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Orthotics and Prosthetics

Journal of the American Orthotic and Prosthetic Association


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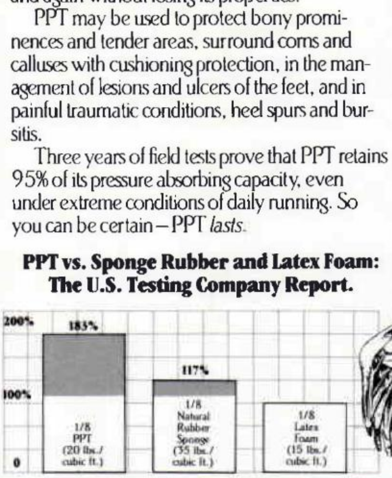

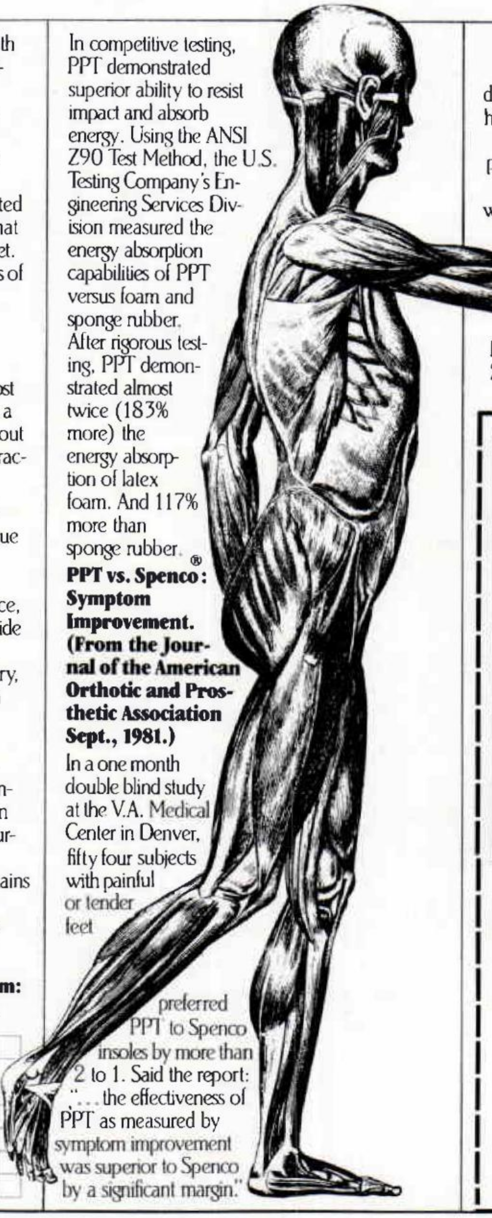

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1983

September 2, Fall meeting of the Maritime Region, Canadian Orthotic and Prosthetic Association, Queen Elizabeth Hospital, Charlottetown, Prince Edward Island, Canada. Contact: Barry McKennon, c/o the hospital, P.O. Box 6600, Riverside Dr., Charlottetown, Prince Edward Island, Canada C1A 1H0; 902-566-6111.

September 5–9, The IV World Congress of the International Society for Prosthetics and Orthotics and General Assembly of INTERBOR, Imperial College of Science and Technology, London, England. Contact: Joan E. Edelstein, Secretary-Treasurer, U.S. National Member Society of ISPO, 317 East 34th Street, New York, New York 10016; 212-340-6683.

September 15–16, Forum '83—A National Symposium on Custom-Fitted Seating Systems, sponsored by the Academy and the Newington Children's Hospital. Contact: The Newington Children's Hospital, Orthotics and Prosthetics Department, 181 East Cedar St., Newington, Connecticut 06111.

September 16–17, Combined Meeting of the Ohio Orthotic and Prosthetic Association and the Ohio Academy Chapter, Quaker Square Hilton, Akron, Ohio.

September 21–23, Annual Advanced Course on Lower Extremity Prosthetics, Nassau County Medical Center, East Meadow, New York. Contact: Dept. of Physical Medicine and Rehabilitation, Nassau County Medical Center, 2201 Hempstead Turnpike, East Meadow, New York 11554.

September 22–23, ABC Technician Examination, 916 Area Vo-Tech Institute, White Bear Lake, Minnesota. Contact: ABC National Headquarters, 703-836-7114.

September 30–October 2, Combined Meeting of the California Academy Chapters, Golden Tee Lodge, Morro Bay, California.

October 17–21, UCLA Seminar, "Advanced BK Prosthetics Techniques." Contact: Peggy Colton, Program Coordinator, UCLA P.O.E.P., Rm. 22-46 Rehab. Center, 1000 Veteran Ave., Los Angeles, CA 90024.

October 25–29, AOPA National Assembly, Hyatt Regency, Phoenix, Arizona. Contact: AOPA National Headquarters, 703-836-7116.

December 12–13, UCLA Seminar, "Amputation Surgery Immediate Post Surgical Prosthetic Techniques for Physicians/Prosthetists." Contact: Peggy Colton, Program Coordinator, UCLA P.O.E.P., Rm. 22-46 Rehab. Center, 1000 Veteran Ave., Los Angeles, CA 90024.

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January 25–29, Academy Annual Meeting and Seminar, Dutch Resort Hotel, Lake Buena Vista, Orlando, Florida. Contact: Academy National Headquarters, 703-836-7118.

April 6–7, Academy New England Chapter Annual Meeting, Worcester Marriott, Worcester, Massachusetts.

April 12–15, AOPA Region IV Annual Meeting, Waverly Hotel at the Galleria, Atlanta, Georgia.

April 19–22, AOPA Region V Annual Meeting, Amway Grand Plaza Hotel, Grand Rapids, Michigan.

May 3–4, AOPA Regions I, II, and III Combined Annual Meetings, Concord Hotel, Kiamesha Lake, New York.

June 1–3, AOPA Region IX, COPA and the California Chapters of the Academy Combined Annual Meeting, Lake Arrowhead, California.

June 21–24, AOPA Region VI and the Academy Midwest Chapter Annual Combined Meeting, Holiday Inn, Merriville, Indiana.

June 28–30, AOPA Regions VII, VIII, X, and XI Combined Meeting, North Shore Convention Center, Lake Coeur d'Alene, Idaho.

October 17–22, AOPA General Assembly and International Congress, Fontainebleau Hotel, Miami Beach, Florida. Contact: AOPA National Headquarters, 703-836-7116.

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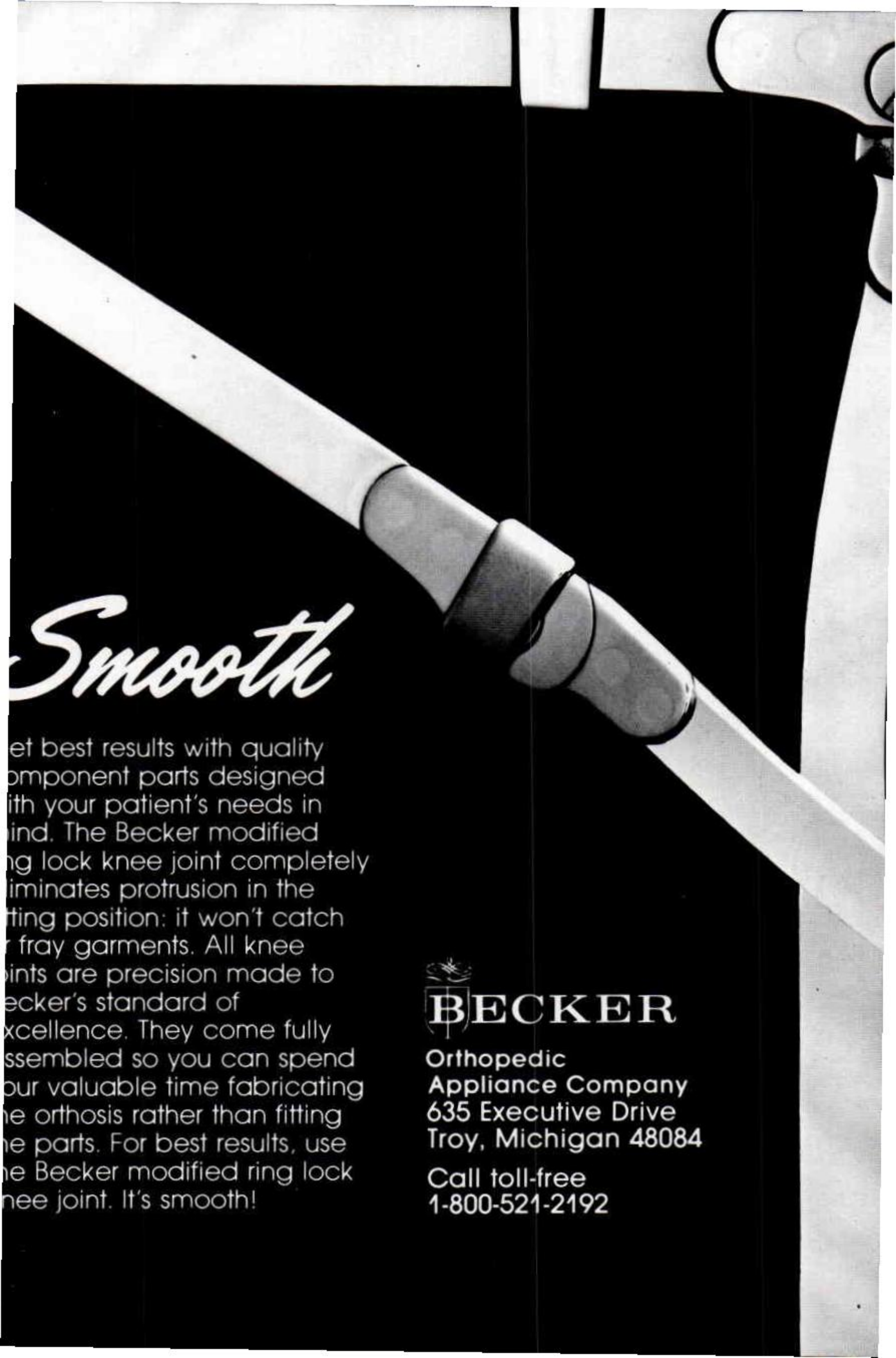
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Four Bar Linkage Knee Analysis

by Michael P. Greene, B.S., M.E., C.P.O.

INTRODUCTION

Modern prosthetists have a wide selection of prosthetic knees to fulfill many individual specifications. The names "friction," "safety," "lock," "hydraulic," etc. quickly recall particular classes of single axis knees. For these single axis knees, the name (friction, safety, etc.) simply states a unique feature which defines the major mechanical advantage of that class of knees.

Polycentric knees, however, may present the prosthetist with confusion. This confusion results from the fact that the term "polycentric" does not define any specific function. Secondly, these knees require more than a simple knowledge of mechanics to fully understand their functions.

This paper will examine one category of polycentric knees which are known as "four bar linkages." Simple methods for evaluating these knees will be presented. These evaluating methods will enable the prosthetist to determine the major mechanical or cosmetic advantage of most four bar designs. The prosthetist will also learn comparative methods of evaluating the efficiency of a particular four bar design in attaining its specific mechanical or cosmetic goals. This skill is extremely important since each four bar design is unique in its operation. Specifically, each four bar knee has been designed to enhance individual characteristics such as safety, cosmesis, energy conservation and/or swing phase motion.

DEFINITION OF TERMS

1. *Translation* or *translational motion* is the movement of a machine element along a straight line.

2. *Rotation* or *rotational motion* is the movement of one element of a mechanism about a pivot point.

3. *Center of Rotation* is the point about which rotational motion occurs. This may be an actual mechanical pivot point on the mechanism or a purely hypothetical point which may or may not actually be on the mechanism.

4. *Single Axis Knee*—Any knee in which the shin moves in pure rotation about a

constant center of rotation located at the knee bolt.

5. *Polycentric Knee*—Any knee whose design allows the shin to move in a combination of rotational and translational motion. At any given instant of time, this combination can be mechanically described as a purely rotational motion about a constantly changing center or rotation known as the instantaneous center of rotation.

6. *Instantaneous Center of Rotation* (or Instant Center)—The point about which a particular element (shin) may be *assumed* to be moving in pure rotation at any given instant of motion being analyzed. For a single axis knee this will be a constant point at the knee bolt center. For a polycentric knee this will be a theoretical point in the plane of motion (sagittal plane).

7. *Four Bar Linkage Knee*—A specific class of polycentric knees. The knees are characterized by four elements joined at four separate points. The four elements include the thigh, shin and two links. (Note: In actual practice, a single link may be a pair of parallel links acting together. However, for mechanical purposes these pairs are considered as single links.)

Fig. 1A is a typical four bar linkage knee. The thigh is considered as a link or bar joining points B and E. This link is defined BE. The shin is considered as a link joining points C and D. This link is called CD. Link BC and ED join the shin to the thigh. Together, all four links join at four points to complete the four bar linkage. Fig. 1B is a kinematic schematic representation of the knee seen in Fig. 1A which shows this typical link arrangement.

STABILITY IN STANCE PHASE OF A FOUR BAR LINKAGE KNEE

Alpha (α) Stability—At this point it is assumed that the reader understands the basic theory of the T.K.A. (Trochanter-Knee-Ankle) line and the accepted T.K.A. alignment method of simple single

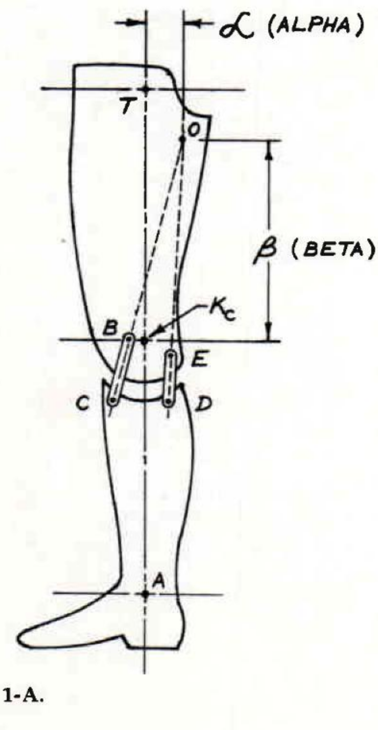

Fig. 1-A.

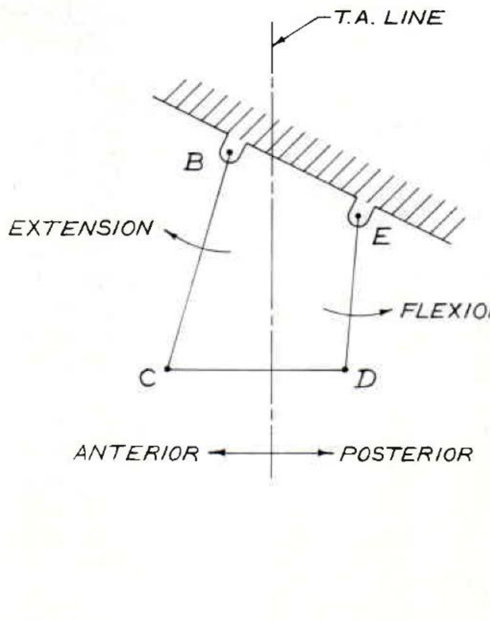

Fig. 1-B.

axis knee mechanisms. In this method the knee is made more stable (safer) by moving the knee center posterior to the T.A. (Trochanter-Ankle) line. Conversely, moving the knee center anterior to the T.A. line decreases weight bearing stability.

Stability of a four bar knee system is also determined by using the T.K.A. theory. The knee center becomes the theoretical "instantaneous center of rotation" in this case. This point must be determined for each position of the knee which is in question.

For static (bench) alignment purposes, the accepted knee position is that of full extension. With the knee fully extended the instantaneous center for rotation is determined by drawing a line through each of the two links joining the shin to the thigh (see Fig. 1A). The instantaneous center of rotation (point O) is the point where these two lines intersect. The stability of the system is determined by noting the position of this instant center in relation to the T.A. line. As in the single axis knee, the center of rotation must be posterior to the T.A. line to be considered as a stable weight bearing system.

At this point the reader's understanding of the "instantaneous center of rotation" and of four bar knee motion may be unclear; this confusion can be eliminated if one understands that a four bar knee is mechanically equivalent to a particular hypothetical single axis knee at any instant of motion being analyzed. This hypothetical knee has its knee bolt located at the instant center of the equivalent four bar knee. Fig.1C gives the single axis equivalent of the four bar knee depicted in Fig. 1A (at the full extension position only). Therefore, the motion and mechanical reaction of the four bar knee in Fig. 1A is precisely identical to that of the single axis knee seen in Fig. 1C at this position of extension. Often it is easier to understand the reaction of the four bar if one visualizes this instantaneous single axis equivalent rather than the actual four bar mechanism.

Since the instant center of a four bar is changing through each position of flexion, the equivalent single axis knee will also be different for each position of flexion. Therefore, care must be taken to analyze the four bar mechanism at the exact angular position which is in question.

A simple method of estimating the instantaneous center of rotation of an actual four bar knee mechanism would be to lay two straightedges along the links and note the point of intersection. A third straightedge could be aligned with the trochanter and ankle center to simulate the T.A. line. Stability of the system is estimated by measuring the distance from the T.A. line to the instant center. For the sake of this discussion, this distance will be defined as "α" (alpha). A positive α value is defined as a knee center which is posterior to the T.A. line. This is a stable or "positive α stability" condition. A negative α value indicates an unstable system with the knee center anterior to the T.A. line.

