Clinical Prosthetics & Orthotics

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Influence of Government Funding on Prosthetics Research and Development

Eugene F. Murphy, Ph.D.*

Historically, tragically, warfare has been the major stimulant for the development of prosthetic devices. Much of the early history is traced in the introductory chapter of the *Orthopaedic Appliances Atlas, Volume 2,* published by the American Academy of Orthopaedic Surgeons in 1960. A fascinating source is the book *Historic Artificial Limbs* by the Italian surgeon Putti, published by Hoeber, New York, 1930, based upon the outstanding collection of artificial limbs in the Stibbert Museum at Florence, Italy. With that museum's distinguished collection of armor, it was perhaps natural that the byproduct of artificial hands, arms, and legs made by armorers for knights should also be assembled there. The story of the German knight Goetz von Berlichingen, commemorated in a drama by Goethe, stresses the knight's iron artificial hand.

Surgery generally and amputation surgery in particular were developed by the French surgeon Paré in connection with the religious wars in France; a corresponding development of artificial limbs was done by a locksmith known as "le petit Lorrain." Very likely only the relatively well-to-do knights and nobility were able to afford these early prostheses, with common people left to relatively crudely carved prostheses or crutches as illustrated, for example, by Breughel.

After the American Civil War, the government provided an allowance for artificial limbs for Union veterans. This financial incentive, plus the rapid increase of amputees from industry and railroads, led to great competition among private developers. In that era artificial limbs were essentially sold as commodities rather than fitted as professional services. Some interesting patents are cited in the *Orthopaedic Appliances Atlas, Volume 2.*

In World War I, countries among both the Central Powers and the Allies carried on simultaneous attempts to treat their patients and to develop better methods of surgery and fitting. Work in the Central Powers, notably in German military hospitals and in the Technical University of Berlin under Schlesinger, an engineering professor, was covered in great detail in the classic book *Ersatzglieder und Arbeitshilfen* (Substitute Limbs and Work Aids) published in 1919. Florent Martin worked extensively in Belgium, developing relatively early methods of fitting of temporary plaster-of-paris sockets on pylons for amputation of the lower extremity. His work was recorded particularly well in his critical analysis, *Artificial Limbs; Appliances for the Disabled,* published by the International Labour Office at Geneva in 1924. Efforts in England, including development of the specialty of limb fitting surgeon and the standardization of mechanical construction of a series of light metal limbs for many basic levels of amputation, are described in E. Muirhead Little's book *Artificial Limbs and Amputation Stumps,* published in England in 1922. During World War I, the Artificial Limb Manufacturers Association (ALMA) in the United States developed rapidly to advance the industry and cooperate with the government. Its descendant, the American Orthotics and Prosthetics Association (AOPA), along with the American Board for Certification (ABC), and the American Academy of Orthotists and Prosthetists (AAOP) continue today to develop the profession.

In World War II, the ALMA set up a small laboratory on the premises of the Rowley prosthetics facility in Detroit, under the name of the Research Institute Foundation. Its extremely limited financial and technical resources allowed very meager efforts.

Late in the war, partly because of growing demands from servicemen and unfavorable publicity, the Surgeon General of the United States Army asked the

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National Academy of Sciences (NAS) and its operating arm, the National Research Council (NRC), to select and standardize the best artificial limb designs. At a conference in 1945, the only unanimous agreement seemed to be on the concept that the best was not too good and that further improvements were needed on all aspects.

The Surgeon General then asked the NAS-NRC to organize a systematic program "to conduct with utmost dispatch research and development in the field of prosthetic devices." The resulting interdisciplinary Committee on Prosthetic Devices initially was financed by the wartime Office of Scientific Research and Development, then the Army briefly, and later the Army and Veterans Administration (VA) jointly. On July 1, 1947, it was reorganized as the Advisory Committee on Artificial Limbs to provide advice to other agencies which wished to conduct their own programs. The NRC committee structure underwent a variety of changes from 1945 to the mid-1970's but has now disbanded. AOPA-ABC-AAOP members were frequent members of committees, subcommittees, and technical groups in this structure.

