Fatigue pain" was also a common finding in amputees. In lower-limb amputees, fatigue pain in the intact limb was reported more frequently than in any other group, the difference being statistically significant and the pain commonest in the knee and ankle area. Thirty-eight per cent of upper-arm amputees and 29 per cent of forearm amputees stated they often suffered fatigue in the intact arm. No such pain was reported by the control group.

Phantom-limb pain was reported as a "great inconvenience" in 42 per cent of the above-elbow, 4 per cent of the below-elbow, 60 per cent of the above-knee, and 26 per cent of the below-knee amputees. This apparently had little bearing on use of the prosthesis by lower-limb amputees, with 98 per cent of the above-knee and 96 per cent of the below-knee amputees reportedly using the prosthesis every day of the week. Of the above-elbow amputees, 44 per cent used their prosthesis every day, and 8 per cent did not use it at all. Prostheses, *per se*, were not investigated in this study.

Physiological examinations included ergometric tests to determine physical condition and also investigation of the circulation in the intact leg and stump by means of a Cameron heartometer. The amputees passed the physiological tests for physical condition practically as well as the persons of the control group, the only exception being the amputees with two stumps. The oscillographic findings indicated that in the intact arm of the upper-limb amputees and the intact leg of the lower-limb amputees the arterial circulation was normal, being considerably weaker in the stump than in the intact limb. The authors observed, however, that the circulation required is less in an amputation stump than in a normal limb.

Additional information on the findings reported in this abstract as well as other aspects of this investigation may be found in the original article, which is being reprinted in the December 1965 and March 1966 issues of the *Orthopedic and Prosthetic Appliance Journal.*

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News and Notes

Fifteenth Meeting of CPRD

The Fifteenth Meeting of the Committee on Prosthetics Research and Development was held in the National Academy of Sciences Building, Washington, D. C., on November 11 and 12, 1965. Dr. Herbert Elftman, Professor of Anatomy at the College of Physicians and Surgeons, Columbia University, who assumed the chairmanship of CPRD on July 1, 1965, presided.

Mr. Louis Jordan, Executive Secretary of the Division of Engineering and Industrial Research of the National Research Council, extended greetings from the Division and from NAS-NRC to CPRD and to Dr. Elftman as the new CPRD Chairman. Mr. Jordan explained that NRC is the service arm of the National Academy of Engineering as well as of the National Academy of Sciences and said that NAE has shown considerable interest in the field of biomedical engineering.

Mr. Colin A. McLaurin, Chairman of the Subcommittee on Design and Development, said that there had been no formal meeting of the Subcommittee since the last meeting of CPRD; however, a number of workshop panels had been active under the auspices of the Subcommittee. Moreover, considerable interest had been shown in student engineering problems in prosthetics design, a project of the Subcommittee to interest new talent in the general field.

Mr. McLaurin said that it was anticipated that the Workshop Panel on Upper-Extremity Prosthetics Fitting, Harnessing, and Power Transmission would convene under its new chairman, Mr. Joseph E. Traub, early in 1966 and that the work of the panel would proceed along two lines: assistance to UCLA Prosthetics-Orthotics Education in the preparation of the new *Manual of Upper-Extremity Prosthetics*; investigation of new ways of fitting (for example, open sockets) and biomechanical analysis.

Mr. McLaurin announced that Dr. Edward Peizer has assumed the chairmanship of the Workshop Panel on Upper-Extremity Components. This panel has been directly instrumental in the development of a large number of items, many of which employ external power.

Professor Herbert Elftman, Chairman of the Committee on Prosthetics Research and Development.

The Workshop Panel on Lower-Extremity Prosthetics Fitting--perhaps the most active of the panels—had focused its attention on below-knee problems and regarded the air-cushion socket developed at the Biomechanics Laboratory of the University of California, San Francisco, as a major development in below-knee fitting. The next meeting of the panel will be under its new chairman, Mr. James Foort, in the Seattle area in February 1966.

At the first two meetings of the Workshop Panel on Lower-Extremity Orthotics the membership was primarily physicians who had been assigned to identify problems. Following the second panel meeting, the membership was reconstituted under the chairmanship of Mr. Anthony Staros. The new panel—composed primarily of engineers and orthotists with some physicians from the original panels—will endeavor to solve the problems defined in the first two meetings. The next meeting of the panel will be early in 1966.

A small Workshop Panel on the Control of External Power will meet early in 1966.

The members of CPRD observed brief demonstrations of a number of recently developed devices: an electrically powered assist for a conventional body-powered arm and a shoulder incorporating a ball-and-socket joint, both

developed at the Northwestern University Prosthetics Research Center; an electrically operated elbow unlock, in which the on-off switch was actuated by a chest strap, and a forearm-flexion-extension arm for use with an electric hand, both developed at the Army Medical Biomechanical Research Laboratory; and an electric elbow developed at the Ontario Crippled Children's Centre.

In the absence of Dr. Charles H. Frantz, Mr. Hector Kay reviewed the activities of the Subcommittee on Child Prosthetics Problems. Mr. Kay said that the Subcommittee is currently undergoing some changes in membership, including that of the chairman. The clinic organization continues to grow, now numbering some 22 member clinics with some four or five additional clinics pending. Major interests of the Subcommittee on Child Prosthetics Problems are: prosthetic devices, which recently have been augmented considerably; informational activities, such as the *Inter-Clinic Information Bulletin*; and survey activities involving the sending of questionnaires to the various participating clinics.

Dr. Sidney Fishman reviewed two significant recent studies conducted by New York University under the auspices of the Subcommittee on Child Prosthetics Problems: one on the prosthetic fitting of children sustaining amputations for malignancy, the other on a classification nomenclature for congenital limb deficiencies.

Professor Robert W. Mann, Chairman of the Subcommittee on Sensory Aids, briefly reviewed the first meeting of the Subcommittee (*Artificial Limbs*, Spring 1965). At present, Professor Mann said, research is concerned primarily with the blind and the deaf-blind; however, the Subcommittee intends to concern itself with all forms of sensory deprivation.