At this point it is interesting to compare a prosthesis with a single axis knee to the four bar knee prosthesis seen in Fig. 1A. The single axis knee has an $\alpha = 0$ value at

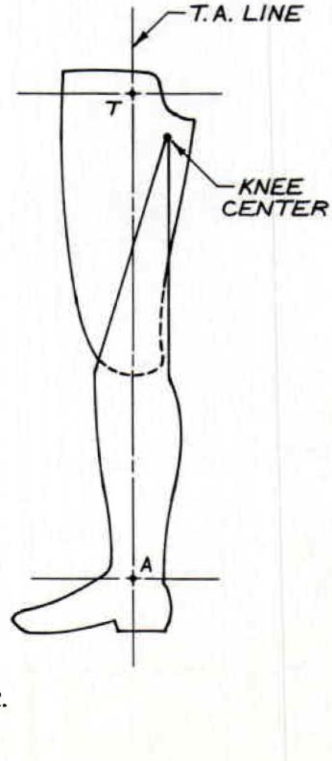

Fig. 1-C.

full extension. As it begins to flex, α becomes negative and progressively more unstable as flexion continues. The special four bar knee in Fig. 1A has a positive α value at full extension. As flexion begins, the value becomes smaller but it remains *positive* for the first few degrees of flexion. Obviously, this knee was designed to have enchanced stance stability and therefore could accurately be called a "four bar safety knee."

Beta (β) Stability—A second and unique condition affecting knee stability exists with all four bar knee mechanisms. Referring to Fig. 1A, it is noted that the instantaneous center of rotation is superior to the level of the mechanical (or cosmetic) knee center (point K_c). With this prosthetic knee the patient gains a mechanical advantage over a typical single axis knee. This mechanical advantage is gained in *two* ways as a result of raising the instant center.

Fig. 2A is a free body diagram of a typical above knee prosthetic shin shortly after heel strike. The force $\bar{L}$ is the axial component of load applied at the knee bolt by the thigh section. The force $\bar{E}$ is the force applied to extend the knee mechanism. This force is also applied by the thigh at the knee bolt. Forces $\bar{R}_v$ and $\bar{R}_h$ are the vertical and horizontal components of the floor reaction force. To analyze this situation, moments are summed to equal zero about the point "f" to yield the equation:

$$\bar{L}y = \bar{E}h \ (\textstyle\sum M_f = 0)$$

It is noted that if the knee center is raised, the value of "y" and of $\bar{L}$ will remain unchanged. However, the value of "h" will increase and for the above equation to balance; the value of $\bar{E}$ will proportionately decrease. This simply means that the moment tending to cause knee buckling is reduced and therefore the patient uses less force, $\bar{E}$, to hold the knee in extension.

The second way in which knee stability is increased by raising the knee center is demonstrated in Fig. 2B. This represents a typical above knee prosthetic thigh. Force $\bar{W}$ and $\bar{I}$ are the loads applied to socket by the patient. (note: $\bar{W}$ and $\bar{I}$ are assumed to act on a point along the T.K.A. for this

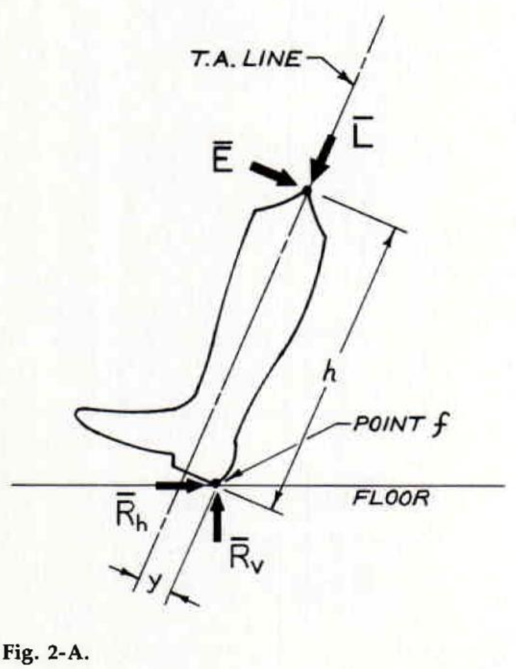

Fig. 2-A.

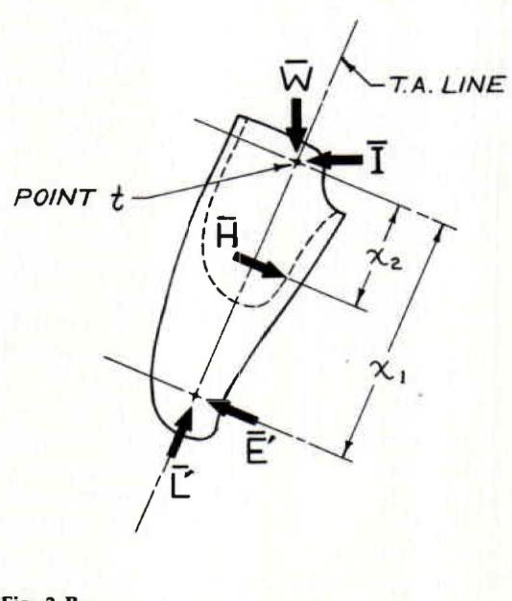

Fig. 2-B.

analysis. $\overline{L}'$ is the axial component of reaction force applied by the shin at the knee bolt ($\overline{L}'' = -\overline{L}$). $\overline{E}''$ is the force applied by the shin tendng to buckle the knee ($\overline{E}'' = -\overline{E}$). $\overline{H}$ is the extension force applied by the residual limb to hold the knee in extension. x_2 is the effective lever arm of the residual limb. To analyze this situation, moments are summed about the point "t" to equal zero:

$$\overline{H}x_2 = \overline{E}'x_1 \; (\Sigma M_t = 0)$$

It is noted that if the knee center is raised, the value of x_2 would remain constant. This condition would also decrease the value of $\overline{E}$ (reduce buckling force as seen above) and thus reduce the values of $\overline{E}'$ and $\overline{H}$ proportionately. It is also observed that x_1 would decrease in value creating a second way in which $\overline{H}$ would be proportionately decreased. This second advantage can also be described as increased leverage for the residual limb.

In summary, raising the knee center reduced the knee buckling moment and increases the patients leverage advantage in controlling that moment. With single axis knees these advantages would only be available by sacrificing the cosmetic appearance of bending at the anatomical knee center. This is not the case with a four bar knee mechanism. The four bar knee can give the cosmetic appearance of bending at the proper anatomical height while providing the added stability of a proximal instantaneous knee center. Fig. 1A depicts a typical four bar knee prosthesis and its anatomic (or cosmetic) knee center, $K_c \cdot \beta$ (beta) is the vertical difference between the anatomical knee height and the instantaneous knee center at full extension. The β value (or "β stability") gives a relative value of stability for comparing four bar mechanisms to each other and to single axis knees. β is measured positive if the instantaneous knee center is above the anatomic knee center, and conversely negative if this instant center is lower than the anatomical center.

The simple method outlined previously for determining the instant center will also yield β stability. By determining these values the prosthetist now has a guage for selecting a particular four bar mechanism when "safety" or "stability" are primary concerns. It is interesting to note that both α and β stability are permanently built into a prosthesis and do not require maintenance or adjustment as is typical of single axis safety knees. α and β stability are also independent of any extension aids, hydraulic mechanism, etc.

(WARNING: α and β stability are features of only *certain* four bar mechanisms which were originally designed for stability. Some four bar mechanisms may be designed for cosmetic or swing phase characteristics and therefore may have poor values of α and β stability.)

SHORTENING OF A FOUR BAR KNEE PROSTHESIS DURING SWING PHASE

With the standard single axis knee prosthesis a typical problem encountered is that of foot to floor clearance during swing phase. It is sometimes necessary to

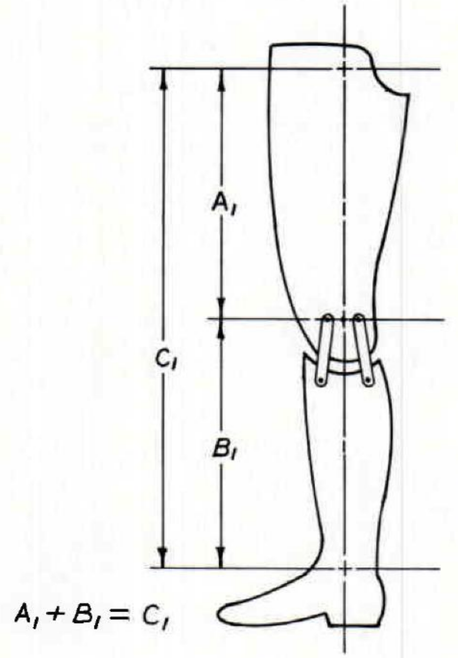

Fig. 3-A.

shorten the prosthesis excessively to provide floor clearance during swing phase. Certain four bar knees, however, actually shorten as they pass from full extension to flexion. This feature allows fabrication of a "full length" prosthesis which automatically "shortens" during swing phase, similar to the actual human knee joint.

Fig. 3A depicts a four bar knee at full extension. The thigh length is "A_1," and the shin length is "B_1." The overall prosthesis length is "C_1" as follows:

$$A_1 + B_1 = C_1$$

In Fig. 3B the mechanism is in the 65° flexion position,* which is generally accepted as the "mid swing" position. The value of $A_2 + B_2$ or C_2 has now decreased and therefore results in additional foot to floor clearance. The amount of overall shortening is defined as the "L" value:

$$L = C_1 - C_2 \text{ (at 65° flexion)}$$

L values for common four bar knee mechanisms are given in Table 1.

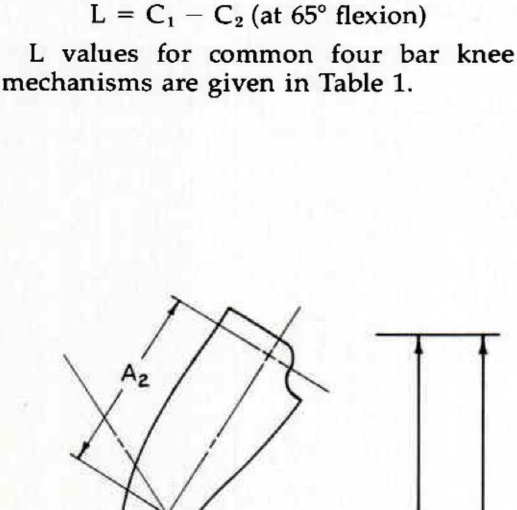

Fig. 3-B.

* Page 178 Northwestern University Above Knee Prosthetic Manual

ACCELERATION/ DECELERATION OF A FOUR BAR LINKAGE KNEE DURING SWING PHASE

Precise kinematic and dynamic studies of four bar knee units can be extremely complex. Therefore, this paper will not attempt to analyze the complex motion of these mechanisms by any quantitative means. In lieu of a detailed analysis, a general qualitative examination will be presented.

Basic single axis knees with mechanical friction and spring assisted extension are essentially "linear" in their response during swing phase. The term "linear" applies a "constant" or "constant rate of change" of some property of the system. The mechanical friction is constant regardless of knee position or velocity. The spring assisted extension assist constantly increases (approximately) as knee flexion increases. The extension assist is also independent of knee velocity. Both of these features are adjustable to allow "tuning" or the swing phase characteristics of "heel rise" at "toe off" and impact at full extension.

Often it is impossible to suit a particular patient's gait pattern by tuning a basic single axis knee. Adjustment of friction or extension may cure one problem only to create another. Although both heel rise and terminal impact may finally be adjusted to prosthetic tolerances, the result may be a system that requires excessive effort by the patient. In this case, the patient often insists that the system be adjusted to suit his requirements for ease of flexion at the sacrifice of smooth operation.

Four bar knees are nonlinear in their operation. As the position of the shin changes, acceleration (deceleration) vary relative to position. This variance can be nonlinear depending on the design of the four bar mechanism. Therefore, it is possible to design a knee with motion characteristics similar to normal human knee motion. For example, certain four bar knee designs have built-in terminal deceleration which requires no use of mechanical friction or other devices.

To understand the acceleration-deceleration of a four bar mechanism the shin can be compared to the pendulum of a pendulum clock. By lowering the weight on the pendulum, the effective pendulum moment arm is lengthened. This adjustment slows the pendulum movement. Raising the weight conversely increases the speed of the pendulum. In the four bar knee the "pendulum moment arm" is increased as the instant center moves proximally during flexion. This action slows the shin movement and causes the deceleration phenomenon. Conversely, as the instant center moves distally, the shin accelerates.

As stated above, the precise quantitative analysis of a four bar motion is very difficult. However, the prosthetist can observe the operation of these knees and then make certain qualitative judgments regarding the swing phase characteristics of a particular mechanism. Terminal deceleration and response time (from "toe off" to full extension) are two characteristics which are very easy to observe. These observations can be made by either manually swinging the knee mechanism or by actual testing on a patient.

It should be noted that hydraulic and pneumatic knee mechanisms are also considered "nonlinear" in their operation. However, this nonlinearlity is not the same as that of a four bar mechanism. Hydraulic and pneumatic knees respond nonlinearily to different *velocities of operation*. This is not the case with four bar mechanisms. Four bar mechanisms are nonlinear with respect to shin position; not velocity. If a four bar mechanism is desired which automatically adjusts to varied gait speed, that mechanism must incorporate a hydraulic or pneumatic unit.

ADVANTAGES OF A FOUR BAR KNEE IN THE SITTING POSITION

General case—A sitting advantage of a four bar knee is the effective shortening of the shin as it passes into flexion. This feature was noted above as a swimg phase benefit of a four bar prosthesis which simulated the motion of the actual human knee joint. This advantage also gives the unilateral above knee amputee the visual appearance of legs with matching knee heights when sitting.

For tall amputees, an excessively long shin can cause clearance problems when sitting at desks or tables. In addition, when sitting on low chairs the tall amputee is forced into an uncomfortable position of excessive hip flexion. The four bar knee reduce both of these problems by the shortening action of the shin when sitting.

The "L" value was defined above at 65° knee flexion to provide a comparative method of analyzing shortening of a prosthesis. If the same calculation is made at 90° of knee flexion, the value obatined would be the effective shortening of the prosthetic shin when sitting. This value is defined as the "S" value. S values for common four bar knees are listed in Table 1.

$$S = C_1 - C_2 \text{ (at 90° flexion)}$$
(see Fig. 3A and 3B)

Special Case-Knee Disarticulation—Conventional single axis knees present a particular cosmetic problem when fitting long above knee or knee disarticulation amputations. With these amputations, it is impossible to fabricate a prosthesis with a knee center at the anatomical height unless outside joints are used. However, outside joints have no friction adjustment, are not durable, and increase knee width. The distal end of the socket can only be placed wihin ½ to 2¼ inches proximal (depending on the particular knee mechanism) to the knee bolt center when a conventional above knee joint is used. In the case of knee disarticulation this could require lowering the prosthetic knee center approximately 2 to 4 inches below the anatomical (cosmetic) knee center, resulting in an excessively long thigh and short shin components. This condition is cosmetically unsightly when sitting and causes clearance difficulties when sitting in confined areas such as the rear seat of small automobiles.

With certain four bar knee designs it is possible to place the distal end of the socket

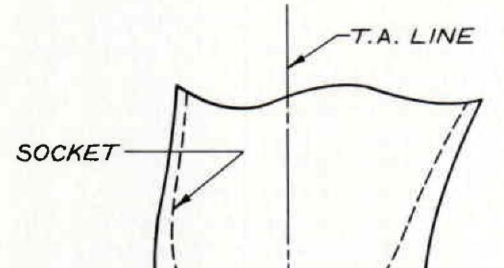

Fig. 4-A.

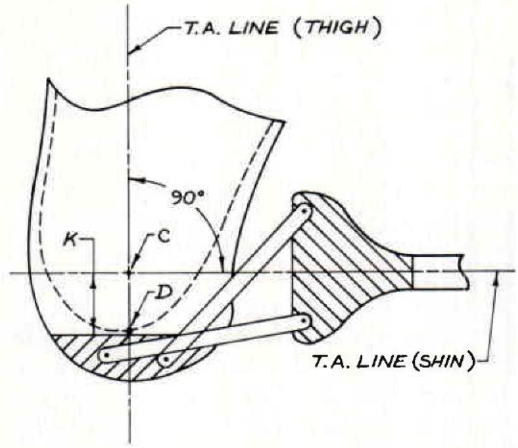

Fig. 4-B.

at a level distal to the cosmetic (anatomical) knee center. A simple method of quantitatively evaluating this property of "cosmetic advantage" for a four bar knee is presented in Fig. 4A and Fig. 4B.

Fig. 4A is a schematic of an endoskeletal four bar knee mechanism that has been designed to have the aforementioned "cosmetic advantage." The point D is the most distal position at which the socket can possibly be placed along the T.A. line. With the knee mechanism fully extended, the T.A. line is noted on both the shin and thigh. The point D is also noted. The knee mechanism is then flexed 90° as seen in Fig. 4B. The point at which the shin T.A. line and the thigh T.A. line intersected is noted and defined as point "C." Finally, the distance from point C to point D is measured and this value is defined as "K" or the "K factor." If the point D is distal to the point C, the K factor is positive. If the converse is true, the K factor is negative. A positive K factor indicates a "cosmetic advantage" over single axis systems (Note: C is the "Cosmetic Knee Center").

All single axis knee shin units have negative K factor values ranging approximately from minus ½ to minus 2½ inches. Outside joints, however, have a positive K factor value that can be as large as necessary.

Table #1 lists K factors for the most common four bar linkage knees. Those knees with a positive K factor would give the best cosmetic knee center for knee disarticulation amputations. Those knees with negative K factors would tend to be undesirable cosmetically for knee disarticulation amputations.

Positive K factors and L values are not the only property affecting true cosmetic analysis of a four bar knee. Each mechanism must be judged by the individual prosthetist to determine the ease of finishing or the general appearance of the finished prosthesis. Certain four bar mechanisms may have positive K factors but may be difficult to finish-fabricate with an acceptable cosmetic appearance.