The Army, Navy, and Veterans Administration each operated a laboratory. The VA, initially alone and later in parallel with other agencies, supported a series of projects with universities, industrial laboratories, and, in recent years, particularly through intramural projects in VA Medical Centers. After a change in its basic laws, the Office of Vocational Rehabilitation or its successors, now the National Institute of Handicapped Research (NIHR), has supported an increasing number of Rehabilitation Engineering Centers and projects.

In addition to stimulating a wide variety of basic studies on locomotion and arm and hand motions, phantom limb pain, and psychological aspects, and development of a wide range of devices for all levels of upper-and lower-limb prostheses, the total government-supported program became a major force in educational efforts and dissemination of information. The early suction socket schools brought together distinguished surgeons and prosthetists, teaching the surgeons about mechanisms and the prosthetists about anatomy and physiology, as well as fostering team work between the two professions, promptly involving therapists, and helping to upgrade the entire field. Follow-up of the early suction sockets led to organization of formal clinic teams. The suction socket certification program, operated by Orthopedic Appliance and Limb Manufacturers Association (OALMA) in conjunction with the NRC committee and recorded in the Veterans Administration, led to joint certificates and helped to pave the way for the founding of the American Board for Certification with its remarkable interdisciplinary board of directors. The suction socket schools led, in 1953, to organized university-level post-graduate education in prosthetics and later in orthotics.

Frustratingly slow as development often seems, nevertheless in retrospect it would appear that numerous major changes in devices, techniques, materials, and management methods were made in this continuing program. Voluntary cooperation was the key element in holding together this loose confederation. Diverse disciplines, many government agencies, some private foundations, separate organizations, sometimes competitive interests, and strong personalities worked together for the improvement of the lives of the disabled.

The fact that substantial government funding was available, though never on the scale needed for the awesome task of truly replacing human parts and functions, tended to minimize the importance of private funding for the research and development and even for the dissemination of results. One chronic problem, though, has always been the transition from a reasonably well-developed laboratory model with a very limited clinical experience on "professional" pilot wearers into a routinely available, commercially manufactured component available in high quality and at low cost to skilled and trained practitioners throughout this country and abroad for fitting to large numbers of individual patients.

Some devices were purchased in modest quantities for field tests through the National Academy of Sciences itself in the 1950's or through the Veterans Administration Prosthetics Center after that group was organized in 1956. Typically, AOPA was asked to suggest a group of potential bidders to make proposals for tooling and for construction of some modest number of models needed for a wide scale field trail or evaluation. Because of fiscal restraints and practical problems, numbers of copies were usually smaller, and statistical validity was low. (Early attempts to interest other organizations lacking experience and distribution facilities in the prosthetics field had been frustrating and largely disappointing.) Typically, the manufacturer of the initial test models has evolved into the principal, if not sole, manufacturer of the final device—if indeed it proved to be successful in the field trials. The field has been so small that there

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frequently has been no room for multiple manufacturers of a single relatively complex device, although other versions with somewhat comparable yet somewhat different functions sometimes evolve in parallel. Field trials should refine not only the hardware but the prescription, fitting, and training techniques, the manuals, and the maintenance procedures. All participants in a clinic team become familiar with the new development.

There has long been interest in stimulating private support of research and development, presumably based upon the results of fundamental studies conducted under government auspices. The government-supported program has sometimes received or purchased a few early test models of private inventions and has had its intramural or contract laboratories conduct studies with these test models, thereby providing a useful consulting service to the inventor or manufacturer which he probably could not readily obtain otherwise. This kind of independent evaluation may well become increasingly important under the medical device amendments in order to prove safety and effectiveness of new devices.

In any evaluation, there are problems in simultaneously assuring competence without bias and in providing constructive criticism in useful form which can be applied to improving the device for all disabled.

With the continuing and indeed increasing pressure upon government budgets, it would seem that the developers must increasingly come from private industry. Karl Vesper, the engineer and investment expert who organized the original Hosmer Corporation in the 1940's, was an early participant in the NRC and VA programs. He pointed out that as a private entrepreneur he could effectively estimate the potential strengths of competitors and their ability to develop and market new products within given time periods, so he could make his own choice of development expenditures wisely. Conversely, though, he could not predict what a government agency might do, particularly under political and other pressures. Though the existing government research and development projects are public knowledge, for example through progress reports published in the Bulletin of Prosthetics Research, private developments may well be "proprietary secrets." The net balance between these and other disadvantages and advantages for private development is hard to estimate. From the standpoint of the disabled of the world, one can only hope for a frank, friendly, and cooperative relationship between private entrepreneurs, government sponsors and regulators, government purchasing or using services at all levels, third-party purchasers, and the several professions concerned.