Two major problems of the blind are communication and mobility. At present, greater progress is being made in communication. Work on Braille has advanced to a point where the acquisition of recorded information is amenable to machine translation to contracted Braille and a computer-type "print-out." Thus Braille can be brought speedily to blind users. Work is being done to eliminate the imperfections of the Braille coding process with the objective of achieving an audio output. Mobility is a more difficult problem. Work is proceeding on two levels: the generation of devices and the determination of the effectiveness of devices. The problem of mobility includes not only searching space before the blind traveler, but also the means of conveying the acquired information to him so that he can use it effectively.

The immediate responsibility of the Subcommittee on Sensory Aids is an over-all review of research supported by the Veterans Administration.

Dr. Elftman advised the members of CPRD that there presently existed no Subcommittee on Evaluation and said that a reorganization of CPRD evaluation procedures is in progress. He indicated his intent to appoint a Subcommittee to carry on through the remainder of the year and to make specific recommendations concerning evaluation procedures at the next meeting of CPRD.

Captain Frank L. Golbranson, MC, USN, reported on the activities of the *Ad Hoc* Committee on Immediate Postsurgical Prosthetics Fitting, of which he is chairman. He said that the data-collection instrument to be used by the *ad hoc* committee is now in final form and copies will be forwarded to the approved contributing centers. With respect to the immediate postsurgical fitting technique in general, Captain Golbranson said that there is no doubt of its value for child and adult patients possessing normal vasculature. For certain other patients, the advantages of the technique were not so clearly evident. Perhaps one year from now a more definitive comment may be possible on the basis of the data expected to be collected. Dr. Golbranson emphasized that the *ad hoc* committee in no way wishes to control, but merely to advise and teach the new method of approach.

In the discussion that followed Captain Golbranson's report, it was brought out that there are difficulties in conducting a retrospective study to obtain data for purposes of comparison; that the critical phase in applying the procedure is in the treatment of older patients with vascular insufficiency and tendencies toward emotional depression; and that saving the knee joint of the patient is extremely im-

portant in achieving his eventual rehabilitation.

Dr. Eugene F. Murphy, Chief of the Research and Development Division of the Veterans Administration's Prosthetic and Sensory Aids Service, said that VA looks forward to receiving the reports of the Subcommittee on Sensory Aids, which is now organized and under way. With respect to the renewals of contracts and the consideration of new proposals in general, VA would very much like to supply all information necessary to enable CPRD to make detailed recommendations.

Dr. J. Warren Perry, Deputy Assistant Commissioner of the Vocational Rehabilitation Administration, said that CPRD has been most helpful to VRA in the review of proposals and expressed appreciation for the cooperation. He said that, with the increased availability of funds, the standards and specificity for proposals are more strict. With respect to the University Council on Orthotic-Prosthetic Education, Dr. Perry said that the last UCOPE meeting was held in Colorado Springs, Colo., during August 1965. Programs leading to the degree of Associate in Arts have been started at Cerritos College and at Chicago City Junior College, with some 20 to 25 students enrolled. UCOPE continues to provide coordination and communication to the educational effort. In conclusion, Dr. Perry extended best wishes to Dr. Elftman as the new Chairman of CPRD.

Dr. Roy M. Hoover, Chairman of the Committed on Prosthetic-Orthotic Education, advised the members of CPRD of the interest of CPOE in CPRD activities and of the desire of CPOE to cooperate. He said that CPOE has appointed a Subcommittee on Orthotics to study the field and develop a list of projects that CPOE might appropriately undertake. He said that the CPOE Subcommittee on Prosthetics Clinical Studies, under the chairmanship of Dr. Herbert E. Pedersen, is cooperating with VA to make a survey of amputation practices in VA hospitals throughout the United States.

Dr. John Lyman reported briefly on the Conference on the Control of External Power in Upper-Extremity Rehabilitation held under the auspices of CPRD at Warrenton, Va., during the period April 8–10, 1965 (*Artificial Limbs*, Spring 1965). Dr. Lyman, who served as conference chairman, said that the proceedings will be published as a numbered report of the National Academy of Sciences.

Dr. Eugene F. Murphy, speaking in behalf of the Editorial Board, gave a brief progress report on *Artificial Limbs*, the journal of CPRD and CPOE.

In the general discussion that followed Dr. Murphy's report, it was brought out that international interest in United States publications is high, and some consideration was given as to whether the name of the journal should be changed in view of the expanding nature of its subject matter. It was decided, however, that *Artificial Limbs* should retain its present name for the time being.

Mr. Anthony Staros reported on a meeting of the United States Subcommittee of the International Society for Rehabilitation of the Disabled held in Colorado Springs, Colo., during August 1965. He said that the members of the U. S. Subcommittee had decided that it would be appropriate to integrate with Canadian representatives to form a North American Subcommittee, in keeping with the recent formation of regional subcommittees of the International Society for Latin America and the Far East. The U. S. Subcommittee has done considerable work on an international catalogue of prosthetic and orthotic appliances and is also developing sets of projection slides that will be available at the headquarters of the International Society in Copenhagen.

Dr. James B. Reswick described his recent visit to Russia, where he visited the Central Institute for Prosthetics Research and Development in Moscow. There followed a brief general discussion of research and development in a number of countries.