TABLE 1 (VALUES IN CENTIMETERS)

FOUR BAR KNEE		$\alpha_{0°}$	$\beta_{0°}$	$K_{0°}$	$L_{65°}$	$S_{90°}$
OTTO BOCK-HABERMAN 3R20 (WITH 4R41 ATTACHMENT)	LEAST STABLE	0.3	10.2	-3.6	1.5	1.4
	MOST STABLE	6.7	18.3	-3.3	0.8	0.6
OTTO BOCK 3R21 FOR KNEE DISARTICULATION		-0.3	4.5	1.4	3.7	4.5
ORTHOPEDIC HOSPITAL IN COPENHAGEN (O.H.C.) BY UNITED STATES MANUFACTURING CO. (5M100)		3.0	9.3	1.2	2.5	2.7
UNITED STATES MANUFACTURING COMPANY'S SMALL POLYCENTRIC KNEE DISARTICULATION (5M-105)		-0.2	10.5	-3.4	0.7	-0.1
HOSMER 4-BAR POLYCENTRIC KNEE (70507) (EXOSKELETAL)		2.6	-0.2	0.0	1.4	2.4
POLYCADANCE AK-4		NOT AVAILABLE AT TIME OF PRINTING				
TEH-LIN TK-4000 (ALL TEH-LIN FOUR BARS ARE IDENTICAL)		10.4	30.0	-4.0	0.9	0.5
POLYMATIC (EXOSKELETAL)		5.5	29.8	-?	2.3	2.4

Table #1 was composed using methods which are graphical. Therefore the values derived are subject to a wider margin of error than purely calculated values. Manufacturers should be consulted for more precise data.

The values tabulated were measured using the methods described above. The T.A. line was *assumed* to be a line passing through the foot bolt and the center of the pylon or shin unit. This assumption was made simply to provide a uniform method of evaluating and comparing four bar knee designs. This T.A. line should not necessarily be used for alignment purposes. For this purpose the manufacturer's instructions should be strictly followed.

The Polymatic and Polycadance knees are not in production at this time but are included to show the uniqueness of each four bar design.

Certain knees can be tilted in the sagittal plane. This feature allows some adjustment of α and β values by moving the instant center relative to the T.A. line. The values tabulated in Table #1 were measured with all knees in the vertical position (no tilt).

The Otto Bock 3R20 knee has an adjustable extension stop which adjusts all of the values listed. Therefore the least stable and most stable positions are listed to show the full range of adjustment.

ENERGY CONSUMPTION WITH FOUR BAR KNEE MECHANISMS

The amputee consumes energy during ambulation through muscular activity. This muscular activity develops the forces necessary for ambulation. It is the goal of the prosthetist to eliminate unproductive forces and minimize the productive forces required of the patient. This results in a proportional decrease in the energy loss of the patient during ambulation.

It was shown above that α and β stability reduce the force required from the patient to maintain extension during the early part of stance phase. This force reduction results in a directly proportional energy savings and therefore, α and β give a relative means of evaluating this energy loss.

It was noted that the four bar knee prosthesis can shorten as it passes from extension to flexion. This feature eliminates energy losses due to gait defects such as "hip hiking," "vaulting," "circumducting," etc. This feature also eliminates the need for excessive shortening of the prosthesis. The amount of prosthetic shortening causes a directly proportional energy loss. Moving the patient's mass center up and down during each full cycle of gait is the source of this loss. Therefore, the L value gives a relative means of analyzing the reduction of this particular energy loss.

The special acceleration-deceleration properties of certain four bar mechanisms also contribute to energy savings. The efficient operation afforded by these knees reduces the need for mechanical friction. Since mechanical friction is an energy consuming phenomenon, this furnished an additional means of energy conservation for certain four bar knees.

Finally, the acceleration and deceleration of a four bar knee are relative to knee position. In effect, these properties are perfectly timed controls occuring only at the position at which they are required. The precision and efficiency thus provided can also serve as a source of energy savings.

CONCLUSION

Four bar knee mechanisms can provide the prosthetist with a selection of knee characteristics which were previously unavailable with a single axis knees. The prosthetist should, through simple analysis of any four bar mechanism, be able to define the unique qualities or advantages of that knee mechanism. With this skill the prosthetist can confidently select a four bar knee to meet the specific needs of an individual prosthetic patient.

ACKNOWLEDGMENTS

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The Seattle Prosthetic Foot—A Design for Active Sports: Preliminary Studies

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INTRODUCTION

The concern of many amputees is focused not only on the basic requirements of daily living, but also upon the quality of life as expressed in sports and recreation. A survey of 134 lower limb amputees indicated that 61% participated in some type of recreation, yet only a few of these individuals wore specifically designed recreational prostheses.[6,7,8,9] Many expressed a lack of interest and/or lack of knowledge on the part of prosthetists and other members of the amputee team regarding the need and desire of amputees to participate in physically active recreation.

The ability to exercise naturally affects quality of life. The general concern for improved physical fitness has, during the last few years, prompted national measures to upgrade the level of citizen exercise. For the physically handicapped, this need is even more important. In the case of the amputee, a considerable part of physical performance is related to the prosthesis. This is especially so with younger, vigorous persons. (Fig. 1).

Fig. 1. Prosthetic design can affect the performance of a physically active amputee.

The major specific problem encountered in sports was running, followed by walking long distances. Improved prosthetic design was indicated as the primary requirement to expand physical capability.

ANALYSIS OF RUNNING FOR BELOW KNEE AMPUTEES

The ability to run opens up a wide vista of sports for lower limb amputees. There is a common consensus among amputees that they are unable to run. Therefore few amputees participate in vigorous physical activities which may require this level of participation. There was little objective information on amputee running, thus, three years ago we undertood a research project directed to identifying the kinematics and kinetics of amputee running performance.[2,3,4] A collaborative study with the authors and Dr. Doris Miller and her associates at the University of Washington, Department of Kinesiology was designed to determine how successfully unilateral below knee amputees could run. Data was accumulated in the preliminary study of ten subjects.

Front, back, and side views of physically active candidates, running at self-selected constant speeds, were filmed at 100 frames per second with a LOCAM camera positioned with the optical axis perpendicular to the plane of motion. The measurement of ground reaction forces acting on the prosthesis during running was recorded using a Kistler forceplate. The subjects wore gym clothing and shoes routinely used for sports participation. The running gait was filmed and data stored on magnetic tape, with computer reduction and analysis[10] (Figs. 2 and 3).

A number of noteworthy observations were made. For example, a few of the amputees were not aware that they could run; however, after several sessions they found that they were more mobile than they had been before the training. In fact, one unilateral below knee amputee was able to run forty yards in five seconds after coaching.

The most common undesirable characteristics exhibited by the ten subjects were: (1) maintenance of an excessively straight knee (locked knee) on the prosthetic side during heel contact, which reduced the shock absorption function of the residual limb and placed unnatural stress on the knee, hip and vertebral column and, (2) restricted range of motion of the intact limb at the knee and hip during swing phase. Recovery of the limb with so little knee flexion could only be accomplished by additional contraction of the quadriceps muscles resulting in unnecessary fatigue.

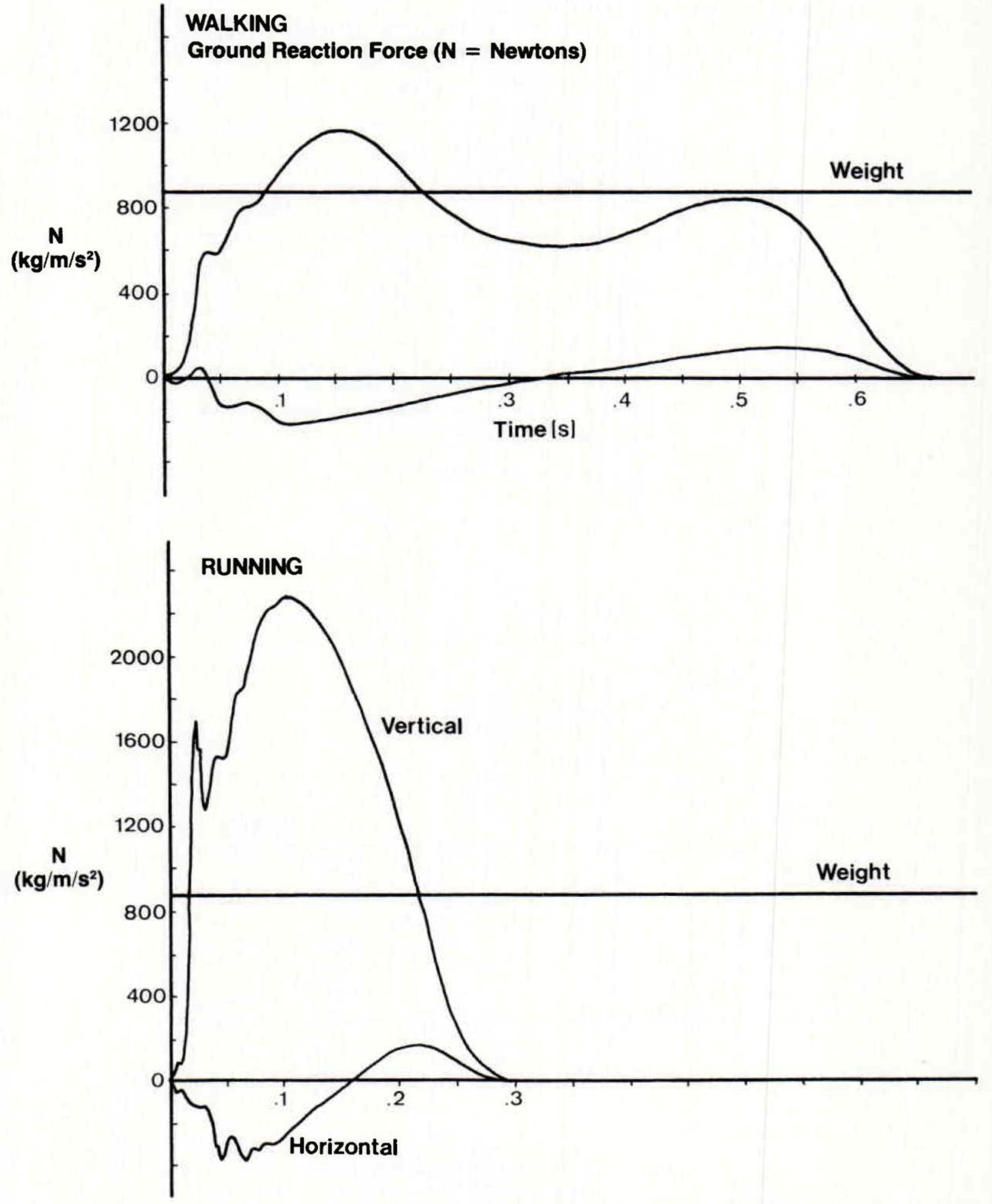
As was expected, there were marked differences between the intact and prosthetic feet, particularly in the ranges of plantar flexion and dorsiflexion. Normal foot function during running also requires a pronation/supination factor which allows the foot to roll inward on the lateral border after contacting the ground. This component is not adequately built into most prosthetic feet.[11]

Design, alignment, suspension, and materials also contribute to successful below knee "running" prostheses. Preliminary studies show that running prostheses should not be set in 5 to 10 degrees of flexion as compared to a conventional prosthesis, but should be plantar flexed so that the runner's weight can be centered over the ball of the foot during pushoff.

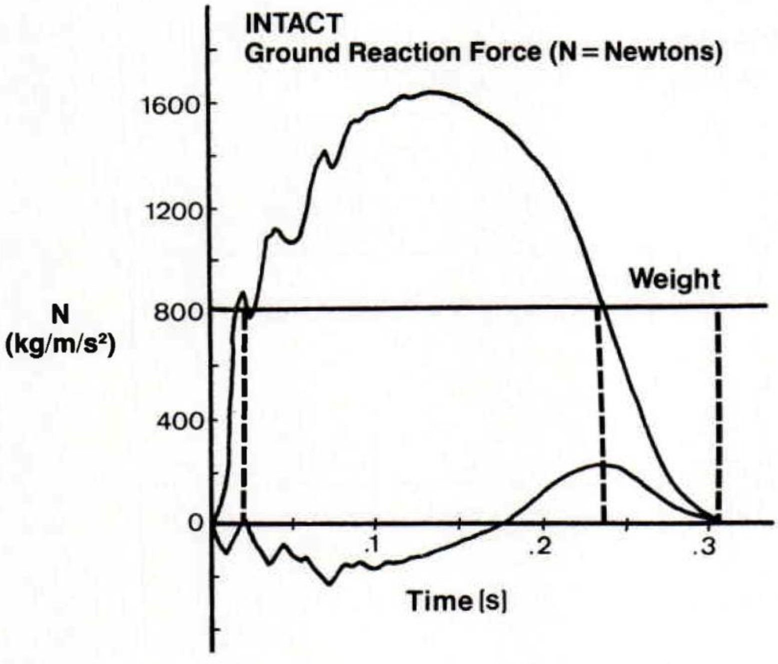
Several amputees preferred rubber latex sleeves or similar suspension straps to minimize pistoning while running.

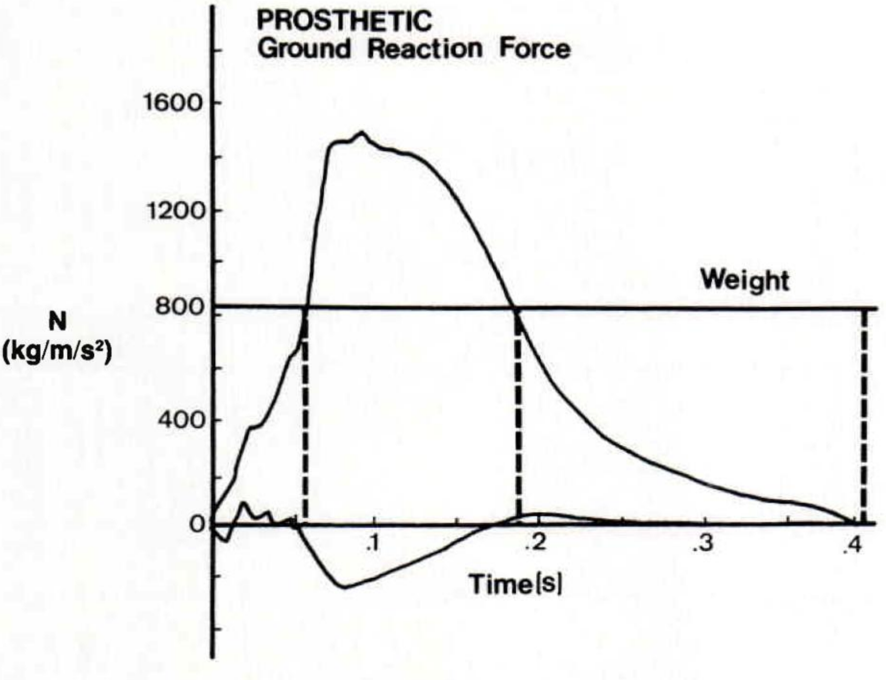
Since the conventional prosthesis is intended for walking, the vertical ground reaction (or impact force) is rarely much greater than body weight. In running, however, this force reaches two to three times body weight. The net effect of this mismatch between design specifications and utilization is two-fold: a shortening of the life of the prosthesis and the development of a gait which is potentially damaging to lower limb joints.

In our analysis of the prosthetic requirements to improve performance, the need for an energy storing ankle/foot design became evident. Using the data from the kinesiology studies, we have designed a foot incorporating a leaf-spring mechanism to aid in pushoff, imitating the activity of the gastrocnemius and soleus muscles. The spring stores and releases the energy of gravitational compression for the purpose of enhancing running performance (Fig 4).[1,5]



Figs. 2-A & 2-B. Comparison of ground reaction force/time histories in walking and running.





Figs. 3-A & 3-B. Ground reaction component force/time histories during intact (above) and prosthetic stance (for one subject). Solid bars designate double support while the vertical arrows indicate the beginning of knee flexion prior to take-off.

Fig. 4. The leaf spring in the foot stores energy by compressing as weight is placed upon it.

PROSTHETIC DESIGN

To be practical, the foot needs to be simple in design, lightweight and durable. Since action depends upon the spring assembly, certain constraints with regard to materials and their performance need to be made. Force requirements and the amount of deflection during force application become critical. It was through running analysis that the optimum deflection angle of 22 degrees, or 1¾ inches, was determined. Given the load and the amount of deflection, the number of leaves in the spring could be calculated. After comparing the weight of each material and the performance requirements together with the need to minimize weight, fiberglass was selected.

It became evident through testing that one spring alone could not provide enough downward force during pushoff. The design initially utilized contained three springs with a rubber deflection bumper. Problems emerged, however, specifically at the point of attachment where repetitive testing caused spring breakage. After a series of additional design modifications, including extensive bench and field testing, the present design emerged (Fig. 5A & B).