Meetings and Events

Please notify the National office immediately concerning additional meeting dates. It is important to get meeting notices in as early as possible. In the case of Regional Meetings, check with the National Office prior to confirming date to avoid conflicts in scheduling.

1982, April 16–17, AOPA Region I Meeting, Marriott Hotel, Worcester, Massachusetts.

1982, April 24, New York State Chapter, AAOP Seminar, Albany Medical College, Albany, New York.

1982, April 24–25, ABC Practitioner Certification Written Exam, New York City, San Francisco, Chicago, Atlanta and Dallas.

1982, April 29–May 1, AOPA Regions VII, VIII, X, XI Combined Meeting, Alameda Plaza, Kansas City, Missouri.

1982, May 6–9, AOPA Region IV Meeting, Radisson Plaza Hotel, Nashville, Tennessee.

1982, May 10–13, Advanced Course on Below-Knee and Through-Knee Amputations and Prosthetics, ISPO, Copenhagen, Denmark.

1982, May 27–29, AOPA Region V Meeting, Charleston House, Charleston, W. Virginia.

1982, June 1–3, Canadian Association of Prosthetists & Orthotists National Convention, Skyline Hotel, Ottawa, Ontario, Canada.

1982, June 4–6, AOPA Region IX, COPA, and the California Chapters of the AAOP Combined Annual Meeting, Harrah's, South Lake Tahoe, Nevada.

1982, June 10–13, AOPA Regions II and III Combined Meeting, Claridge Hotel, Atlantic City, New Jersey.

1982, June 17–20, AOPA Region VI and AAOP Midwest Chapter Combined Meeting, Indian Lakes Resort, Bloomingdale, Illinois.

1982, June 22–25, Orthopadie Technik '82 International Congress, Wiesbaden, Germany.

1982, July 30–31, AAOP Northwest Seminar, Portland, Oregon.

1982, August 13–14, AAOP Midwest Seminar, Kansas City, Kansas.

1982, September 8–10, Second Annual Advanced Course of Lower Extremity Prosthetics, Nassau County Medical Center, East Meadow, New York.

1982, October 19–23, AOPA National Assembly, Shamrock Hilton, Houston, Texas.

1983, January 26–30, AAOP Roundup Seminar, Hyatt Islandia, San Diego, California.

1983, April 21–23, AOPA Region IV Meeting, Jackson, Mississippi.

1983, May 12–14, AOPA Regions II and III Combined Meeting, Colonial Williamsburg, Williamsburg, Virginia.

1983, May 25–28, AOPA Regions VI, VIII, X and XI Combined Meeting, Hotel El Tropicano, San Antonio, Texas.

1983, June 3–5, AOPA Region IX, COPA, AAOP California Chapters Combined Annual Meeting, Harrah's, South Lake Tahoe, Nevada.

1983, September 5–9, The IV World Congress of the International Society for Prosthetics and Orthotics, Imperial College of Science and Technology, London, England.

Winter Honorarium

Peter A. Ockenfels, CPO has been awarded the $100 honorarium for his article, "Management and Construction Procedure of Bilateral Split-Bucket Type Hip Disarticulation Prosthesis."

Presidential Message

This issue not only carries a new face and name to reflect more appropriately the subjects presented in this publication, but also marks the beginning of my year in office as President of the AAOP.

I am pleased to announce the appointment of Charles Pritham, CPO, as the new Editor of *Clinical Prosthetics and Orthotics (C.P.O.)*. I know he will continue to maintain the high quality of this publication. My thanks and appreciation are due to the members of the Editorial Board who worked with me during the past three years to make this one of the finer publications in the field of prosthetics and orthotics, and for agreeing to continue to serve on the Board. Joanne Klope Shamp, CPO, is a new member on the Editorial Board. I am confident that her background as a clinician and teacher will enhance the quality of *C.P.O.*