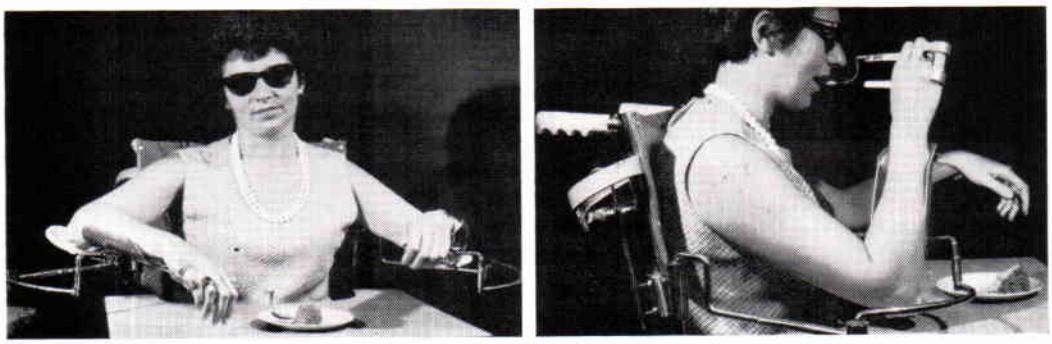
Dr. Elftman invited the CPRD members' attention to a list of basic studies that are being carried on in the general area of prosthetics and orthotics and expressed the view that more discrete attention should be paid to fundamental studies. There was hearty concurrence in the Chairman's suggestion, and it was decided to establish a Subcommittee on Fundamental Studies that will be responsible for organizing small workshop panels for the exchange of ideas by persons directly interested in basic studies.

Conference on Linkage Feeders Sponsored by CPRD

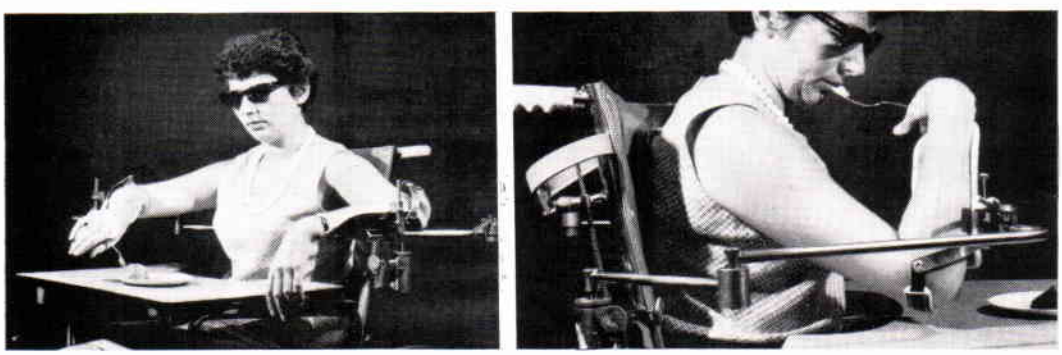
The Committee on Prosthetics Research and Development sponsored an informal workshop conference on linkage feeders (upper-extremity orthotic devices to assist severely paralyzed patients) at the Department of Physical Medicine and Rehabilitation of the University of Michigan Medical School in Ann Arbor, Mich., on July 26 and 27, 1965.

The conference was an outgrowth of a decision made by CPRD in 1962 to enter the field of orthotics through the study of a number of specific orthotic devices. One of the devices selected for study was the linkage feeder designed at the University of Michigan. However, it was apparent that this device, plus a number of others, was essentially a variant of the ball-bearing feeder developed two decades ago by the Georgia Warm Springs Foundation. It was thought that it would be profitable to examine closely the several different versions of linkage feeders with a view toward focusing attention on any significant differences and unique contributions characterizing the various models. Prosthetic and Orthotic Studies at New York University prepared a preliminary design analysis of five linkage feeders in current use, and it then seemed desirable to bring the designers together in the company of impartial engineering experts. The primary purpose of the conference was the interchange of information. Additional—hoped-for—goals are changes by the designers on the basis of the discussion at the conference and insights into the needs for further study.

Co-chairmen of the conference were Dr. Herbert Elftman, Professor of Anatomy at Columbia University's College of Physicians and Surgeons and Chairman of CPRD, and Dr. Sidney Fishman, Director of Prosthetic and Orthotic Studies at New York University



Front and lateral views of the Georgia Warm Springs Foundation feeder. *Courtesy of Prosthetic and Orthotic Studies, New York University.*



Oblique and lateral views of the University of Michigan feeder. *Courtesy of Prosthetic and Orthotic Studies, New York University.*

Co-chairmen of workshop conference on linkage feeders. Dr. Sidney Fishman, at left, is Director of Prosthetic and Orthotic Studies at New York University. Dr. Herbert Elftman, at right, is Professor of Anatomy at the College of Physicians and Surgeons, Columbia University, and Chairman of the Committee on Prosthetics Research and Development. *Courtesy of Thorkild Engen.*

Three of the engineering consultants at the conference on linkage feeders, left to right in foreground: A. Bennett Wilson, Jr., Executive Director, CPRD; Colin A. McLaurin, Ontario Crippled Children's Centre; Hans Mauch, President of Mauch Laboratories. Dr. Eugene F. Murphy, Chief, Research and Development Division, VA Prosthetic and Sensory Aids Service (who does not appear in this photograph), also served as an engineering consultant. *Courtesy of Thorkild Engen.*

Participants in the conference included representatives from the Georgia Warm Springs Foundation, the University of Michigan, Texas Rehabilitation Center, Texas Institute for Rehabilitation and Research, and Rancho Los Amigos Hospital, and a number of engineering consultants not affiliated with any particular feeder-design center.

The conferees estimated that approximately 150 new applications of linkage feeders are made each year by the centers represented at the conference. It was also estimated that if knowledge of the device were sufficiently widespread, approximately 150 additional new applications might be made in the United States per year. While the number of new polio victims has declined, increasing numbers of persons with high spinal-cord injuries resulting from automobile, diving, and trampoline accidents and war are surviving. Patients of this latter type require more sophisticated devices than the existing linkage feeders, which were considered fairly adequate for polio patients.

While the five feeders reviewed at the conference are obviously useful to many patients, the engineering consultants were able to point out a number of specific improvements in design that could be made.