This design proved effective with one exception; if forcibly plantarflexed, the foot could delaminate. Delamination oc-

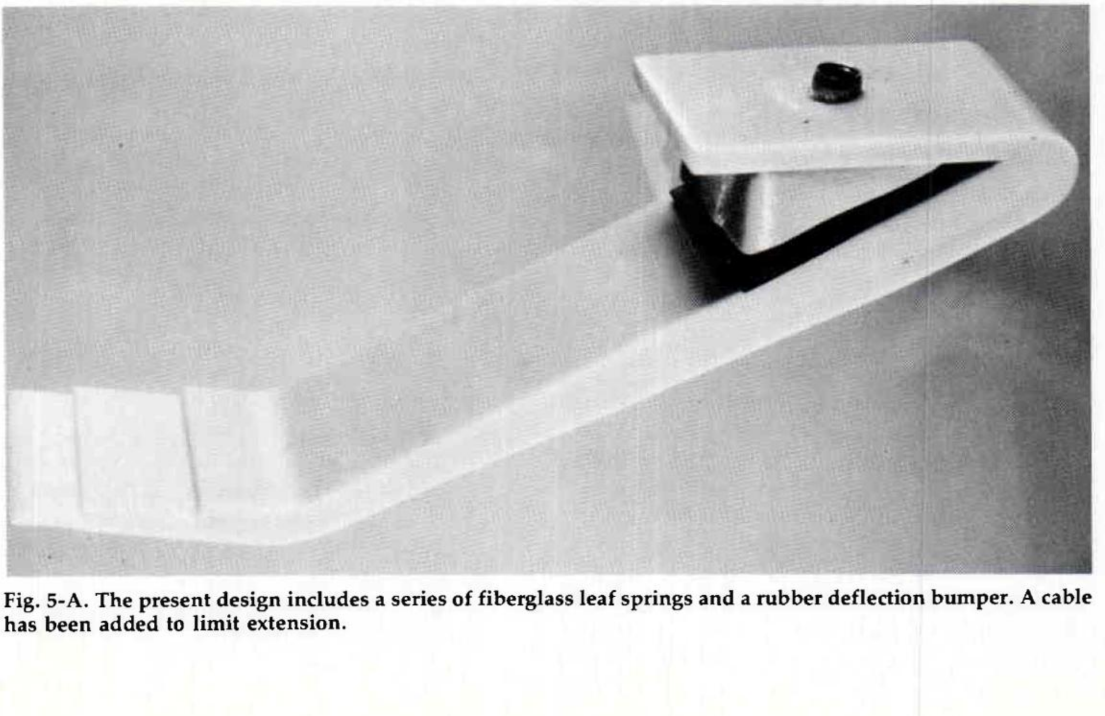


Fig. 5-A. The present design includes a series of fiberglass leaf springs and a rubber deflection bumper. A cable has been added to limit extension.

curred while one of our subjects was skiing downhill. He leaned back in an exaggerated position causing the lever arm of the ski to forceably extend the foot. The problem was solved with the addition of an extension limitation cable added just anterior to the deflection bumper, allowing the foot to compress but not extend.

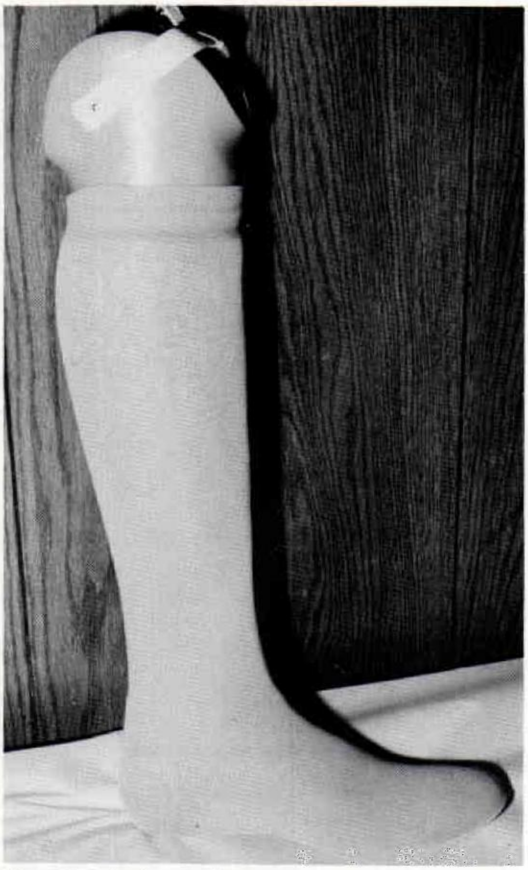
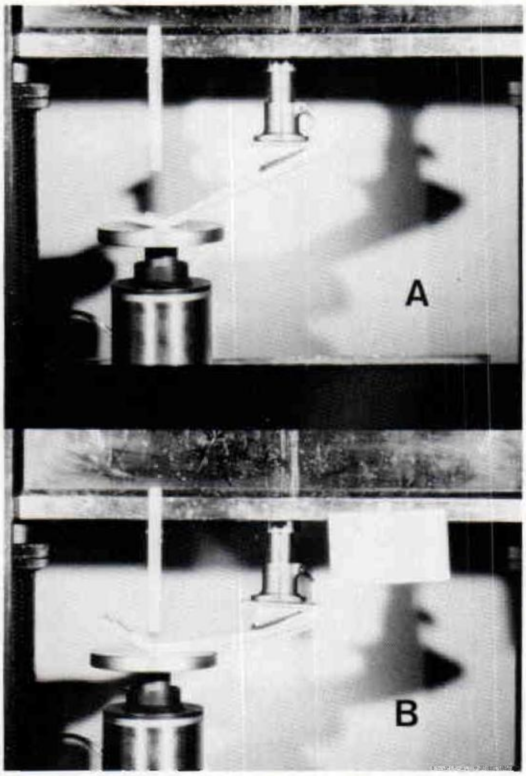


Fig. 5-B. The foot is finished to appear like a normal SACH foot.

PERFORMANCE

Performance of the foot is being evaluated first through laboratory testing. The strength in the spring assembly is tested on a machine which records the amount of deflection measured against the force supplied to the point of breakage (Fig. 6A & B). The second performance evaluation is running analysis through the Kistler forceplate studies. Since most of the amputees



Figs. 4-A & 4-B. Testing force related to deflection in order to determine performance characteristics and the failure point.

have endoskeletal systems allowing alignment and foot changes, the Kistler forceplate provides a good means of comparison not only against the normal but against other prosthetic components. The third performance evaluation is through criticism of the wearer (patient response).

The patients' response has been varied with the following comments being characteristic:

1. On the average, the patient got used to the foot in approximately one week.
2. Initially, some of the patients had difficulty with slow walking. The foot tended to throw the leg forward, but through continued use, this problem seemed to alleviate itself.
3. Running was easier with increased stride length and pushoff. This is accomplished through the foot's ability to store and release energy.

4. It made ascending ramps and stairs easier because it offered the patient more pushoff.

5. Generally, the foot increased one's activity level to include those activities such as running, jumping, etc., with increased ease and comfort.

6. Some patients felt a psychological attachment to the foot and were unwilling to give up its use because of the improved function and performance it provided them.

While the foot's performance has allowed amputees to participate in a broad and increasing vista of activities through the storing and releasing of gravitational energy, research is continuing to improve overall function. There are also plans to modify the energy storing characteristic so that the design and performance characteristics can be included for routine walking activities.

CONCLUSION

The Seattle prosthetic foot design presented is a combination of materials and engineering knowledge. It has been constructed to dynamically store and release energy through controlled spring motion. This preliminary report outlines our progress to date.

ACKNOWLEDGMENTS

We would like to express our appreciation towards those individuals who contributed to the development of the Seattle prosthetic foot, in particular, Mr. Jack Graves for his preliminary ideas relating to spring assemblies in prosthetic feet; for the support of Joseph H. Zettl, C.P. who assisted in improvements and initial prosthetic fabrication; and the staff at the Prosthetics Research Study Center for their participation. This research was performed through Veterans Administration Contract No. V663P-1323.

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The Use of X-Rays and Xerograms in Prosthetics

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INTRODUCTION

The amputation of a limb causes a patient to suffer both a physical and an emotional loss. This loss is magnified by the socioeconomic effects of an amputation. As certified prosthetists, we are charged with the responsibility of replacing the lost limb in a manner accepted both by the medical prescription and the patient, and then with the prosthetic management of the patient for years to come. X-rays or xerograms (Fig. 1) of the residual limb are a valuable evaluation tool which will assist in the design of the prosthesis and future successful management of the patient.

An x-ray provides much valuable information about the residual limbs' bony structure and any calcification of blood vessels. The xerogram, a relatively new procedure, reveals not only the skeletal structure and vessel calcification, but also soft tissue, blood vessels and muscular structures.

The replacement of a human limb with an artificial one requires that the prosthetist evaluate the needs of the patient—socially, emotionally, and physically—in order to assist in the proper design. This many include x-rays of the residual limb prior to casting and also during the preparatory prosthetic stage. X-rays can be used in two ways: a) to visualize conditions beneath the skin which may alter prosthetic design and prescription and b) to maintain the relationship between the skeletal structure and the prosthesis during fitting.

CASE STUDIES

Case 1

Mr. C was a 47 year old traumatic above knee amputee, successfully fit three years ago with a total contact suction socket, who returned for the fitting of a new prosthesis, necessitated by weight gain.

Following normal casting and measuring procedures, the patient was fit with a new total contact ischial weight bearing test socket on an adjustable pylon. During

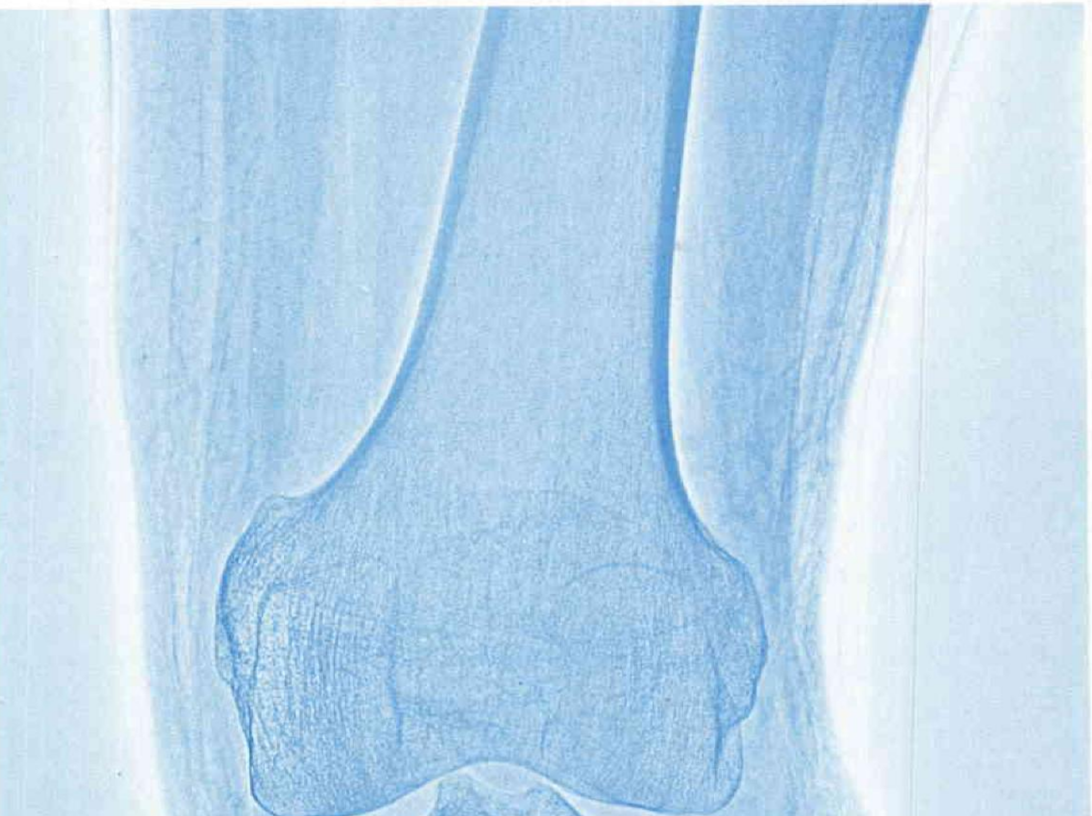

Fig. 1. Xeroradiograph of a below knee residual limb. The xeroradiograph is printed on paper and shows excellent definition of bone structure and density.

ambulation the patient complained of severe cramping and pain on the distal ⅓ of his residual limb. Upon examination of his residual limb, a firm area of tissue was palpated on the medial distal and posterior distal aspects of his limb. X-rays (Fig. 2) were then taken of his limb which revealed a massive calcium formation on his medial and posterior distal femur. This growth was probably secondary to multiple foreign bodies (buckshot) remaining in the soft tissues.

Fig. 2. Conventional x-ray of the distal femur of Mr. C showing calcium formation of buckshot.

A clinical decision was made to continue the attempt to fit Mr. C with a total contact suction socket because he had successfully worn one in the past. Mr. C was fit with multiple test sockets with x-rays taken during the fittings, and is now a successful wearer, and has returned to his job as a policeman.

Case 2

Mr. J was referred to our facility with a prescription for a below knee prosthesis. Visual inspection (Fig. 3A) noted a well healed, non-edematous below knee amputation with a longitudinal scar along the lateral aspect of his leg. Even though there were no complaints of pain or tenderness, an x-ray (Fig. 3B) revealed two metal plates, one along the lateral aspect of the femur and one along the lateral aspect of the tibia. Several of the plate screws extended into the soft tissues in some weight bearing areas. Also, a butterfly shaped bone fragment was found to be dislodged in the medial tibial condyle area. Mr. J was initially fit with a preparatory prosthesis with gel insert and M.A.A.I.A. [multiple axis audio indicating ankle] (Fig. 4); a double layer of gel was used on the medial aspect of the socket and an M.A.A.I.A. was used to initially limit weight bearing and then

Fig. 3-A. Mr. J presents a normal-appearing below knee amputation.

Fig. 3-B. An x-ray revealed femoral and tibial plates with screws extending into weight bearing areas.

Fig. 4. Patient Mr. J was fit with a gel insert, PTB socket, multiple axis audio indicating ankle, and waist belt. The tibial plate loosened in response to weight bearing and was surgically removed.

slowly progress the patient to a full weight bearing status. This was accomplished in two weeks and, as anticipated, four weeks post fitting, the tibial plate began to loosen and was surgically removed.

The patient is now doing well using a patella tendon bearing prosthesis, gel insert, A.F.P. [adaptive fixation prosthetic] construction and SACH foot. If x-rays were not used to determine this patient's problem, a great amount of time and effort could have been wasted attempting to reduce the pain by different prosthetic modifications.

SUMMARY

An x-ray of the patients' residual limb should not be a luxury, but a necessity. Not only can fractures and plates be seen on an x-ray but also calcification of blood vessels, bony spurs, arthritic changes, osteoporosis and other potential problems. Without x-rays and other vital patient information, both physical and psychological, the prosthetist is also handicapped during the rehabilitation process of the patient.

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How to Prepare an Article for Publication

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Michael J. Quigley, C.P.O.

INTRODUCTION

As a general rule, prosthetists and orthotists do not write articles. One only needs to consider the developments and techniques that have been described verbally at seminars and meetings and never written about in our various journals to substantiate this claim.

If you are not present to hear of the new development, you may never have the opportunity to put it in practice. If you are present but do not have a published reference, you have only your own memory and notes to aid you in attempting it or in telling others of it. With the lack of an accurate written chronicle, progress is slowed as considerable time and effort is spent reinventing the wheel. The end result is that progress in prosthetics and orthotics advances unevenly and imperfectly to the detriment of the patients we are dedicated to helping. After some new development is presented it is not at all uncommon to hear someone say "So what—I did that three years ago." The fault lies not with the individual who had the initiative and energy to tell his colleagues of his work, but with the person who couldn't be bothered.

It is the duty of every professional to advance not only his own standard of practice but also the standards of the profession as a whole. One advances one's own standard of practice by keeping current with new developments, by implementing them, and by striving to build upon them and develop new procedures. One advances the profession's standards by transmitting new developments to one's colleagues. The most efficient and durable way of doing this is by doing it in writing. The reasons we as a profession have neglected this vital obligation are not hard to fathom.

Unlike the academic professions where the "publish or perish" syndrome prevails, success or failure as a prosthetist/orthotist does not hinge on one's ability to write. Only in recent years, with the advancement of standards for entry into the profession, have communication skills been a criteria for being a prosthetist/orthotist. At a more fundamental level, writing an article is a solitary, time-consuming chore that often goes unrewarded, while giving a verbal presentation oftentimes is rewarded with a free trip to somewhere and the attention of one's peers while you give it.

Recognition of the problem has been widespread. One attempt to counter it has been Michael Quigley's "Author's Assistance Progam." T.R. Owens, C.O., in response to the problem, requested one of the authors (C.H.P.) to give a presentation on the topic at an AOPA Regional Meeting in San Antonio, Texas, in May, 1983. It was T.R. Owen's belief that if an outline could be developed, an individual would add a few words to it, and that someone more experienced could take the results and refine them into a finished article.

This article is essentially a merger of the two approaches and an attempt to reach a wider audience. It presents not only suggestions on format, but also details on the preparation of the manuscript and illustrations and what to do with them afterwards. The hope is that it will simplify the process enough to encourage someone to write who would not otherwise attempt it. The object is to get something recorded on paper. If a manuscript, however crude, has merit, there are adequate facilities to refine it.

FORMAT

The most difficult problem any fledgling writer faces is how to organize and present his material. In its most basic form, any article is divided into three parts—introduction, body, and conclusion. The introduction obviously acquaints the reader with the subject and provides background information necessary to understanding the author's main topic. The body presents this main topic in as much detail as necessary. The conclusion brings the article to a proper ending by briefly restating the main points of both the introduction and body. Each of these three parts consists of various subparts and, if necessary, one or more of these subparts may be so large as to warrant a subheading of its own. Such subheadings include: review of the literature, method, clinical material, results, and discussion.

Any article, however long and elaborate, is an attempt at imparting information and to answer a variety of questions. In the appendix a simple format is presented for each part of the article and a variety of questions have been posed. One way to go about writing an article would be to sit down and answer each of these questions. The various questions raised may be moved about and indeed even eliminated if that proves helpful.

The best way to learn to do something is to imitate someone experienced at it. Anyone attempting to write an article should read a variety of articles, especially from recent issues of the journal to which he intends to submit his article. Of particular note in this regard are two books: *Selected Articles from Artificial Limbs* and *Selected Reading—A Review Of Orthotics and Prosthetics*. The various journals of associated professions should be consulted. These include *Journal of Bone and Joint Surgery*, *Archives of Physical Medicine and Rehabilitation*, and *Bulletin of Prosthetic Research*. One cautionary note in regard to these various journals is necessary, however.

Most journals describe the results of various research projects. For these projects to be recognized as scientifically valid, they must adhere to rigid protocols. The articles desribing the results are similarly "force fit" to a common mold and subjected to an elaborate review process. Indeed, so elaborate is the process in some cases, that it can take two years or more to get an article published. The situation in prosthetics and orthotics is quite different.

Not only do we use a less elaborate review process but for the most part the articles published do not describe research projects. We are far more likely to be concerned with the technical how-to-do aspects of a subject. Validation comes not from the use of statistics and double blind tests but the individual's subjective reactions of relatively few patients. This is a fundamental difference in purpose that affects the style and format of an article.