The interdisciplinary nature of *Clinical Prosthetics & Orthotics*, as evidenced by the composition of the Editorial Board, is an extension of the commitment of the AAOP, which publishes *C.P.O.*, to the spirit of interdisciplinary dialogue amongst practitioners in the rehabilitation of amputees and other physically disabled persons requiring exoskeletal assistance. The Academy promotes this interdisciplinary relationship to foster mutual respect, and to promote recognition of the orthotist and prosthetist as an equal professional in the rehabilitation team. Towards this end, I am happy to share with the readers of *C.P.O.* a position paper developed between the AAOP and the American Academy of Physical Medicine and Rehabilitation (AAMP&R), which is reprinted below. This paper has been adopted and approved by the Board of Directors and the Board of Governors of the AAOP and the AAMP&R, respectively. Particularly noteworthy are the requirements that prostheses and orthoses be prescribed in consultation with a ceritifed prosthetist/orthotist, and the elimination of the term

"check-out," which has been an embarrassing bone of contention for prosthetists and orthotists. The adoption of this paper represents, I believe, a giant step forward in the professional maturity of the orthotist/Prosthetist. The mutual respect thus accorded is likely a reflection of the continous upgrading and educational level required to become a certified prosthetist (CP), certified orthotist (CO), or certified prosthetist/orthotist (CPO), and administered by the American Board for Certification in Orthotics & Prosthetics.

During the coming year, a major goal of the AAOP will be to develop a strong liaison with other organizations representing practitioners involved in the rehabilitation of amputees and persons with neuromuscular and skeletal disabilities, e.g., the AAOS, APTA. One such official relationship has already been established between the AAOP and the Rehabilitation Engineering Society of North America (RESNA).

It is only through mutual respect that the practitioner in each discipline involved can bring his or her full uninhibited repertoire of skills to bear for the optimum rehabilitation of the patients we serve.

Dr. H. Richard Lehneis, CPO
Academy President

POSITION PAPER

Professional Relationship Between

American Academy of Physical Medicine and Rehabilitation

and

American Academy of Orthotists and Prosthetists

Professionalism requires set standards of knowledge, skill, and ethics. The two organizations believe that these can best be assured by mutual cooperation.

The American Academy of Physical Medicine and Rehabilitation and the American Academy of Orthotists and Prosthetists jointly resolve:

In the interest of providing better care for patients in need of prostheses, orthoses, and other assistive devices of all sorts, be it resolved that the two organizations work together in improving the knowledge of their mutual professionals by:

1. common and joint educational endeavors in orthotics and prosthetics; e.g., sharing of speakers at annual meetings, assisting each other in the presentation of symposia, courses and publications.
2. establishing joint liaison representation with governmental agencies wherever possible to aid in securing legislation aimed at the provision of better services for patients requiring orthoses and prostheses.
3. requiring that prostheses and orthoses be prescribed by a physician who is knowledgeable by virtue of education, training and experience, in consultation with a certified prosthetist/orthotist.
4. eliminating the term "check out," to be replaced by "final prosthetics/orthotics evaluation," and adoption of the new term by both organizations in their professional vocabulary.

President Lehneis Announces Committee Assignments for the American Academy of Orthotists and Prosthetists

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Members Invited to Serve on AAOP Committees

In a recent letter to all Academicians, President Lehneis invited all Academy members to indicate their willingness to serve on any committee. That invitation is extended again. If you would like to serve on a committee please complete the following form and mail it to: AAOP, 717 Pendleton St., Alexandria, Va. 22314

(Detach here and return)

Last name _____ First _____ MI _____ CO _____ CP _____ CPO _____

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Place an "X" by the committee(s) on which you are willing to serve.

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Local Chapters	_____	Public Relations	_____
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I am willing to be nominated to the board of directors. ( ) Yes or ( ) No

EDITORIAL

Prosthetic and Orthotic Support—The 1982 Budget

The past year has seen a series of legislative successes by the Reagan Administration in its efforts to reduce the federal budget. The budget for the current fiscal year totals roughly $720 billion of which almost $270 billion will go for defense and interest on the national debt. It is estimated that almost four out of five of the remaining dollars will go for entitlement programs. The balance comprises the part often referred to as the controllable budget and includes items such as high wages, veterans hospitals and medical research.[1] The experts at this point have been unable to fully sort out the impact of the proposed cuts but it is estimated that almost $20 million will be in health and human service programs. The cuts will not stop here as the Administration in September proposed another 12 per cent reduction in human services to offset the extra $25 billion budget deficiency caused by the personal income tax cut.[2] One does not have to be an economist to realize that the proposed changes will fundamentally alter the scope of federal programs, particularly health and human services.