Change in CPOE Membership

Mrs. Geneva R. Johnson, Director of the Physical Therapy Curriculum at Western Reserve University, Cleveland, Ohio, has recently accepted appointment as a member of the Committee on Prosthetic-Orthotic Education, replacing Miss Dorothy Baethke, whose

Mrs. Geneva R. Johnson, new member of the Committee on Prosthetic-Orthotic Education.

term of service was completed on June 30, 1965. Mrs. Johnson is active at the national level in physical therapy affairs, having served on numerous committees of the American Physical Therapy Association and the Council of Physical Therapy Directors. She served as president of the Ohio State Chapter, American Physical Therapy Association, from 1963 until 1965.

Annual Assembly for 1965 of AOPA

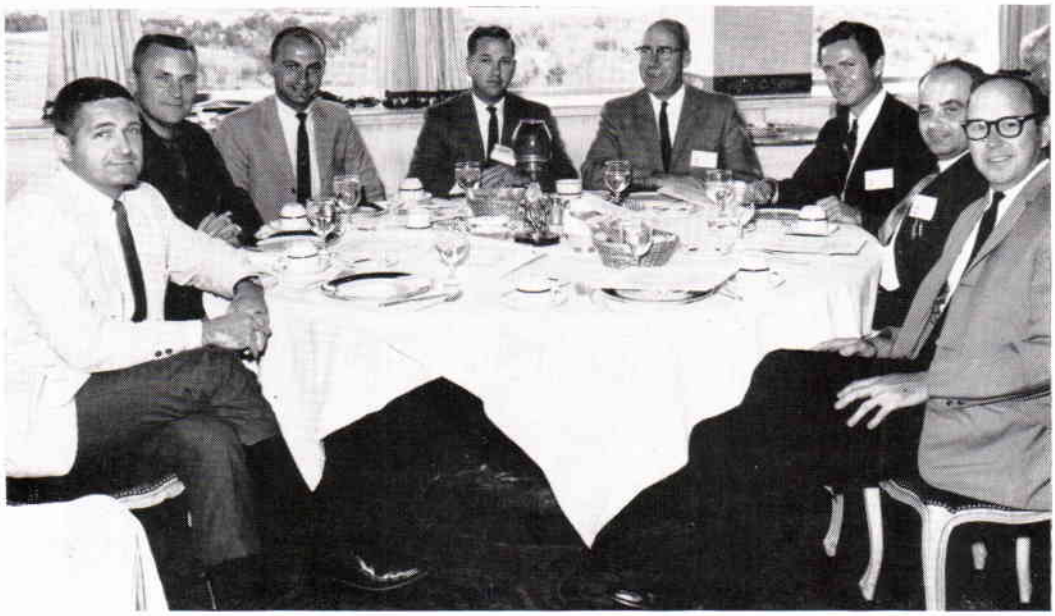
The annual assembly of the American Orthotics and Prosthetics Association was held in Colorado Springs, Colo., during the period September 1–4, 1965. The President of the Association, Mr. Herbert J. Hart, of Oakland, Calif., presided. Registered attendance numbered 505. Exhibitors were well represented. Because the assembly was held prior to school opening, some 60 sons and daughters of members were present.

According to many observers, the program of the assembly, arranged by Mr. Alvin L. Muilenburg, Program Chairman, of Houston, Tex., was the most interesting and educational ever presented at an AOPA assembly.

Mr. Glenn E. Jackson, former Executive Director of AOPA and the American Board for Certification (ABC), delivered the keynote address, entitled *What's in Our Future?*, in which he traced the population and industrial growth anticipated during the next decade and challenged his listeners to professional growth in order to meet the demands on their services.

Two concurrent seminars were featured during the morning of September 2nd. During the seminar on upper-extremity orthotics, Mr. Thorkild Engen described the application and adaptations of the plastic hand orthoses developed at the Texas Institute for Rehabilitation and Research to individuals with various types of upper-extremity impairment. Meanwhile speakers for the seminar on below-knee prosthetic fitting discussed principles of alignment and reviewed casting techniques.

Two concurrent seminars were also featured during the morning of September 3rd. Patellar-



Luncheon discussion of Associate-in-Arts degree programs during AOPA assembly. Left to right: Vert Mooney, M.D.; Roy Snelson, C.O.; Don E. Irish; Russell L. Forney, Ph.D.; Elwyn C. Saferite; Jack D. Armold, Ph.D.; Alfred Maier, C.P.; and J. Warren Perry, Ph.D. Dr. Perry is Deputy Assistant Commissioner, Research and Training, VRA. Dr. Armold and Mr. Irish represented Northwestern University and Chicago City Junior College. Others represented Cerritos Junior College.

tendon-bearing bracing was the subject of one, and the speakers included representatives from the Veterans Administration Prosthetics Center and New York University. The other seminar was concerned with prosthetic fittings for the juvenile amputee, and Mr. Carl T. Sumida and Mr. Vance Meadows presented a well-documented overview of special and experimental prostheses designed to meet the needs of the limb-deficient child.

A seminar on immediate postsurgical fittings for amputees, sponsored by the Committee on Prosthetics Research and Development, was conducted during the afternoon of September 3rd. Clinton L. Compere, M.D., served as chairman, while Captain Frank L. Golbranson, Medical Corps, U. S. Navy; Ernest M. Burgess, M.D.; and Joseph E. Traub, C.P., served as panelists. Experiences in immediate postsurgical prosthetic fittings at the Navy Prosthetics Research Laboratory in Oakland, Calif., and at the Prosthetics Research Laboratory in Seattle, Wash., were described and illustrated, with emphasis on both the advantages and the disadvantages of the new technique. Dr. Compere underscored the experimental nature of the work now in progress, the need for much wider experience before broad applications could be made, and the need for a highly skilled and integrated surgical-prosthetic team.

Colin A. McLaurin, of the Ontario Crippled Children's Centre, Ontario, Canada, who serves as Vice-Chairman of the Committee on Prosthetics Research and Development, gave an excellent analytical overview of developments in external power, both in North America and overseas. He discussed the advantages and disadvantages of various systems and present and future possibilities for practical applications.