STYLE AND CONTENT

The field of prosthetics and orthotics sponsors three publications. The *Almanac* appears monthly and features news and current events. The journal, *Orthotics & Prosthetics* is intended as a scientific publication that in an objective verifiable fashion describes new devices and procedures as well as the results of scientific investigations. *Clinical Prosthetics & Orthotics (C.P.O.)* addresses broader, more philosophical issues, and by its very nature is intended to be more subjective; it endeavors to publish editorials and to stimulate discussion, pro and con. Both *Orthotics & Prosthetics* and *C.P.O.* publish technical notes: this article presumes that the aspiring author will be writing a technical article for *Orthotics & Prosthetics*.

In writing an article the author should bear in mind the reason he is writing it. He is attempting to communicate to his fellow practitioners news of a new device or development that he has found useful in his practice. He should tell them what it is, why it came about, and how to do it. Appropriate precautions should be taken in telling what it does, how to use it, and for whom it is good. Wild or extravagant claims should be avoided.

No journal with pretentions to being scientific or objective can put itself in the position of publishing a commercial advertisement in the guise of an article. It is all well and good for an author to have a vested interest in describing a development, but he must take due care in doing so. The advantages and disadvantages should be set forth honestly and nothing should be said that cannot be verified. His interst in the item should be clear. If an author finds himself troubled by this point he would do well to review the recent articles of Timothy Staats, C.P.O., and Carlton Fillauer, C.P.O., as examples, and to discuss the matter with the editor.

A technical note differs from a lead article in length and formality. Essentially it is intended to describe a simple modification or variation of an existing technique that does not merit the full-blown formal treatment of a lead article. It should contain the same sort of information, but in shorter form with little or no background information with few, if any, references, and maximum reliance on photographs.

TITLE

The title should succinctly and accurately describe the topic of the article. Its purpose is to get the reader's attention. The title is often used as a basis for listings under a variety of subheadings in medical abstract publications (Fig. 1).

18. PROSTHESIOLOGY

18.1. Prosthetics

266. A case of forearm amputation with additional multilevel partial amputations - Fogdestam I., Hamilton R. and Lundborg G. - Dept. Plast. Surg., Univ. Goteborg, Sahlgrenska Sjukhuset, S-41345 Goteborg SWE - *HANDCHIRURGIE* 1981 13/1-2 (120-125) - summ in GERM, FREN

A right-handed 4½-year-old boy had a sharp amputation 3 cm proximal to his left wrist joint in a hay-cutting machine accident. In addition, he

Fig. 1. An accurate title is important as many articles are listed by title in medical abstract publications. The example shown above is from *Excerpta Medica Rehabilitation and Physical Medicine,* a publication that summarizes hundreds of articles from many related journals.

AUTHORS

The names of the author or authors should appear next and with them their degrees or qualifications. A separate footnote for each author at the foot of the first page or at the end of the article should identify his position or title, and address. Authors' names may be listed in order of importance or alphabetically. It is common practice to add the names of other professionals as co-authors if they provided assistance in the development of the new technique, even though they did not help write the article. The first name to be listed is most important and should be the one responsible for the article. If you cannot decide whether or not an individual should be listed as a co-author, it is best to include his name to be safe and prevent misunderstandings.

REFERENCES

Each reference should be identified the first time it appears in the text and consecutively numbered. Thereafter it is referred to by the same number. In the bibliography there is a correct form for describing each of a variety of sources. The correct forms will vary from journal to journal. For *Orthotics and Prosthetics*, they are:

a. Book

Murphy, Eugene F., Ph.D., "Lower-Extremity Component," *Orthopedic Appliances Atlas*, Vol. 2, J.W. Edwards, 1960, pp. 217–224.

b. Journal Article

Panton, Hugh J., B.S., C.P.O., "Considerations for Joints and Corset," *Newsletter . . . Amputee Clinics* 8:3: June, 1975, pp. 1–3, 6–7.

c. Lecture or Verbal Presentation

1. Holmgren, Gunnar, "The PTB Suction Prosthesis" from the written material of a lecture delivered at the third of the "Strathclyde Bioengineering Seminars" 8–11 August, 1978.
2. Wagner, F.W., Jr.: "Classification and treatment for diabetic foot lesions"; Instructional Course, American Academy of Orthopedic Surgeons, New Orleans, Louisiana, Feb. 1976.

d. Personal Communication

Irons, George, C.P.O., Personal communication, June 1977. Presently, Director of Research, United States Mfg., Glendale, California. Formerly, Research Prosthetist, Patient Engineering Service, Rancho Los Amigos Hospital, Downey, California.

ILLUSTRATIONS

Good photographs are extremely important for orthotics and prosthetics articles, as a device cannot be described adequately in words alone. While it is possible to print illustrations from Polaroid photographs, far better quality is obtained from black and white prints. Color slides cannot be used. Thirty-five millimeter cameras with electronic exposure controls are readily available today, convenient to use, and give better results than "instamatic" style cameras.

Considerable care should be taken during the photographic session to arrange proper lighting, frame the shot, and to avoid distracting clutter in the background (refer to the Forsgren, Hittenberger article in this issue). If more than one person is involved and especially if the photographer is not totally familiar with the subject, the matter should be thoroughly discussed and what is desired to be shown in each view identified.

Action shots should be kept to a minimum, but, when necessary, the motions should be rehearsed and allowance made to do it more than once if possible. Plan on taking four to five times as many photographs as will actually be used. Photographs can, of course, be useful other than just as illustrations.

In writing about a technical procedure or process, many individuals have found it helpful to first take a full series of photographs and then to arrange them in proper order. This helps the writer to organize his thoughts and to make sure he does not miss a point. The task then becomes one of writing a narrative describing the technical procedure illustrated and of filling in the blanks that cannot be properly shown in a photograph. Each photograph should be numbered and referred to appropriately in the text. If doubts exist as to which of two photographs properly illustrates a point, use both but give them a separate number. The editor can always eliminate one.

Captions should be provided for each photograph. The captions can repeat portions of the text, and can stress certain aspects of the technique or device that would be difficult to describe by words alone. Captions for all illustrations can be typed out on one sheet that can be attached to the end of the article.

Graphics, or drawings, are very helpful. One good drawing can clearly illustrate a number of points, where photographs may fall short. Graphic drawings are not expensive. Most printers can refer you to an artist who can convert your idea to a professional illustration for a moderate fee. Graphics add clarity to articles and present a professional touch.

PREPARATION OF THE MANUSCRIPT

When the author is satisfied with the final content of the article, a process which may take two or more revisions, he should prepare it for mailing to the editor. The manuscript should be typed double space, with wide margins, and on a single side of the paper. Each page should be numbered, for the convenience of the editorial staff during the editing process. Similarly, three copies should be sent. Care should be taken not to mar the face of the photographs, and, if they are mounted on paper, to use only rubber cement. On the back of each photograph indicate proper orientation by using an arrow pointing up, give the last name of the first author, and the figure number. The manuscript, caption, list, and photographs should all be checked carefully to make sure that the numbers of illustrations, captions, and references match those in the text and are in proper order.

The three copies of the manuscript and the photographs should be mailed flat in a large manila envelope with cardboard sheets or a manila file folder used to protect the photographs. For caution's sake, the author should retain one copy of the manuscript, the negatives, and if at all possible, a set of the prints for his own records. A brief cover letter should accompany the manuscript. Mail to:

Managing Editor
Orthotics and Prosthetics
National Office
717 Pendleton Street
Alexandria, VA 22314

THE EDITORIAL PROCESS

When it is received, the managing editor sends a letter acknowledging receipt of the article to the lead author and makes copies for distribution to the Editorial Board for their review. Two originals with photographs are mailed to the editor. The Editorial Board consists of six orthotists and prosthetists who are appointed by the AOPA President to review the articles submitted for publication. Editorial board members voluntarily read every article and review it using a brief review form. The Editorial Board's recommendations determine which articles are published, and frequently recommend that more information on a certain aspect of a technique be clarified. Specifically, the Editorial Board looks at the following aspects when reviewing each article:

1. Clear and understandable description of the technique.
2. Adequate explanation of indications and contraindications.
3. Validity of studies when a number of cases are reviewed and statistics are used.
4. Correct terminology.
5. Author's bias.

Finally, the Editorial Board determines whether or not to accept the article and the priority for publication. The Editorial Board forwards its comments to the editor.

The editor of the journal is a prosthetist/orthotist employed by AOPA with overall responsibility for the scientific, technical and grammatical aspects of the journal. The editor works closely with the Editorial Board and meets with them on an annual basis. The editor reads the reviews of the Editorial Board members and acts upon their comments by editing the articles, getting more information from authors, notifying authors of acceptance or rejection of their articles, and by determining which articles will be published in each issue. The editor checks every article a minimum of three times for spelling, grammar, format, terminology, references to illustrations, etc. Once the editor has completed his initial work on an issue, the entire issue is forwarded to the managing editor and his assistant at the AOPA National Headquarters.

The managing editor is on the National Headquarters staff and is responsible for all publications. Once he receives the journal from the editor, he reviews the manuscript for any further editing, marks the copy for typesetting, and forwards it to the typesetter. After the type is set into long columns called "galleys," the managing editor and his assistant then lay out "dummy" pages resembling the pages in the journal allowing space for any advertisements and announcements. These dummy pages are mailed to the editor for his review. At this stage, editorial changes can still be made, but they are more expensive because the type must be reset.

Once the typesetting and pasteup are complete, and reviewed at the National Headquarters, the journal is forwarded to the printer, who adds all illustrations and makes a "blue line" copy of the journal that looks the same as the final printing will look. Small errors can still be corrected on the blue line copy, but all corrections at this stage are very expensive. The blue line is reviewed by the editor who then phones in his corrections to the managing editor.

When the journal is printed, extra reprints are provided to the authors of each article.

The time from submission of an article to actual printing averages from between six months to one year. The earliest an article can possibly be published is three months from the date of its receipt at the National Headquarters, and that only occurs when the article is extremely well written and is considered by the Editorial Board to be of high priority.

CONCLUSION

As professionals, we are obligated to do what we can to advance the state of the art and share new developments with each other; the most lasting way to do this, and the way that has the greatest impact, is to write. There are a variety of reasons why most of us do not live up to this obligation, but ultimately all these reasons boil down to one thing. Inertia! When we consider the magnitude of the task and the time available, most of us give in to inertia and nothing gets done.

The only way to tackle any large complex task is to break it down into a number of simple small tasks that can be accomplished in the time available. As with any such job, the first task is to get organized and develop a scheme of action. This article has been developed in an attempt to assist you in overcoming the first hurdle. Once a beginning is made, and if the basic principle of doing one small task at a time is adhered to, then finishing the job simply becomes a matter of perserverance.

APPENDIX I

with

Outline, Suggested Titles and Subtitles

Title of Article

Author(s)

Introduction

Description of device or technique
- Review of previous methods (refer to articles when possible)
- Indications and Contraindications
- Follow-up experience

Description of Technique

- Patient evaluation
- Negative impression procedure
- Positive model modifications
- Fabrication
- Fitting procedure
- Finishing
- Instructions to patients
- Follow-up schedule
- Modifications of technique for other circumstances

Discussion

Patient preferences, planned improvements, overall experience with technique, number of patients fit

CONCLUSION

Brief statement summarizing major reasons why the technique is used

References or Bibliography

APPENDIX II

The following gives a list of some of the questions an author might wish to address in his article and an order in which he might consider them. Some of the questions have been stated in more than one fashion. For a particular article it may not be necessary to answer all the questions. It may be desirable to change the order.

I. Introduction (Background information and basic description of idea)

What is your new development, device, procedure, material?
What are its advantages?
What are its disadvantages?
Why did you develop it?

What are the current or old ways of doing the same thing?
What is wrong with each of them?
Why is your way better?
What variants did you work with before you settled on this final version?
Why is it better?
How would you describe it?
What are the properties of the new material?
What is the mechanical, biomechanical, physiological basis behind it?
What are the specific precautions to be observed?

Results
How long have you used it?
How many patients have you used it with or for?
How many of them liked it?
How many disliked it?
Why?
What advantages did they observe?
What advantages did you and others observe? Disadvantages observed by them, you, and others?
How many of the new device or devices fabricated with the new material or process failed?
Why?
What did you do to remedy the situation?

II. Body (How To)

A. Patient selection criteria
For what specific situation do you recommend this?
What do you discuss with the patient to make sure he is interested?
Advantages?
Disadvantages?
What do you look for?
Patient evaluation procedures?

B. Measurement
What materials and devices do you need?
How do you position the patient?
What is the patient to do to assist you?
What is the assistant to do?
Is it necessary to rehearse the position with them?
What landmarks do you mark?
What measurements do you take?
How do you take the cast?
What type of plaster of paris bandage do you use?
Any special precautions to be observed in preparing the measurements and training or in pouring the positive mold?

C. Model Modification
Where do you remove material; how much?
Where do you add material; how much?
What do your measurements tell you about the model, how do you use them, what are the tolerances and reduction factors to be observed?
What are your trimlines?
How do you prepare the model for fabrication of the device?

D. *Fabrication*
How do you do it?
How much do you use?
What do you use?
What size, thickness?
How do you prepare it for use?
What temperature?
How long?
How do you handle it?
How many people?
Special precautions?
Cooling, drying, setting time?
Trimlines?
How do you finish it?

E. *Fitting*
What position should the patient be in?
What should he be wearing next to the skin?
How do you don the device?
How do you evaluate fit?
How do you evaluate function?
Specific trouble spots?
How do you modify it?
How do you take it off?

F. *Finishing*
How do you finish the device?

G. *Delivery*
What should the patient be told to watch out for during the break-in period?
Specific areas or spots?
How long to wear at a time?
How long to take off?
Length of break-in period?
When should they get in contact with you?
What do you look for in evaluating final fit and function of the device?
Specific problems they should look for?

H. *Follow-up*
When should you see the patient again?
How often?
What should be done?
Specific precautions?
Training necessary?

III. Conclusion
Briefly summarize the main points of the article telling what, why, and advantages at the very least. Generally, just a few sentences and rather stilted in tone.

Planning and Producing Slide Presentations for Orthotics and Prosthetics

Shirley M. Forsgren
Tina L. Hittenberger, C.O.

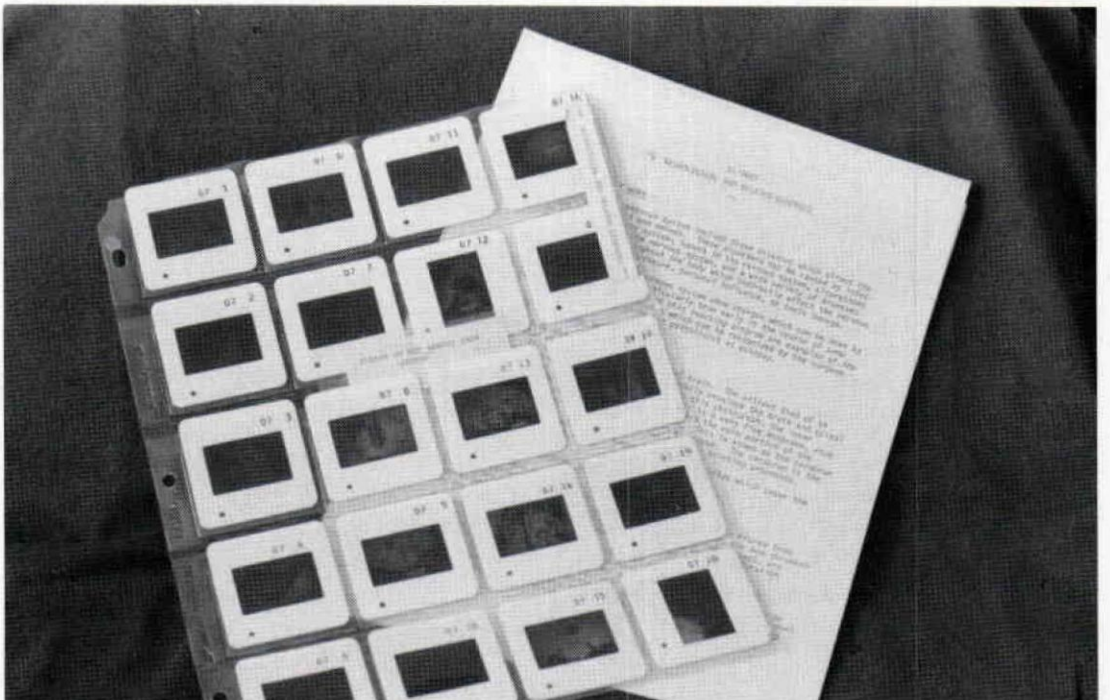

Fig. 1. Slides can supplement the text of the speech and reinforce the key points.

INTRODUCTION

Slides and audio-visual presentations are recognized as a medium in medical presentations and are effective in training patients, doctors, therapists, agencies and professional personnel. With proper visual support, the impact of any speech can be greatly enhanced. Visuals encourage a smoother flow of communication from the speaker to the audience and, when used properly, can even accelerate the flow of communication and further the audience's retention. Slide presentations are the visual support that can aid orthotist or prosthetist by clarifying and amplifying the message with concise visual simplification.

The purpose of this article is to instruct the orthotic-prosthetic practitioner in the use and technology of slide presentations. High quality, visually appealing slides are essential for a successful presentation. Slide support can supplement the text of the speech and reinforce its key points by giving the audience facts, examples, illustrations, contrasts, and motivation (Fig. 1). For the most effective presentation, slides should be chosen that build around the speech. The ideal situation is, of course, to work with a specialist in the preparation of a speech and the production of slides. But no matter who plans the presentation or who prepares the visual aids, the following procedures will ensure a quality product.

PLANNING THE PRESENTATION

Know the audience—never underestimate their intelligence, and never overestimate their interest. Respect their time and their right to not listen. Most people in an audience are experienced at looking attentive. Engage them in thinking, comparing, experimenting with a new perspective. Keep your presentation brief: there are few things worse than nothing to say—except taking a long time to say it.