It also becomes apparent that prosthetic and orthotic services as well as training, research, and development in those areas will be affected. Historically, the level of federal involvement and support has been substantial when one considers that laboratories engaging in prosthetic-orthotic research were operated by the Army, the Navy and the Veterans Administration. The Veterans Administration alone and in parallel with other agencies has supported a number of projects with universities, industrial laboratories, and in recent years has sponsored intramural projects in Veterans Administration Medical Centers. The office of Vocational Rehabilitation and its successor, the National Institute of Handicapped Research, (NIHR), supported Rehabilitation Engineering Centers and projects throughout the United States.

The budget reconciliation process has been utilized in the Congress to fashion this new reduction of the federal role. Funds administered through the NIHR vitally affecting prosthetic and orthotic research and training have been exposed to this budgetary process. The Appropriation Committees of the House and the Senate have reviewed this aspect of the budget.

The programs for crippled children, which reach many children requiring prosthetic and orthotic devices, have not escaped budget cuts. Maternal and Child Health (MCH) and Crippled Children's Services (CC) have been consolidated into a block grant to the states under Title V of the Social Security Act. Included in this particular block grant are: supplemental security income for disabled children; lead-based paint poisoning prevention; sudden infant death syndrome; hemiphelia treatment centers, and adolescent pregnancy. The House-Senate Conference agreement currently under the continuing resolution provides for an authorization of $347.5 million for fiscal 1982 for the MCH block grant. This amount is 25 per cent less than the 1981 appropriation of $456.2 million. It is hoped that support will continue for valuable programs presently funded at least in part at CAPP in Los Angeles, the Area Wide Amputee Center in Grand Rapids, and at New York University. Presently there are five projects funded at a level of $1.3 million. It is proposed to accomplish a reduction of 77 percent to a level of $300,000 in fiscal 1982. These projects, considered an aspect of technology transfer, constitute an activity of vital national concern. A reduction of this magnitude (77 percent) will substantially impair the programs.

These are areas where private initiatives and voluntarism cannot replace the federal support. The private sector has been unwilling or unable to support totally even the more glamorous and highly visible activities such as symphony orchestras, art and scholarship support. Prosthetic and orthotic projects pale by comparison in their ability to attract private support when compared to other highly visible programs. It remains, therefore, the task of each of us to write or wire our Representatives and Senators requesting support of action in the Appropriation Committees of Congress that will insure at least a continuation of the present level of support, if not an increase in the funding for prosthetic and othotic research and training. The present level of funding will deprive patients of needed services and cripple the research and training efforts perhaps beyond recovery.

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LETTER TO THE EDITOR

A RETURN TO RESEARCH?

Thirty-seven years ago, with funds from the United States Government, the National Academy of Sciences, initiated a research and development program in artificial limbs because amputees in Army and Navy hospitals expressed quite vociferously their dissatisfaction with the artificial limbs provided at that time, and because there had never been, in this country, any concerted scientific effort to solve the problems of amputees. Although the research program, funded until the late 1950's largely by the Veterans Administration, was not looked upon with favor by many prosthetists during its early stages, with the help of a few of the more progressive prosthetists and orthopaedic surgeons sufficient progress was made by 1952 to warrant the initiation of a formal education project at the University of California at Los Angeles, which set the pattern for the present education program in prosthetics and orthotics.

The Department of Health, Education, and Welfare, about 1955, joined the VA in supporting research, development, evaluation, and education; orthotics was added to the mission in the late 50's; and progress continued to the point that by the early 70's nearly every aspect of prosthetics had been replaced by newer techniques and devices, and work in orthotics was progressing rapidly. Although it was, and is, recognized by many that further, continuing research was needed, the government agencies have all but abandoned research and development in prosthetics and orthotics, and as a result very few improvements have been introduced to the practice of prosthetics and orthotics during the last few years.

This unfortunate situation has been brought about because of a number of factors: the decision by the National Academy of Sciences to withdraw from the program; reorganization by the VA in 1973 that resulted in transferring research and development responsibility from the Prosthetic and Sensory Aids Service to general medical research, and to conduct most of the research and development in VA hospitals; and an unbelievable proliferation in all government agencies of "red tape" required in awarding contracts and grants.