Fred J. Eschen, of New York City, was installed as the new President of the Association for 1965–1966. Serving with him are President-Elect George H. Lambert, Sr., of Baton Rouge, La.; Vice-President Basil Peters, of Philadelphia, Pa.; and Secretary-Treasurer M. P. Cestaro, of Washington, D.C.

The American Orthotics and Prosthetics Association maintains its national headquarters at 919 Eighteenth St., N.W., Washington, D.C. 20006. Executive Director of the Association is Lester A. Smith.

Study on VAPC PTB Braces Published by NYU

A study entitled *A Survey of Eight Wearers of the Veterans Administration Prosthetics Center Patellar-Tendon-Bearing Brace* has recently been published by Prosthetic and Orthotic Studies of the School of Engineering and Science, New York University. The report was prepared by Hector W. Kay (formerly Associate Project Director, Prosthetic and Orthotic Studies, NYU, and now the Assistant Executive Director, Committee on Prosthetics Research and Development) and Heidi Vorchheimer, Assistant Research Scientist at NYU, on behalf of a review team consisting of Sidney Fishman, Ph.D., Anthony Gristina, M.D., Hector W. Kay, Nancy Kester, M.D., H. Richard Lehneis, John E. Sarno, M.D., and Heidi Vorchheimer.

To meet the needs of a patient who was unable to bear weight on his foot, the Veterans Administration Prosthetics Center designed a below-knee, weight-bearing brace (*Artificial Limbs*, Spring 1965). The patient had previously been fitted with both a locked-knee, ischial-bearing brace and a short leg brace with weight borne on the tibial condyles and had rejected both of these devices. The VAPC design is based upon current below-knee prosthetics techniques. The primary weight-bearing component is a partial socket of laminated plastic, similar to the proximal portion of a patellar-tendon-bearing (PTB) below-knee prosthesis. A steel frame is laminated to this socket. Uprights anchored to the frame transmit the patient's weight, through rigid or limited-motion ankle joints, to the heel of the shoe and the ground.

In 1961, when the design was first submitted to the Committee on Prosthetics Research and Development, procedures for the evaluation of orthotic devices were not yet available. However, in December 1963, CPRD selected the VAPC PTB brace as a suitable item for evaluation under its newly inaugurated orthotics evaluation program. Evaluation of the VAPC brace was planned to cover three phases: review and examination of subjects fitted by VAPC; selection, fitting, and evaluation of subjects by NYU; selection, fitting, and evaluation of patients by cooperating field clinics.

The recently published NYU report is confined to the procedures employed and the results obtained in the first phase of the evaluation.

The first phase of the evaluation involved an examination of eight of the 22 patients fitted by the developer during the period 1958–1963. Three possible levels of findings were hypothesized with respect to the effects of the experimental brace, namely: positive, stabilizing, or negative. The objective evidence obtained (comparative x-rays) indicated definite improvement in the skeletal condition of one subject; two subjects showed slight improvement, and five showed no change. The one subject exhibiting definite improvement also reported pain-free ambulation. Six of the remaining seven subjects reported that they still experienced some pain but significantly less than with earlier braces. One subject indicated that pain was recurring after several years of relief. Thus, in seven of the eight cases reviewed, results appeared to be positive or at least stabilized.

NYU has now embarked upon the second phase of the evaluation, that is, fitting of subjects by NYU.

ASTM Publication on Plastics in Surgical Implants

The American Society for Testing and Materials has recently published a 104-page, illustrated, paperbound book entitled *Plastics in Surgical Implants* (ASTM Special Technical Publication No. 386), which is a report of a symposium conducted by Committee F–4 on Surgical Implant Materials in Indianapolis, Ind., during the period November 5–6, 1964. (See the "News and Notes" section of the Autumn 1964 issue of *Artificial Limbs*.)

In the introduction to the report, Dr. Fred Leonard, Scientific Director of the Army Medical Biomechanical Research Laboratory, who served as chairman of the program committee for the symposium, points out that the wide range of mechanical properties available in plastic materials makes them attractive candidates for utilization in repairing or replacing tissues or organs which have been damaged as the result of trauma or disease. However, he adds, there are many questions which cannot be answered with certainty at the present time.

Major divisions of the report are entitled "Medical Applications," "Properties and Design," and "Compatibility."

Under "Medical Applications," there is discussion of the development of artificial heart valves; synthetic prostheses fabricated from Teflon, Silicone, and Etherone; and the principles of polymer implant applications.

The discussion under "Properties and Design" is concerned with molecular structure and the properties of macromolecules, surface properties and wettability of plastics, designing and fabricating with textiles, designing and fabricating with elastomers, and designing and fabricating with rigid polymers.

Under "Compatibility," there is discussion of resistance of polymers to degradation, change in properties of plastics during implantation, biological endpoints for compatibility, antigenicity of synthetic polypeptide antigens, effects of implants on the blood, and studies on polymer implants in humans.

Copies of the report may be obtained from the American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa., at $5.00 per copy ($3.50 per copy to members of the Society).

Bibliography on Spinal Cord Injury Published by VA

The Medical and General Reference Library of the Department of Medicine and Surgery, Veterans Administration, has published a selected bibliography entitled *Spinal Cord Injury* covering the period 1940–1963. Major sections of the 121-page publication are entitled "General Aspects," "Neurological Aspects," "Internal Medicine," "General Surgical Aspects," "Decubitus Ulcer," "Orthopedic Aspects," "Prosthetic Appliances, Self Help," "Urological Aspects," "Psychological Aspects," "Physical Medicine," and "Social and Vocational Aspects." There is an author index at the end.

Copies of the publication may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, at 60 cents per copy.