Have a clear purpose. Before outlining the information in your presentation, ask the simple question: What am I trying to say? Answer this question in one, simple sentence. Most often a speaker wants to change something (an attitude, a misunderstanding, a point of view). Know the result that is to be produced. The presentation is less likely to be boring if the audience is considered first and the presentation second. It must relate to their needs. Few people are interested in more information unless it is relevant to them personally, would be of value in their practice, or is critical to their professional expertise. Ask yourself these questions: Who is the audience? How much do they know? How much are they able and willing to understand? How can they be interested in this subject?

ORGANIZING THE PRESENTATION

People remember more when they see as well as hear. Well-organized slides allow the speaker to document the past, focus on the present, and project the future. Visual impact can convey ideas that would not otherwise be as easily or readily understood. However, the process of "letting the pictures do the talking" involves thinking visually.

Once the subject matter has been determined, slides should be selected that visually outline and emphasize the main points of the presentation. Each frame should contain only a single idea in the simplest form possible. Before photographing such ideas or examples, illustrate that point with a general sketch on a single card. Group these sketches together in sequences. Sort out, but do not discard, the impractical or irrelevant ideas (they may be the basis for another presentation). Ask: Is this slide necessary? Does it have continuity? Does it add to the presentation? Are distractions removed? Is it the best way to illustrate the point? *If you cannot visualize an idea, consider rewriting it.*

Most slides are projected for less than one-and-a-half minutes. Keep it simple. Separate the information on each slide. Add a variety of angles, close-up shots, and perspective. Do not have too much to say on one slide. Each slide should be loaded and marked accurately. The 80-Slide Carousel Tray is recommended (Fig. 2), as the 140-Slide Trays tend to lock or jam slides. Even with slides of the finest quality, a presentation can be ruined by malfunctioning equipment or disorganized slides. If the slides are out of sequence, upside down, or remain on the screen for too long a time, they will lose their impact.

EQUIPMENT

Never let the equipment determine the format or content of the program. There are technical brochures, schools and classes available for every piece of equipment. The most expensive is not always necessary.

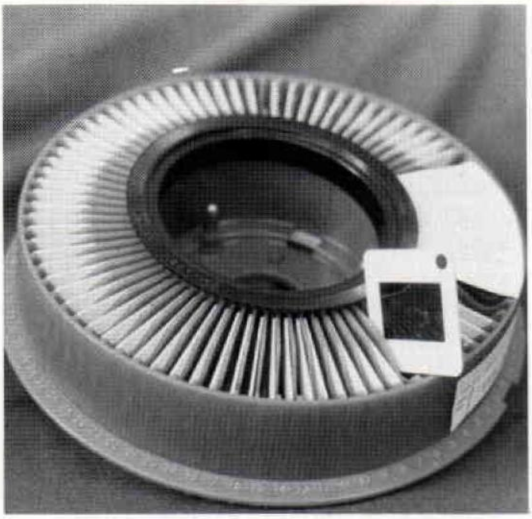

Fig. 2. The 80-slide tray is recommended to prevent jamming. Each slide should be loaded and marked accurately.

There is no need to be a professional photographer—just approach it that way.

The 35mm camera is recommended for flexibility, accuracy, and control. Two cameras at the same time are necessary if black & white photographs (for publication) are also required. Polaroid cameras are good for instant documentation, but remember that their prints are hard to duplicate and slides cannot be produced from Polaroid prints.

A copy stand is absolutely necessary for photographing books, flat documents, title slides or precision close-up shots. These stands eliminate distortion and assure proper focus, exposure, alignment, and positioning. Copy stands can be either purchased or simply constructed by using a stable platform and an adjustable bracket for the camera. An illuminator is useful for comparing subjects, checking exposure, and inspecting slides. An illuminated editor (Fig. 3) is even better because it is

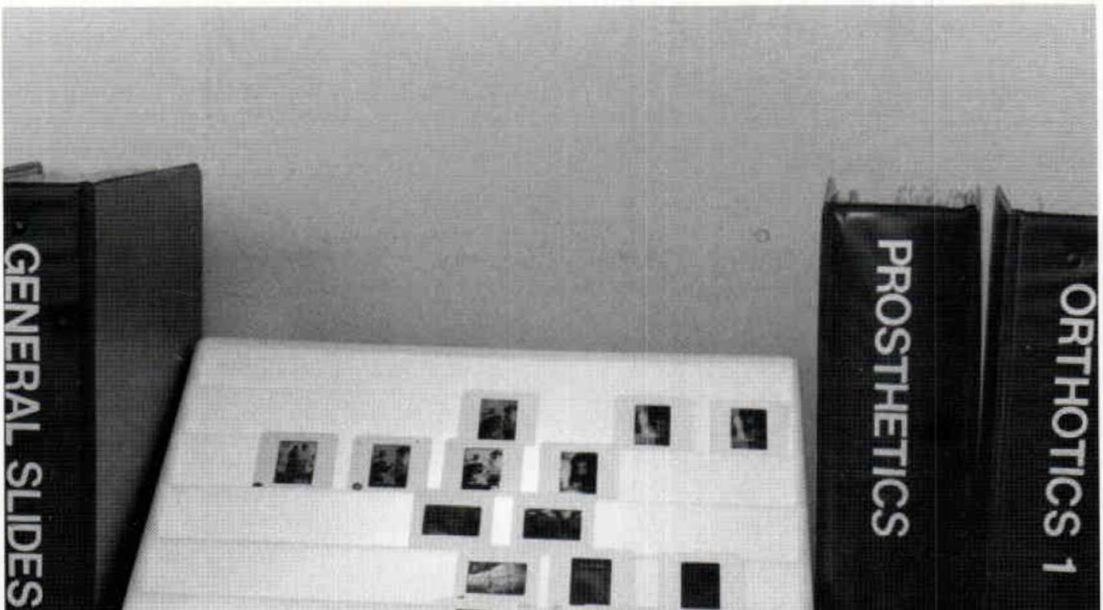

Fig. 3. An illuminated editor can be used to review and organize slides.

specifically designed for editing, previewing and organizing an entire presentation. More elaborate illuminated editors can also be used for storage.

The projector is the final, and critical, link in the complete presentation. When a projectionist is available, clearly mark the slide trays with the title of the presentation, time and the speaker's name, and give them directly to the projectionist. Request to have the remote control attachment located on the podium. It is a distraction to keep asking the projectionist for "next slide, please." Several preliminaries and many rehearsals will ensure a smooth-running presentation.

More sophisticated slides presentations engage mutliple projectors, dissolve units, sound synchronization, and multi-media demonstrations. Keep in mind that more equipment exponentially complicates the program, and gives multiple opportunities for equipment failure and uncertainty. Simplicity and well-rehearsed familiarity can often produce a far more efficient, confident and successful presentation.

TITLE SLIDES AND ARTWORK

Titles are important to the slide presentation to introduce the program, answer questions, bridge gaps, introduce a new concept, or emphasize a specific point. There are a number of ready-made title subjects available for immediate shooting such as signs, billboards, nameplates on equipment, labels on doors, etc. Title slides can also be "custom-made" quickly, inexpensively, and easily.

The simplest title slides are write-on slides. On these blanks, the speaker can add drawings, diagrams, comments or titles. For a more professional look, presstype letters are recommended. No photographic developing is necessary with the technique, therefore it is excellent for the last minute changes or when working with existing slides that simply need to be organized and titled.

Title slides can be simply typed on a typewriter and then photographed, but the results are usually uninteresting. The amount of type per slide should always be limited to three or four lines, with no more than seven words per line. Adequately space the type and letters within the slide frame, leaving plenty of open space. Between the lines, always leave space equal to the height of a capital letter. A black background will increase legibility; the familiar diazo slide is royal blue with white letters. The diazo slides are commercially prepared or can be produced by a medical photography department in a hospital.

More interesting title slides can be bold and creative using presstype letters on bright colorful backgrounds, or on sheets of acetate gels with graphic backgrounds. These backgrounds can be photographs from medical journals, magazines, cartoons, illustrations from books, historical photographs, artwork, or a limitless source of excellent visual communications. Transfer letters are easy to apply and give the impression of a neat, professional printing job. Because the work message is on the transparent sheet, the same background can be used over and over again with different gels. These creative backgrounds provide a psychological effect to hold the audience's attention and interest.

All illustrations should be simple, bold, and graphic. Never copy graphs or complicated diagrams directly out of books. They are difficult to read at a distance and, unlike reading a book, the audience does not have the luxury of studying the drawing in detail and analyzing the content. Do not insult the audience by reading line by line off a tabular chart. Be sure to use round numbers and keep the captions to a minimum. If tables must be used, don't crowd the slides. Draw diagrams, charts and graphs to read horizontally, clearly and simply. To attract attention and lighten the tone of the presentation, cartoons are ideal. However, do not include pictures that have nothing to do with the presentation simply for shock value. It is common sense: irrelevant visuals only ultimately detract from the speech.

For a complex concept, use a series of simple visuals. Use many illustrations rather than one confusing drawing. One technique for presenting a list of items is to use Progressive Disclosure. This technique builds on the next slide and allows the presenter to disclose and emphasize each point as they are ready. It is an exciting way to pace a presentation. The method is extremely simple: merely shoot the entire list or completed photo, then remove a section, shoot, remove another section shoot and so on. For the presentation, simply project the slides in reverse order. The illustration or list will appear to "grow" before the audience's eyes. Similarly, motion can be simulated by repeating different positions of slides in rapid succession. The same slides can also be used more than one time in a presentation to emphasize or reinforce an important point.

COMPOSITION AND PHOTO TECHNIQUES

The art of photography is selection. Editing and composing can be done right in the camera. Similarly, selective forms can eliminate such confusion. By intentionally blurring a background or by having a closer shot, the resulting slide becomes more interesting. There are long, medium, and close shots. Look at the purpose of the shot and then determine the proper perspective to be viewing the action. Simply—look before you shoot and shoot with a purpose. A photograph can be candid (there is a low probability of effective composition), arranged, or staged depending upon the photographer's attention. The "rule of thirds" suggests that the main subject be located at a point where visual lines intersect. Symmetry can be used for accent, horizontal placement is generally relaxing, and diagonal visual lines are dynamic. Knowing these basic visual laws of composition can be useful in avoiding the "snap shot" or unprofessional look of amateur slides.

All "studio" shots (that is, shots taken where there is some control of the environment) should be professional. Backdrops add visual clarity, focus, contrast, and start building consistency in a slide library. Drapes should be dark, unwrinkled and cover all irrelevant areas. Using a system of propping or wedging will result in a clean and stable-looking subject. Only the well-manicured hand should be included in any photograph—and only if it is used for scale or is an integral part of the device.

Photographing people is a particularly delicate area in orthotics and prosthetics. Every person has the right to refuse to be photographed. It is unwise to publish or show the face without a written release granting permission to do so. Masking facial features, or photographing only the body or extremities are the most practical methods of concealing identity. Editing and composing in the camera often eliminates much unnecessary embarassment. It is imperative to remember that people with deformities, abnormalities or amputations are often self-conscious. Explanations should always be made to the patient as to how the photograph will be used. A dark drape, again, is useful in both composing the photograph and in easing the patient's attitude. In addition, patient street clothing rarely contributed to the photograph. The drape eliminates most distractions.

Another technique for effective photographs is the use of masking and taping. Silver tape may be used to improve slide composition, block out irrelevant information, conceal a patient's identity, or emphasize a particular area. This is also useful in title slides when background edges are visible. Masking slide mounts are available at the same photographic stores where silver tape is purchased. These mounts allow the combination of one or more slides on the same mount. By using these mounts, comparisons are more easily identified and they add visual interest to the standard horizontal format.

One final note to the photographer: *take two shots—always.* Take multiple exposures, multiple angles, multiple perspectives, especially when photographing people. The opportunity may not come again. Secondly, the cost of a duplicate slide is far more expensive than the click of another frame. In building a slide library, multiple slides allow for many complete programs rather than having to reshoot or reorganize for each presentation.

CARE AND HANDLING OF SLIDES

The primary factors affecting color slides are light, moisture and heat. Avoid projection times longer than one minute. Also, do not allow color negative to remain on the illuminated editor for an extended period of time. Store them in transparent plastic sleeves or slide trays (Fig. 4). There are two other lethal enemies of slides: fingerprints and dust. Slides can be professionally cleaned, but throwing then in a drawer is not only disorganized, but it will also ruin the slides.

Transparent plastic sleeves may be stored in labeled notebooks. Slide trays are ideal for storage purposes. They keep the slides clean, orderly and always ready for the next presentation. Trays should always be carefully handled.

The production of an effective slide presentation involves planning, visual design, composition, photography expense, time in preparation, rehearsals and careful protection. The accumulation of a complete slide library represents a considerable investment of time, money, and a commitment to education, vision, and the profession. Slides should be treated with all the care, respect, and integrity that has gone into their production.

CONCLUSION

The production of slide programs is technically not difficult, in fact, it can be recreational. The careful planning, preparation and professional presentation is well worth the effort. Well-produced programs result in an effective demonstration of skill and expertise. The goal is to keep them simple—the result is a visual impact that conveys more than words alone.

Shirley M. Forsgren is with the Prosthetics Research Study in Seattle, Washington. Tina L. Hittenberger is Vice-President of Hittenberger's, Inc., in San Francisco, California.

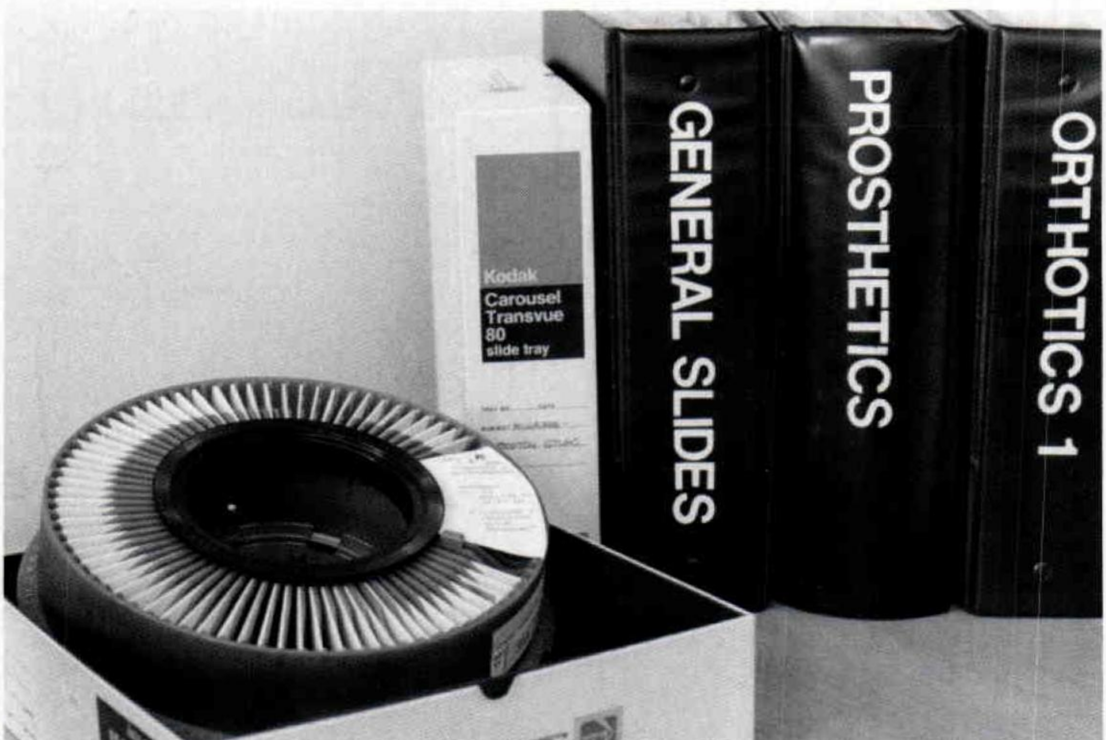

Fig. 4. Slides should be stored in trays or in transparent plastic sleeves, which can be kept in binders.

Appendix

Slide Resources

A Guide to Medical Photography by Peter Hansell, University Park Press, 233 East Redwood Street, Baltimore, Maryland 21202, c. 1979.

Available Publications of particular interest to persons producing slide programs for any audience:

Kodak Guide to 35mm Photography	AC-95
Kodak Color Films	E-77
Sources of 2 × 2 inch Color Slides	S-2
Audio-Visual Projection	S-3
Images, Images, Images—The book of Programmed Multi-Image Production	S-12
A Pre-show checklist for effective dissolve Projection	S-14
Speechmaking—more than words alone	S-25
Slides with a Purpose	I-15
Presenting Yourself, by Michael Kenney	S-60 (new)
Reverse Text Slides	S-26
Kodak Sourcebook—Ektagraphic Projects	S-74
Kodak Ektagraphic Tray Bands (for Single and Multi-Images)	S-85
Kodak Ektagraphic Tray Bands (for Dissolve presentations)	S-86
Basic 2 × 2 inch Slide Packet	S-100
Clinical Photography	N-3

The Communicators Catalog:

Publication #S-4 lists approximately 250 Publications covering Kodak products and services in professional motion pictures, television and audio-visual applications.

The Index to Kodak Information:

Publication #L-5 is a comprehensive listing of approximately 800 Publications produced by Eastman Kodak Company.

One FREE COPY of each of the Indexes (The Communicators Catalogue and the Index to Kodak Information) can be obtained by writing to:

Eastman Kodak Company
Department 412 L
Rochester, New York 14650

Services of Commercial Laboratories

You may find it practical to use the services of a commercial laboratory that specializes in processing slides. If so, you or your staff would make all of the original photographs and the artwork and then order slides from the laboratory. Because prices and quality vary radically, we recommend using only reputable laboratories. The names and addresses of color laboratories are listed in:

Photo Methods for Industry Catalog
Director of Products and Services
Ziff Davis Publishing Co.
1 Park Avenue
New York, New York 10016

and

Industrial Photography
1980 Gold Book Directory of
Photo Equipment and Services
United Business Publications
750 Third Avenue
New York, New York 10017

Technical Note:

Elastic Suspension Sleeve for Below the Knee Prostheses

Jon P. Leimkuehler, C.P.O.

A system involving an elastic knee support to suspend a below the knee prosthesis has been in use, for selected patients, in our facility for more than eighteen months (Fig. 1). The idea originated as an alternative to the latex suspension sleeve, and although it is used in a manner similar to the latter, it has many advantages over the sleeve.

An elastic knee support such as Bell Horn Model 120 (Fig. 2) or any other comparable support may be used. Although supports are available in sizes small to large, small and medium are most often used.

The sleeve may be the only means of suspension on a PTB or may be worn over a cuff strap for added effectiveness. For a PTB SCSP in which a fleshy thigh prevents good suspension, this sleeve may enable the prosthesis to function without additional straps or a belt.

The elastic suspension sleeve cannot always replace a cuff strap and belt or a latex sleeve and is effective only for selected patients. In some who are not good candidates, there is pistoning or sliding up and down. The sleeve is not recommended for a new amputee who will shrink a great deal or for the young active amputee.

Fig. 1. Elastic knee support suspending a PTB below knee prosthesis.

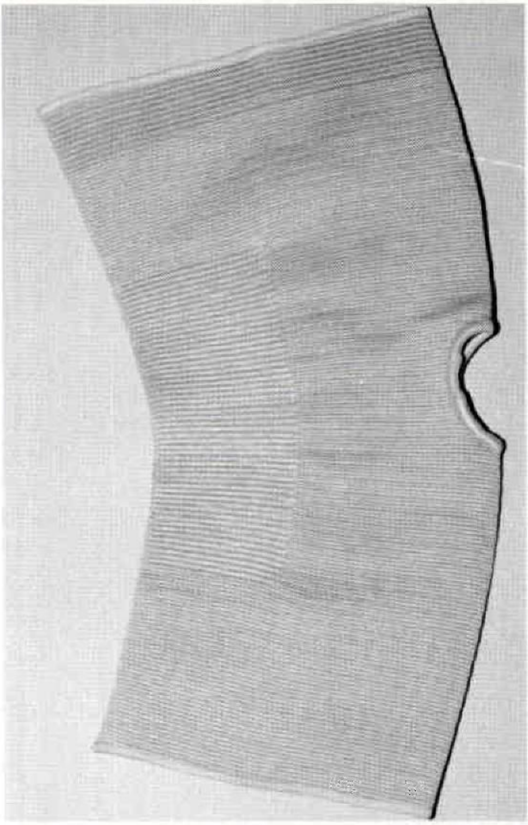

Fig. 2. Bell Horn model 120 knee support.

Fig. 3. Pulling on the elastic suspension sleeve.

Fig. 4. Amputee sitting with knee flexed at 90°. Note the smooth appearance as compared to the conventional cuff strap.

The elastic sleeve works well on a very light weight prosthesis where the suspension demands are not as great and when the amputee is stable in size. It is especially indicated for the amputee who is thin and less active.

The chief advantage over a latex suspension sleeve is that it is easier to pull up over the knee (Fig. 3). Also, due to its porosity, perspiration is not a problem, as frequently occurs with the use of the latex sleeve. These are important factors, particularly for the geriatric amputee. The sleeve is comfortable with the knee flexed and provides a smoother appearance than the cuff (Fig. 4).

I frequently give the patient a choice of suspension system. In the alignment fitting, the prosthesis is worn with a cuff strap and belt and then with the elastic suspension sleeve and sometimes the latex sleeve. In this way the amputee can compare the systems and decide which works best.

CONCLUSION

The elastic suspension sleeve is inexpensive, easy to use and does not present a perspiration problem. As in the use of other suspension designs, patients must be carefully selected.

Jon Leimkuehler is Secretary/Treasurer of Leimkuehler, Inc. in Cleveland, Ohio.

Technical Note:

The Rapid Adjust Prosthetic Harness

Bob Radocy

Illustrated in the photos (Figs. 1 to 3) is a simple modification to standard Figure 8 or Figure 9 prosthetic harness systems to achieve increased flexibility in harness adjustment. This change allows a greater range of control for the upper limb amputee.

The modification employs the use of a lightweight, high strength buckle, similar in design to a seat buckle, which is added to the harness system, close to the retainer ring. The buckle allows the harness to be adjusted rapidly (approximately three inches in length), thereby varying the amount of excursion required to operate terminal devices using standard Bowden cable systems.

The primary applications for the Rapid Adjust System are the new voluntary closing GRIP[1] terminal devices, but the system is applicable to all types of terminals that use cables.

Unilateral amputees will find the most use for the Rapid Adjust System. A unilateral amputee can merely reach behind and under his shirt with his "normal" hand, release the buckle's locking clip, adjust the strap to suit the activity, and then snap the buckle's clip back into the locked position.

A rapidly adjustable harness gives the amputees greater freedom for reaching and grasping with a fully extended arm or additional security in manipulating objects in close to the body's median line. Lengthening the harness will aid in activities such as shoveling, swinging an axe, or manipulating objects above one's head or away from the body. Shortening

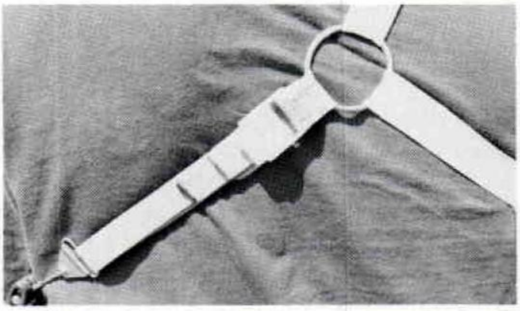

Fig. 1-A.

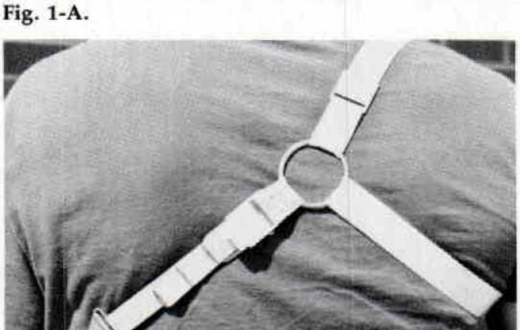

Fig. 1-B.

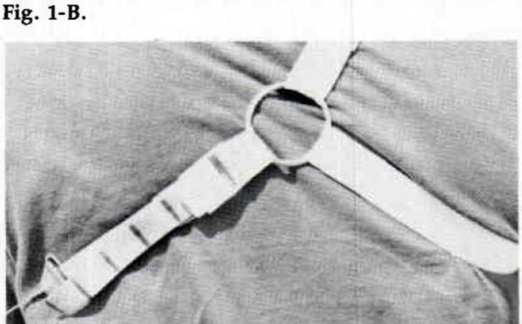

Fig. 1-C.

Figs. 1-A, 1-B, & 1-C. The Rapid Adjust System used on a figure 9 harness. A) The harness is lengthened for activities such as shoveling. B) Normal adjustment. C) Shortened for handling objects close to the body.

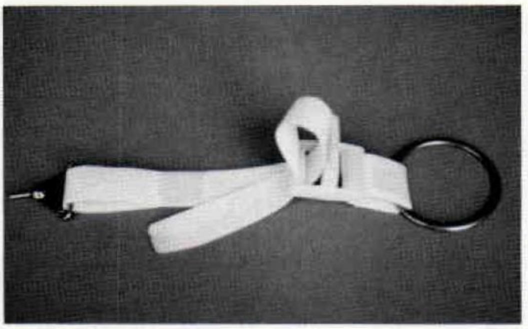

Fig. 2. A lightweight plastic buckle, similar to a seat belt, is used with ¾" Dacron webbing.

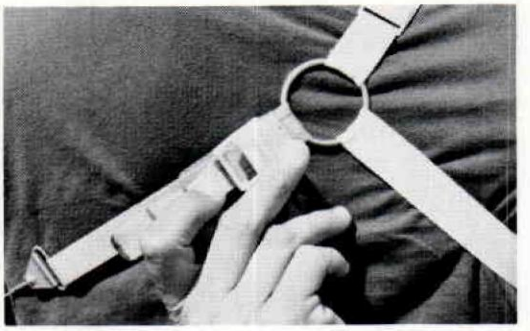

Fig. 3. The wearer can reach back with his "normal" hand and adjust the system.

the harness can improve dexterity during assembly tasks, handling utensils or other small objects, especially those in close to the body. Active amputees will find this buckle system useful in a variety of vocational and recreational situations where a standard harness might restrict the use of their terminal devices of movement of their residual limb and prosthesis.

The buckle is threaded using three-quarter inch strapping. Three-quarter inch strap can be used throughout the harness system or merely added at the buckle site as indicated by the model in the photos. The prosthetist will want to ensure that the length of the cable housing permits adjustability and that the cable itself does not bear upon the amputee's body during use, for comfort's sake.

Field testing on unilateral amputees indicates that it is advantageous to design the harness so that the retainer ring and buckle are located towards the middle of the back rather than higher towards the neck for easy access by the amputee.

Previously, these buckles* have been used in orthotics. The prosthetist should consider them as an easy answer to certain harness problems or purely to give the upper extremity amputee a greater range of capability in the use of his artificial limb.

REFERENCES

[1]GRIP is a registered trademark of Therapeutic Recreation Systems, Inc., and refers to the GRIP prehensile action terminal devices.

Bob Radocy is President of Therapeutic Recreation Systems, Inc., in Boulder, Colorado.

*Available from Feiner Brothers, Mineola, New York

REVIEWS

by Charles H. Pritham, C.P.O.

"A Helping Hand" a production of Film Arts for CBC (Canadian Broadcasting Corporation). 16mm, sound. 21 minutes. Available from Kinetic Enterprises Ltd., P.O. Box 232, 181 Notre Dame St., Westfield, MA 01085.

This film, which won first prize at the 1982 American Film Festival, describes the fitting of two preschool children with myoelectric below elbow prostheses. This work was undertaken by the staff of the Ontario Crippled Children's Center, Toronto, Canada. Anyone at all familiar with the field of prosthetics and orthotics knows of the work of this Center over the years.

The film is intended for a general audience, so that while it is of interest to people in the field, it contains a minimum of technical information. Nonetheless it does provide a good overview of the decision making process, the fabrication of, and the training with, the prostheses. Used by a skilled discussion leader, well familiar with the topic, it could be used as a precursor to a thorough exploration of the subject of externally powered prostheses.

A note of caution must, however, be sounded. Many in the United States would consider the very suggestion that these services are widely available as very disturbing. Anyone using the film and showing it to an audience, other than one quite familiar with the topic, would have to be most careful to point out (as does the film) that the film chronicles a research project undertaken by a very specialized and experienced Center. Moreover it should be borne in mind that the system of paying for medical care is quite different in Canada than it is in the United States and that this creates differences in and of itself.

Amputation Surgery and Rehabilitation—The Toronto Experience, edited by John P. Kostiuk, M.D., Pres. Churchill Livingstone, Inc., 1560 Broadway, New York, New York 10036. 448 pages, Index. $48.00, 1981.

The editor of this book states that it is intended to provide "the early and intermediate student" of whatever discipline with an overview of prosthetics. In fulfilling this purpose he calls upon the assistance of some 28 of his colleagues to cover a wide range of topics from history of amputatons and prostheses to social and psychological problems of amputees. Topics related to the needs of both children and adults are covered, with considerable emphasis placed on the question of the dyvascular amputee. Of particular interest are the chapters devoted to amputation following vascular reconstruction, limb replantation, and powered prostheses. While prostheses are discussed, they are purposely not covered in extensive detail.

In general, the various authors write clearly and concisely. Their opinions, and the reasoning behind them, are set forth so that while we may not agree totally with each author's position, we may profit from considering it. As the title imples, this is a survey of the field of amputation from the perspective of a definite locale and it does not attempt to be all things to all people. This should not be taken to imply that the book is tendentious or disagreeable in tone; it is not. Those for whom the book is intended should find it a useful introduction. The more experienced should find it equally useful as a refresher course and to reconsider the particular nature of prosthetics as practiced in their own locale.

Amputations: Immediate and Early Prosthetic Management, J.J. Gerhardt, M.D., P.S. King, M.D., and J.H. Zettl, C.P.O., Hans Haber Publishers, Bern Switzerland. 1982, 305 pages, 514 figures, Appendix, Bibliography, and Index. Available from: Jack K. Burgess, Inc., Publisher. 2175 Lemoina Avenue, Fort Lee, New Jersey 07024. $99.00 plus $2.00 postage charge.

This book is an interesting and worthwhile addition to the library of prosthetics. It provides a comprehensive and indepth review of the topic, placing particular emphasis on the importance of the team role. As with any such book discussing the management of amputees in western society it devotes considerable attention to amputations for vascular insufficiency. Techniques of assessing circulation, preoperative planning, and surgery are covered in moderate detail. Considerable space is devoted to a pictorial step-by-step description of methods of applying rigid dressings for various levels. Subsequent follow up is reviewed with a discussion of when and how to initiate and control progressive weight bearing and ambulation. Of considerable value is the attention paid to the role of the nursing staff; a matter oftentimes taken for granted with predictable results.

In a more general vein the book describes the history and development of the concepts involved and the advantages of the approach. Of special interest in this regard is an appendix that consists of excerpts taken from an article written by Dr. P.D. Wilson in 1922 in which he discusses use of early postoperative prosthetic management in World War I by himself and others. In this article he sets forth the advantages as he sees then and advocates adoption of the technique in peacetime. A number of other appendices are more puzzling. They deal with means of measuring joint motion and related topics. While of interest, their connection to the main thrust of the book seems somewhat tenuous.

Nevertheless, this is a well written book that should prove valuable in the clinical setting as well as in school.

ABSTRACTS FROM
Prosthetics and Orthotics International 1982

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317 East 34th Street
New York, NY 10016

April 1982, Vol. 6, No. 1

Retrospective study of 14,400 civilian disabled (new) treated over 25 years at an Artificial Limb Centre

I.C. Narang and V.S. Jape
ARTIFICIAL LIMB CENTRE, PUNE, INDIA

Abstract
This paper reports on 14,400 civilian disabled treated over 25 years at the Artificial Limb Centre, Pune, India. It examines in some detail sex and age distribution, cause of disability, levels of amputation, sources of payment and other factors relating to the rehabilitation of the patient.

Upper limb prosthetics for high level arm amputation

J.K.Ober
INSTITUTE OF BIOCYBERNETIC AND BIOMEDICAL ENGINEERING, WARSAW

Abstract
The paper covers the analysis of residual stump and upper body motions and their involvement in the patients' manipulatory functions. Attention is given to prosthetic techniques that do not restrict the residual motions. A single cable controlled hybrid arm prosthesis is presented with different individual cases. The kinetic structure and the control of prosthesis vary in each case to meet the individual manipulatory characteristic of the patient. The universal unconventional technique is presented which has modular possibilities seen from the kinematic point of view.

New plastic joints for plastic orthoses

H. Watanabe, T. Kutsuna, H. Morinaga and T. Okabe*
DIVISION OF ORTHOPAEDIC SURGERY, SAGA MEDICAL SCHOOL, SAGA
PHYSICAL THERAPY, KUMAMOTO UNIVERSITY HOSPITAL, KUMAMOTO

Abstract
Plastic joints for orthoses have more advantages than metal joints. They are lightweight, noiseless, comfortable to use, rust proof, corrosion free, and radiolucent.

Two types of plastic joints were developed by the authors, one for the ankle joint and the other for the knee joint, elbow joint or hip joint. Polypropylene was chosen as the joint material because of its appropriate flexibility and toughness.

Orthoses for functional treatment of ankle fractures. A preliminary report

S-A. Ahlgren, J. Hultin, J. Nilsson and L. Westman

DEPARTMENT OF ORTHOPAEDIC SURGERY, LASARETTET, HELSINGBORG, SWEDEN

Abstract

This report examines the orthotic management of patients with ankle fractures. Two functional orthoses that allow movement in the talocrural joint are described The results of using these orthoses on ten patients are discussed.

Evaluation pertinent to the gait of children with myelomeningocele

N.C. Carroll, D. Jones, W. Maschuich, M. Milner and C. White

ONTARIO CRIPPLED CHILDREN'S CENTRE AND HOSPITAL FOR SICK CHILDREN, TORONTO

Abstract

Many children with spina bifida who require long term and costly clinical management and rehabilitation are seen at the Ontario Crippled Children's Centre (OCCC). The aims of orthopaedic management can best be achieved through an "effective" assessment of each child, which guides the provision of conservative and operative treatment throughout infancy and childhood.

Surgery and orthotic aids are the major ways available to correct or prevent the formation of orthopaedic deformities. At present the only way of assessing an orthosis is to wait and see if it improves function or prevents a deformity.

This paper addresses pilot work undertaken to elucidate the factors which contribute to deformity progression in the lower limbs. The intent was to measure these factors in as cost effective and non-invasive a manner as possible and utilize the information gained in orthotic assessment and development for these children.

The initial goal of the study was to quantify the effect of a prescribed orthosis upon the gait of each child. Some 15 children with a lumbar or sacral level myelomeningocele have been examined in a total of 59 trials. The data collection process involved a three stage protocol implemented by the orthopaedist, physical therapist and engineer. A comprehensive clinical examination, a visual gait assessment from video-tape and an instrumented gait assessment were performed in the OCCC gait laboratory. Assessment criteria were proposed and extracted from the data collected. These criteria were posed after examining the frequency distribution of certain features of gait in the study group. A case study illustrating the application of the assessment is provided.

In examining the performance and influence of an orthosis upon a child's gait situations were identified in which no clear statement of "best" or "better" could be made. The value of the assessment was to point out the trade-offs and *relative* merits of selected orthotic options. By combining the objectivity of data acquired with gait analysis instrumentation with the subjective, but tangible, skills of the experienced observer, significant improvement in performance of the assessment is likely.