Meeting of U. S. Subcommittee on Prosthetics and Orthotics of the International Society for Rehabilitation of the Disabled

A meeting of the United States Subcommittee on Prosthetics and Orthotics of the International Society for Rehabilitation of the Disabled was held in Colorado Springs, Colo., on August 31, 1965. Anthony Staros, Chairman of the Subcommittee, presided. Members attending the meeting were Dr. Miles H. Anderson, Thorkild J. Engen, Dr. Cameron B. Hall, Dr. Allen S. Russek, Charles M. Scott, Dr. Carl Stolberg, William A. Tosberg, Joseph E. Traub, A. Bennett Wilson, Jr., and Charles Yesalis. Guests attending the meeting were Henry F. Gardner, L. Gavrilovic, Erik Lyquist Jensen, M. Leka, and Charles W. Radcliffe.

In view of the recent formation of regional subcommittees of the International Society for Latin America and the Far East, the members of the U.S. Subcommittee decided that it would be appropriate to integrate with Canadian representatives to form a North American Subcommittee, thereby changing the name of the U.S. Subcommittee to "North American Subcommittee on Prosthetics and Orthotics."

Consideration was then given to several prospective international courses being planned under the sponsorship of the International Society. It was the consensus that the U.S. Subcommittee represents talent which can be made available provided there is sufficient advance notice and the required invitations are received. The courses under consideration will be held in Africa, Germany, and Latin America.

Mr. Scott made a progress report on an international catalogue of prosthetic and orthotic components. It was suggested that the catalogue contain an appendix listing the names, addresses, and interests of research projects in the U.S. and Canada.

There was discussion of a plan to develop a standardized set of slides for the headquarters of the International Society in Copenhagen. Educational slides are now being selected through the joint efforts of the National Academy of Sciences—National Research Council and the U.S. Veterans Administration. It is expected that a standard set of from 200 to 225 slides will be developed. The selected slides will then be submitted to a review group consisting of Dr. Anderson, Mr. Traub, and Mr. Engen, who will evaluate the slides for their international applicability.

There was extensive discussion of the possibility of developing an international association of prosthetists and orthotists (or prosthetic and orthotic technologists). It was recognized that there is a need for some form of international certification and for recognition of presently certified prosthetists and orthotists who possess the capability of making contributions internationally because of their advanced activities in their own countries. It was the consensus that the problem of international certification could not be solved until persons in the latter category were clearly designated in each country. Accordingly, it was decided that the Subcommittee should be expanded to include additional prosthetists and orthotists as members, with the view toward eventually forming a council of prosthetists and orthotists capable of contributing to international activities generally and, particularly, to the development of standards for international certification.

It was recommended that, through the National Academy of Sciences—National Research Council, a proposal be made to the Department of State to provide funds to support the participation of U.S. prosthetists and orthotists in international programs, particularly those of importance to research and education.

The meeting concluded with discussion of the next World Congress of the International Society, which will be held in Germany during September 1966.

European International Seminar on Rehabilitation Held at Oxford

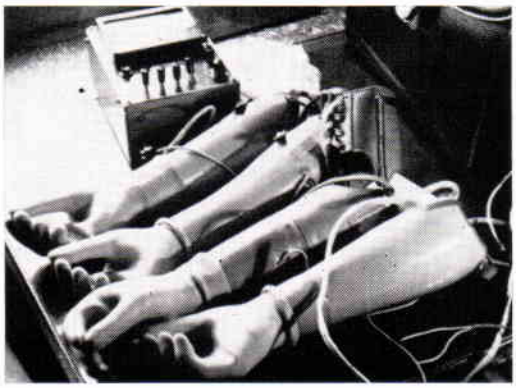
The Second European International Seminar on Rehabilitation, entitled *New Horizons in Rehabilitation*, was held at Oxford University and the Oxford Town Hall, Oxford, England, during the period July 4–10, 1965. Prince Philip sent his greetings to the participants, who numbered some 600, most of whom were billeted in students' quarters. The audience included a large number of paramedical persons, while the speakers were essentially spe-

cialists. Exhibits were displayed in the main gallery and also in a special building. A number of the participants visited Queen Mary's Hospital, Roehampton, where they were much impressed by demonstrations of prosthetic fitting techniques and actual fittings of new devices. It was possible to examine and discuss the fittings with the patients in an informal manner. Among the foreign dignitaries at the Seminar was Dr. Lydia Vosinkoinova, of Moscow, USSR, who is the author of a number of works in the field of bioelectrical artificial limbs. She spoke through an interpreter on two or three occasions and impressed everyone as a charming and competent woman.

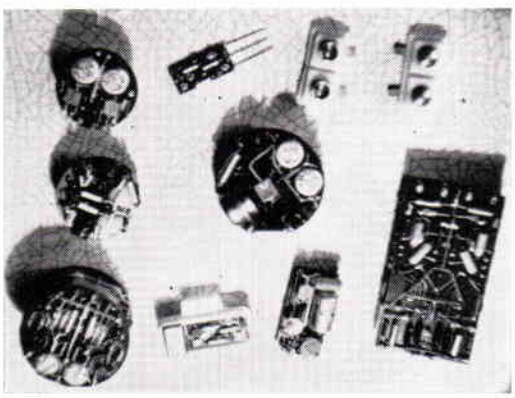
A number of persons who have been associated closely or slightly with the prosthetics and orthotics research program in the United States participated in the Seminar. Among them were: Donald Colwell, formerly a member of the UCLA Prosthetics-Orthotics Education staff; Dr. Wiktor Dega, a leading Polish orthopaedist; Dr. Leon Gillis, Senior Consultant Surgeon to Queen Mary's Hospital, Roehampton; Dr. Henry H. Kessler, founder and Director of the Kessler Institute in West Orange, N.J.; Dr. Ernst Marquardt, orthopaedic surgeon at the University Clinic, Heidelberg, Germany; Dr. George Murdoch, orthopaedic surgeon at the Royal Infirmary, Dundee, Scotland; Dr. D. S. McKenzie, Senior Medical Officer at Queen Mary's Hospital, Roehampton; Colin A. McLaurin, Project Director, Prosthetic Research and Training Unit, Ontario Crippled Children's Centre, and Vice-Chairman of CPRD; Harold Russell, Chairman of the President's Committee on Employment of the Handicapped; and Dr. Bosco Zotović, a specialist in physical medicine and rehabilitation in Belgrade, Yugoslavia.