Technical note—test instructions for the technical testing of mono-functional myoelectrically-controlled prosthetic hands. A proposal.

B. Ingvarsson, I. Karlsson, L-G. Ottosson and M. Thyberg

DEPARTMENT OF REHABILITATION ENGINEERING, UNIVERSITY HOSPITAL, LINKÖPING, SWEDEN

Abstract

To get an acceptable standard of prostheses and orthoses in Sweden, the Swedish Institute for the Handicapped is testing this group of aids. One important part of the work is to draw up test instructions.

In response to a request from the Swedish Institute for the Handicapped, the Laboratory of Rehabilitation Engineering at the University Hospital of Link]oping in Sweden, has suggested instructions for the technical testing of monofunctional myoelectrically controlled prosthetic hands. These test instructions contain different inspection and control factors which are important for the function of the prosthetic hand.

The management of healing problems in the dysvascular amputee

G. Horne and J. Abramowicz*

AMPUTEE UNIT, WEST PARK HOSPITAL, TORONTO

*GEORGE BROWN-WEST PARK PROSTHETICS AND ORTHOTICS SCHOOL, TORONTO

Abstract

This paper outlines the management of the dysvascular amputee. The surgical techniques and postoperative care that would prevent wound healing problems are described. The treatment of patients with established wound healing problems is discussed.

Incidence of major amputations following gangrene of the lower limb

T. Mandrup-Poulsen and J. Steen Jensen

DEPARTMENTS OF ORTHOPAEDIC SURGERY T-2 and T-3, GENTOFTE HOSPITAL, COPENHAGEN

Abstract

The incidence of major amputations following gangrene of the lower limb during the period 1971 to 1979 in the county of Copenhagen was calculated. The overall incidence was found to be about 0.3 per thousand inhabitants over 40 years of age, the ratio of men to women was 2:1. The incidence was found to increase exponentially with age. The amputation-rate of the lower limb did not change during the 8 year period.

An investment of kinematic and kinetic variables for the description of prosthetic gait using the ENOCH system

K. Oberg and H. Lanshammar*

AMPUTEE TRAINING AND RESEARCH UNIT, UNIVERSITY HOSPITAL, FACK, SWEDEN
*DEPARTMENT OF AUTOMATIC CONTROL AND SYSTEMS ANALYSIS, INSTITUTE OF TECHNOLOGY, UPPSALA UNIVERSITY, SWEDEN

Abstract

Gait patterns, joint angles, floor reaction forces and joint moments during walking were investigated for normal subjects and above-knee and below-knee amputees.

The investigation showed that the hip-knee angle diagram as well as different symmetry diagrams (e.g. left knee angle versus right knee angle) provide an easily interpreted means of evaluating abnormalities in the gait pattern. It was further concluded that a combined gait pattern-force vector diagram is valuable for the evaluation of the joint moments.

Floor reaction forces and muscular moments at the joints were also included in the analysis. The joint moments at the knee were quite different for both above-knee and below-knee amputees as compared to the normal subjects. Some interesting trends were also found concerning the knee stability of the amputees.

A system called ENOCH was used for the measurement and analysis. This system consists of a minicomputer connected on-line to equipment for measurement of displacement (Selspot) and floor reaction forces (Kistler). A graphic computer terminal (Tektronix) was used for the result presentation.

Compression testing of foamed plastics and rubbers for use as orthotic shoe insoles

G. Campbell, E. Newell and M. McLure

PHYSICAL MEDICINE AND REHABILITATION, UNIVERSITY OF WESTERN ONTARIO AND DEPARTMENT OF BIOMEDICAL ENGINEERING, UNIVERSITY HOSPITAL, LONDON, ONTARIO

Abstract

Thirty-one materials have been tested in compression in order to generate the stress (force per unit of cross-sectional area) versus strain (deformation) behaviour, for the purpose of assessing the suitability of various foamed plastics and rubbers as shoe insole materials. It was found that the materials could be classified into three distinct categories (very stiff, moderately deformable and very deformable) according to the shape of the characteristic stress versus strain curve. The moderately deformable group has been selected as the most promising for clinical application.

August 1982, Vol. 6, No. 2

The development of an assessment chair

G.I. Bardsley and P.M. Taylor*

LIMB FITTING CENTRE, DUNDEE
*SCHOOL OF BIOENGINEERING, UNIVERSITY OF DUNDEE

Abstract

Initial difficulties in producing seats for the physically disabled have led to an investigation of the process of seat prescription. An adjustable assessment chair was developed for the purpose of identifying patients' seating requirements.

The main variables of the chair's configuration are controlled by a number of hydraulic and mechanical systems.

Different support surfaces can be attached to the chair to simulate different seat characteristics. At present a bean bag vacuum consolidation system is used to simulate moulded seats.

Experience to date has shown that the assessment chair performs a valuable clinical role in the provision of seating.

The physical effect of lumbar spinal supports

N.D. Grew and G. Deane

OXFORD ORTHOPAEDIC ENGINEERING CENTRE, UNIVERSITY OF OXFORD

Abstract

A study has been performed to investigate the physical effects of lumbar spinal supports. Two groups were studied, a group of normal male subjects and a group of male low back pain patients. Five different spinal supports were investigated and their effects upon the skin temperature, spinal movements and intraabdominal pressures of these individuals were examined. The results show surprisingly similar patterns for the widely varying designs of support. The findings also suggest that the longer term wearing of a spinal support results in a degree of physical dependence. The results of this study are aimed at improving the prescription and use of spinal supports in the treatment of low back pain.

Wound healing complications following major amputations of the lower limb

J. Steen Jensen, T. Mandrup-Poulsen and M. Krasnik

DEPARTMENTS OF ORTHOPAEDIC SURGERY T-2 AND T-3, GENTOFTE HOSPITAL, COPENHAGEN

Abstract

A series of 320 amputations was analyzed with regard to wound healing complications and re-amputation rates.

Among 111 AK amputations complications in wound healing were encountered in 14 per cent (15/111) of the cases, leading to re-amputation in 2 per cent (2/111).

TK amputations were followed by wound healing problems in 30 per cent (20/66) of the cases with re-amputation in 20 per cent (13/66) at AK level, as compared to 40 per cent (57/143) with wound healing complications and 20 per cent (28/143) re-amputations in BK-amputees.

As failure of BK amputations leads to re-amputation at AK level it is recommended that the TK level be selected in doubtful cases.

Frame type socket for lower limb prostheses

R. Volkert

ORTHOPAEDIC DEPARTMENT, UNIVERSITY OF MAINE

Abstract

The technique presented uses a frame-type socket for fixation of the prosthesis on the stump. Apart from rigid areas for stabilization and control, the soft tissue of the stump is enclosed by flexible material. This allows self-adjustment of the socket to changes in stump circumference and volume, while maintaining good socket fit.

Technical note—auditory feedback of knee angle for amputees

J.A. Gilbert, G.M. Maxwell, R. T. George Jr.,* and J.H. McElhaney

DEPARTMENT OF BIOMEDICAL ENGINEERING AND *DEPARTMENT OF ELECTRICAL ENGINEERING, DUKE UNIVERSITY, NORTH CAROLINA

Abstract

A new gait training device has been developed to provide auditory feedback of knee angle information to above-knee and hip disarticulation amputees. Traditionally, new amputees have relied on visual feedback of knee position during gait training (van Griethuysen, 1979). This auditory feedback system eliminates the need for visual feedback by providing a frequency encoded tone corresponding to knee angle.

Shoe inserts for small deformed feet

R.G.S. Platts, S. Knight and I. Jakins

ORTHOTIC RESEARCH AND DEVELOPMENT UNIT, INSTITUTE OF ORTHOPAEDICS, UNIVERSITY OF LONDON

Abstract

Modern materials and a better understanding of the biomechanical requirements enable adaptations to shoes to be made quickly and easily in cases where the deformed foot is small enough to fit satisfactorily into standard shop-bought or standard deep footwear. A flexible self-generating polyurethane foam is used inside the shoe. It expands to the internal shape of the shoe and the external shape of the foot. It can be used either against the patient's own foot or against a positive cast of the foot. The technique has been used for 75 patients and has proved successful. The insert so made is durable and economical.

Clinical evaluation of a knee-ankle-foot-orthosis for hemiplegic patients

Y. Morinaka, Y. Matsuo, M. Nojima* and S. Morinaka**

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*DEPARTMENT OF ORTHOPAEDICS, EHIME UNIVERSITY, JAPAN
**MORINKA WORK SHOP, NIIHAMA, JAPAN

Abstract

A knee-ankle-foot-orthosis has been developed that incorporates a genucentric knee joint and a similarly designed ankle joint. Its design is discussed and a clinical evaluation of its use on twenty five hemiplegic patients is presented.

Variation of mechanical energy levels for normal and prosthetic gait

H. Lanshammar

DEPARTMENT OF AUTOMATIC CONTROL AND SYSTEMS ANALYSIS, INSTITUTE OF TECHNOLOGY, UPPSALA UNIVERSITY, SWEDEN AND
NATIONAL BOARD OF OCCUPATIONAL SAFETY AND HEALTH, SWEDEN

Abstract

Mechanical energy levels were investigated for normals and for below-knee amputees during level walking. The weight of the prostheses was varied by attaching 0.5 kg extra weight to the prostheses.

The measurements and analyses were made with the ENOCH system consisting of a minicomputer (HP 21 MX), an opto-electronic device for displacement data measurement (Selspot) and a force plate (Kistler) for measurement of ground reaction forces.

Results by Winter et al (1976) on the energy changes during normal walking obtained from displacement data on one leg only were verified using data from both legs and the trunk.

For the amputees it was concluded that the energy changes increased for the prosthetic shank when the weight increased. For the other body segments and for the body total no significant differences were found.

Material properties of Velcro fastenings

D.L. Bader and M.J. Pearch

OXFORD ORTHOPAEDIC ENGINEERING CENTRE, OXFORD

Abstract

An assessment of the material properties of three types of touch and close fasteners (Velcro) in general orthopaedic usage is presented.

The materials were tested under various loading regimes using an Instron testing machine. The force-extension curves were analyzed and values determined for both the stiffness and strength of the various attachments. Particular reference was made to the alteration in attachment strength after cyclic loading.

The strength of the standard Velcro was found to be least affected after cyclic loading to simulate continuous usage. A recommendation is made on the specific application of each type of Velcro based on their material properties.

December 1982, Vol. 6, No. 3

Angular displacements in the upper body of AK amputees during level walking

A. Cappozzo, F. Figura, F. Gazzani, T. Leo* and M. Marchetti

BIOMECHANICS LABORATORY, ISTITUTO DI FISIOLOGIA UMANA AND *ISTITUTO DI AUTOMATICA, UNIVERSITA DEGLI STUDI, ROME

Abstract

The angular displacements of the longitudinal axis of the trunk, and of the latero-lateral axes of pelvis and shoulder girdle were measured in five normal subjects and four AK amputees during level walking at different speeds. Amputees used single axis prostheses with the SACH foot. Spacial measurements were carried out in three dimensions by means of a photogrammetric technique. The time functions of the target angles underwent harmonic analysis. Based on the Fourier coefficients, comparison was made between normal subjects' and amputees' angular displacements. Relevant findings permitted the identification of compensatory mechanisms adopted by amputees at trunk level as well as the assessment of the relationship between these latter mechanisms and those put into action at lower limb level.

Bracing and supporting of the lumbar spine

S. Schroeder, H. Rössler, P. Ziehe and F. Higuchi

DEPARTMENT OF ORTHOPAEDIC SURGERY, UNIVERSITY OF BONN, WEST GERMANY

Abstract

The orthopaedic surgeon should be familiar with various supports and braces for the treatment of low back pain. Severe cases of spinal instability always need a Hofmann overbridging brace, whereas the milder form of motion-segment instability is treated with one of the elastic supports. In cases of osteoporosis of the spine and insufficiency of the lumbosacral junction of the Lindemann ⅔ semi-elastic brace is prescribed.

Biomechanics of functional electrical stimulation

C.M. Van Griethuysen, J.P. Paul, B.J. Andrews and A.C. Nicol

BIOENGINEERING UNIT, UNIVERSITY OF STRATHCLYDE, GLASGOW

Abstract

Patients with hemiplegia frequently have difficulty in walking due to lack of eversion and dorsiflexion capability of the foot. One method of treating these patients utilizes functional electrical stimulation (FES). The effect of FES on locomotion, co-ordination, proprioception and balance sense was assessed using instrumented gait analysis and a postural sway test. In general patients treated with FES showed either a marked improvement or very little change. Any improvement was reflected in postural sway and ankle control during locomotion. Changes in hip and knee control were insignificant.

Measurement of maximal end-weight-bearing in lower limb amputees

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Abstract
Modern sockets for lower limb amputees utilize total contact and distribute some weight on the stump end. Its tolerance to bear weight varies but is better after joint disarticulation, however, systematic measures have been missing. Different levels, indications, shapes etc. were analysed with 102 measurements in 69 patients. The maximal-end-weight-bearing of the stump measured on a scale was much lower after transmedullar amputations than after disarticulations. Men had a mean tolerance more than 15 kg but women less than 10 kg. There was a positive correlation to body weight. Diabetics tolerated significantly more end-bearing and patients with phantom pain more than patients with stump pain. Within each category of stumps the range of maximal end-weight-bearing was large. Among all below-knee amputees the tolerance was between 2 to 55 kg or 3 to 79 percent of body weight. Pointed stumps statistically tolerated about as much as rounded ones and the variability of contact surface was not measured as its sensitivity to pain must be unevenly distributed. It is concluded that this simplified method is helpful to analyze pain and to modify end-weight-bearing more individually.

An improved above-knee prosthesis with functional versatility

K.K. Chaudhry, S.K. Guha* and S.K. Verma**
DEPARTMENT OF APPLIED MECHANICS, INDIAN INSTITUTE OF TECHNOLOGY, NEW DELHI
*CENTRE FOR BIOMEDICAL ENGINEERING, INDIAN INSTITUTE OF TECHNOLOGY AND ALL INDIA INSTITUTE OF MEDICAL SCIENCES, NEW DELHI
**DEPARTMENT OF ARTIFICIAL LIMBS AND REHABILITATION, ALL INDIA INSTITUTE OF MEDICAL SCIENCES

Abstract
An above-knee prosthesis is described which is designed to permit the patient to assume easily the squatting and sitting cross legged postures which are a part of routine living in Afro-Asian countries. The prosthesis incorporates a multibar linkage mechanism which co-ordinates knee flexion and extension with ankle dorsiflexion and plantarflexion, and a thigh rotation system fitted at the level of the axis.

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TO: PERSONS WORKING IN REHABILITATION

FROM: SIEGFRIED PAUL, CPO(E), SCIENTIFIC PROGRAM CHAIRMAN

RE: CALL FOR CONTRIBUTED PAPERS FOR THE 1984 ASSEMBLY SCIENTIFIC PROGRAM

The American Orthotic and Prosthetic Association is an organization whose 800-plus membership consists of firms involved in the design, manufacture, and fitting of orthoses and prostheses. The primary objective of AOPA is to promote high levels of orthotic/prosthetic patient care services to the orthopedically handicapped. To aid in achieving this goal, each year the Association provides a forum, via its annual National Assembly, for orthotics and prosthetics professionals to share information on the many new ideas and/or concepts of or relating to orthotics/prosthetics. Nearly everyone working in orthotics and prosthetics in the United States attends the Assembly, along with many professionals from abroad. The 1984 Assembly will be held at the Fountainebleau Hotel, Miami Beach, Florida on October 17–22, 1984.

AOPA invites all interested persons to submit an abstract(s) for presentation during the Assembly's Scientific Program. The subject(s) for the abstract(s) should be new ideas, techniques, devices, and/or research that have a practical application in orthotics and prosthetics or a related field. Interested persons are invited to submit more than one abstract. Most presenters will be given 15 minutes for their presentation.

If you are interested in participating in the 1984 Assembly, please fill out the enclosed abstract form and return it to the AOPA National Headquarters no later than December 31, 1983.

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Thank you.

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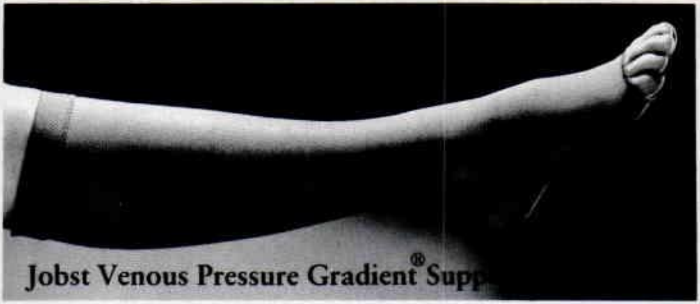
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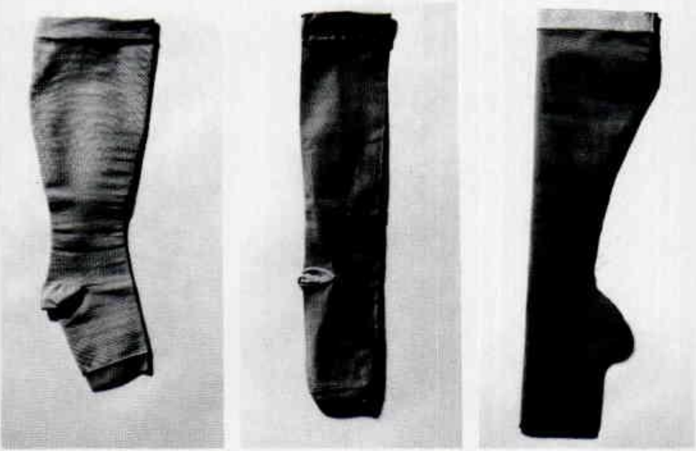

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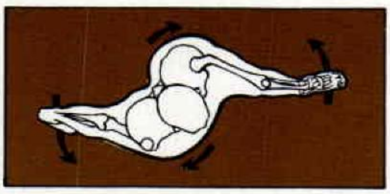

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