Central Institute for Prosthetics Research and Development in Moscow Visited by Dr. James B. Reswick

Dr. James B. Reswick, Director of the Engineering Design Center of the Case Institute of Technology and a member of the Committee on Prosthetics Research and Development, visited the Central Institute for Prosthetics Research and Development in Moscow, USSR, during October 1965. He was greeted most hospitably by the Director of the Institute, Dr. Boris Popov, a professor of orthopaedic surgery, who spoke to him for an hour on the state of prosthetics research and development in the Soviet Union.



Four standard electrically powered Russian arms that are actuated by electromyographic controls. *Courtesy of James B. Reswick.*



Electrical components developed at the Central Institute for Prosthetics Research and Development in Moscow. *Courtesy of James B. Reswick.*

The Central Institute for Prosthetics Research and Development was founded in 1953 for the purpose of attacking the problems of amputations, of both the lower and upper extremity, resulting from World War II. The main research effort is concerned with upper extremities, although the Institute deals with lower-extremity amputations on a clinical basis. It was Dr. Reswick's impression that the status of lower-extremity prosthetics is similar

to that of the United States, the limbs being made primarily of wood with certain friction controls. Experiments were being made with total-contact sockets.

Dr. Reswick was conducted through five laboratories at the Institute: a biomechanics laboratory, two electrophysiology laboratories, a kinesiology laboratory, and an electromechanical development laboratory.

In the biomechanics laboratory, Dr. Reswick was shown a number of scopes, recorders, and goniometric devices to record the movements of the upper and lower extremities. A lower-extremity socket equipped with strain gauges around the top and the inside was also seen. A shoe inner sole was equipped with strain gauges to record the dynamic changes in pressure as the subject walked, and there were walkways and stairs equipped with pressure plates.

In the first electrophysiology laboratory, Dr. Reswick saw a number of electrically powered upper-extremity devices that could be operated by electromyographic signals. A well-engineered arm capable of moving in three degrees of freedom has been developed. However, the problem of training a person to use three separate muscle groups simultaneously to obtain coordinated movements has not yet been solved. Single-degree-of-freedom, electrically powered, prehensile arms are said to be in use by more than 1,500 amputees in the Soviet Union.

In the second electrophysiology laboratory, work was being done on a servo-assist for paralysis patients.

The kinesiology laboratory contained a number of devices for measuring the ranges of motion and force capabilities of patients.

Dr. Reswick was favorably impressed by the high level of manufacturing technique evident in the devices shown him in the electromechanical development laboratory. He noted especially certain equipment that had been developed for quickly prescribing the electric arms—small units approximately the size of a packet of cigarettes, with two electrodes on the bottom and a meter on the top, that were capable of rapidly finding the best point to pick up electromyographic signals.

Literary Awards Offered by National Rehabilitation Association

Entries are now being accepted for the sixth annual Graduate Rehabilitation Literary Awards Competition sponsored by the National Rehabilitation Association.

Cash prizes of $300, $125, and $75 will be awarded to first, second, and third place winners, respectively; in addition, award-winning entries will carry high priority for publication in the Association's *Journal of Rehabilitation*.

All persons preparing at the graduate level in colleges and universities to work professionally with handicapped people are eligible to submit papers. Contributors—students following graduate courses in medicine, nursing, rehabilitation counseling, physical therapy, psychology, social work, speech therapy, and related fields—may write on any aspect of rehabilitation; the maximum essay length is 3,000 words. All entries must be in the offices of the National Rehabilitation Association, 1522 K St., N.W., Washington, D.C. 20005, by March 1, 1966, to be eligible for the 1966 awards.

The National Rehabilitation Association is a private nonprofit corporation dedicated to the rehabilitation of all handicapped and ill persons. Organized in 1925, the Association is the oldest voluntary rehabilitation organization in the country. Its 22,000 members include professional workers in all phases of rehabilitation—physicians, nurses, psychologists, hospital administrators, counselors, social workers, therapists, etc.—and thousands of other persons interested in helping the handicapped help themselves.

Through a program encompassing research, seminars, training institutes, conferences, and publications, the Association reaches across interdisciplinary barriers to cover the entire rehabilitation field in its efforts to identify the needs of the handicapped and to mobilize its members to meet these needs.

The Association carries on an extensive publications program, publishing the bimonthly *Journal of Rehabilitation* and *NRA Newsletter*. The Association sponsors the annual Graduate Rehabilitation Literary Awards competition to

promote professional writing among the thousands of graduate students preparing to enter some phase of the rehabilitation field.

Grants for Research from the Easter Seal Research Foundation

The Easter Seal Research Foundation of the National Society for Crippled Children and Adults provides grants-in-aid for investigations concerned with the prevention and treatment of physical and associated disabilities and the rehabilitation of the physically handicapped. Since it was founded in October 1956, the Foundation has awarded grants totalling $2,269,899.62 to 72 universities and institutions for 113 basic and clinical research projects in all phases of crippling. Grants awarded fall within the following research areas:

1. Investigations of crippling conditions and the causes of congenital malformation.
2. Studies of bone and joint formation.
3. Factors affecting the use or lack of use of prostheses.
4. Psychological, sociological, and familial correlates of injury and disease.
5. Improving the educational, emotional, psychological, social, and vocational adjustment of crippled persons.
6. Rehabilitation research positions for research programs involving universities or medical schools and rehabilitation facilities including workshops.

The Easter Seal Research Foundation offers five types of awards:

1. Grants-in-aid—awards to underwrite the costs of specific projects conducted by experienced investigators.
2. Grants for cooperative university-rehabilitation center programs—awards to underwrite a university research position combining academic duties and research at a rehabilitation facility.
3. Research grants to professors emeriti with distinguished research records to conduct investigations in the field of crippling or of rehabilitation.
4. Conference grants—awards to conduct small research-oriented institutes or conferences having as their purpose the identification or clarification of research problems in fields of interest to the Foundation.
5. Matching grants—awards to state or local affiliates of the National Society for Crippled Children and Adults for research or demonstration programs requiring matching funds.

Furthering research in the fields of crippling and rehabilitation is the primary objective of the Easter Seal Research Foundation. Information concerning grants can be obtained by writing to Dr. William Gellman, Director, Easter Seal Research Foundation, National Society for Crippled Children and Adults, 2023 West Ogden Ave., Chicago, Ill. 60612.

Sixth Annual Report Issued by Dow Corning Center for Aid to Medical Research

The Dow Corning Center for Aid to Medical Research recently issued its sixth annual report. Signed by Silas Braley, Director of the Center, the report briefly describes how the Center came to be founded in 1959. In 1958, the Dow Corning Corporation found itself in a dilemma. It was recognized that the medical profession had need of the silicones which the Corporation manufactured, but it was felt that sales of these very specialized items would be so minuscule as to make it impossible to handle them as industrial products. At the same time, it was recognized that there was an inherent social obligation in having materials that were badly needed by the general public. To resolve this, the Board of Directors decided to set up a special organization within the Research Department of the Corporation, and in August 1959 the Dow Corning Center for Aid to Medical Research was organized. As the original objectives stated, the Center would:

. . . serve the medical profession on a non-profit basis by:
- (A) providing technical aid in the use of silicones in medicine and surgery
- (B) acting as a clearing house for information about the medical uses of silicones
- (C) cooperating in research in organosilicon chemistry in relation to the human body.

These efforts resulted in a modest demand for some of the specialized items that the Center helped to develop, and in 1962 the Dow Corning Corporation formed the Medical Products Division to manufacture and sell such materials. This was a welcome development, since for the first time the doctor was assured of a continuing supply of the items with which he had worked.

The objectives of the Center have remained the same, however. It has continued to work with the medical profession on an academic

basis, and commercial aspects are not the deciding factor in its attempts to supply information and material.

In fulfilling its obligations during the past year, the Center has answered some 5,000 letters from medically oriented persons all over the world; some 218 visitors came to the Center in Midland, Mich., to discuss their problems.

The work of the Center continues to be varied. The use of silicone fluids for soft tissue augmentation continues to show promise, and a quantity of material has been made up to allow limited clinical testing by the authorized investigators.

Artificial heart investigations are growing in number and depth. In fact, this complex area of research is expanding so rapidly that it is becoming very difficult for the Center to service all requests. Some 25 research groups have contacted the Center in relation to this problem alone.

The Center continues to work in many other new areas as well as to improve old ones. Some of the more active and interesting are:

Corneal implants for lamellar keratoplasty.
Artificial heart valves.
Intervertebral disc replacement.
Artificial tendons.
Improved soft tissue replacements for plastic surgery.
Surgical repair of nerves.
Detached retina repair.
Blood oxygenators.

In addition, there are many other new concepts and techniques.

Besides publishing a quarterly *Bulletin*, the Center has prepared a number of information sheets concerning the properties and methods of handling the various silicone materials. These sheets are available upon request to Mr. Silas Braley, Director, Dow Corning Center for Aid to Medical Research, Midland, Mich. 48641. Titles of the information sheets and brief descriptions of their contents are as follows:

Heat-Vulcanizing, Medical Grade Silicone Elastomers. The chemistry of Silastic (Silastic is the trade name of Dow Corning for its brand of silicone rubber) heat-vulcanizing silicone rubbers is discussed in a general manner. Various stocks that are available for medical use are described, as well as fabrication processes for making useful shapes from the puttylike raw silicone rubber.

Room-Temperature-Vulcanizing (RTV) Medical Grade Silicone Elastomers. The Silastic RTV medical grade silicone elastomers are initially thick liquid materials that vulcanize at room temperature within a short time after the catalyst is added. RTV materials are used where heat cannot be tolerated. The chemistry of the room-temperature-vulcanizing silicone elastomers is described in a general manner. The RTV materials used in medical applications are described, and general instructions for their use are given.

Comparison of Implantable Medical Grade Silicone Elastomers. This is a table that summarizes the properties of the Silastic silicone elastomers that are commonly used in medical applications. It compares the room-temperature-vulcanizing silicone rubbers to the heat-vulcanizing types.

Gas Transmission Rates of Plastic Films. Silicone rubber shows an oxygen, carbon-dioxide, and water evaporation rate very much higher than other films. This table compares the rate of diffusion of silicone rubber with 11 plastic films.

Silicone Coating Resins Used in Medicine. Metal parts in medical usage are sometimes coated with silicone resin to keep the blood and tissues from contact with them. Means of applying and removing the resins are given.

Siliconizing Surfaces. Silicone coatings on surfaces delay the clotting of blood and make the surfaces nonwetting. This paper indicates the optimum procedure for siliconizing various surfaces such as glass, plastics, and metal.

Silicone Defoamers in Blood Oxygenators. There is need for eliminating the bubbles in the blood in heart-lung machines. Advantages and disadvantages of using silicone antifoams and methods of application are discussed.

Artificial Limbs

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COMMITTEE ON PROSTHETICS RESEARCH AND DEVELOPMENT
COMMITTEE ON PROSTHETIC-ORTHOTIC EDUCATION
NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL
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CONTENTS

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 by 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 establis hed 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 any 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 and Development* and the *Committee on Prosthetic-Orthotic Education*, units of the Division of Engineering and Industrial Research and the Division of Medical Sciences, respectively, undertake activities serving research and education in the fields 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.