During these 37 years, the prosthetics and orthotics profession has become healthy and strong, in part because the research and development program has provided a teachable body of knowledge and an education program that has produced a group of practitioners who are capable of communicating effectively among themselves and with other groups.

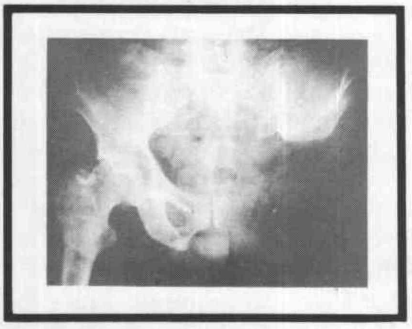
Given this set of circumstances, it seems reasonable that the prosthetists and orthotists in this country should consider taking responsibility for research, development, and evaluation, and relieve the government of most of the responsibility it has assumed in this area for the last 37 years. Certainly a program administered by AAOP-AOPA could be more efficient and more effective than one administered by the government. One way to finance this undertaking is to include in the price of each new prosthesis and orthosis an appropriate percentage to be set aside for the research program. This sum would, of course, be a legitimate business expense.

The coordination and "clearing-house" functions would reside in the National Office, and R&D would be carried out in appropriate facilities and institutions. If properly managed such a program would have many obvious advantages, not the least of which would be improved patient care.

A. Bennett Wilson, Jr.

AAOP Brochure

Introduces Orthotics, Prosthetics To The General Public



What are orthotics and prosthetics? Surprisingly or not so surprisingly many people do not know what these words mean or what is involved in the orthotic/prosthetic profession. To help inform the general public, the American Academy of Orthotists and Prosthetists has published a brochure which defines the terms and offers a description of the profession. The description includes a discussion of professional responsibilities of orthotists and prosthetists; educational and professional standards; and research in orthotics and prosthetics. The Brochure is available from the National Office for $1.25 plus $.75 handling for a total of $2.00. Please make your cheques payable to AAOP.

Post Operative Management of Lower Extremity Amputees Using Tubular Elastic Compression Bandaging

William M. Brady, C.P.O.*

Introduction

Edema is inevitable in a postoperative limb and is a matter of concern to all who are involved in the post-operative care and rehabilitation of amputees. Persistent edema, that is edema that fails to subside over a period of weeks following amputation surgery, delays the rehabilitation process including the fitting of the definitive prosthesis (1).

Several systems of compression bandaging have been investigated and reported in various medical journals. These include soft dressings, pneumatic pressure sleeves, stump shrinkers, semirigid dressings, and rigid dressings with or without a program of early ambulation (2,3,4). Of all of these systems, the most common one is the elastic wrap bandage (5). It is readily available inexpensive, comes in a range of sizes and is washable. In spite of its advantages, however, its users are also aware that it is difficult to apply, doesn't maintain continuous pressure, must be reapplied frequently, cannot be reapplied the same way each time, and loses its compressibility after a few washings.

Since the amount of external compression applied to the limbs seems to be a key factor in reducing edema, studies have been undertaken to define the "ideal" pressure. Some of the findings reported are as follows: 1. less than 5 to 10 mmHg of mercury is undersirable (6); 2. external pressure of 30 mmHg or greater decreased the venous flow rate of the leg (6); 3. external pressures above 25 to 30 mmHg, if sustained, may be potentially harmful (2); 4. pressures obtained from elastic wrap applied by skilled professionals ranged typically from 23 to 72 mmHg (5); 5. elastic compression to the lower limb markedly reduced the volume of the limb (5).

Development of a Product

Early in 1980 Knit-Rite, Inc.,[1] a manufacturer of prosthetic socks and stockinette tubing, initiated the development of a tubular elastic compression material that would be equal or superior to any compression bandage currently available on the market. Believing that such a product would have medical applications in the control of edema but uncertain of how it could be made to achieve the desired pressures and other characteristics, they contacted the Physical Medicine Department, University of Kansas Medical Center, for recommendations. Out of this inquiry evolved an amputee study involving 41 amputees, 35 below knee (B.K.) and 6 above knee (A.K.) and resulted in a paper entitled "Pressure Applied by Stump Bandages: A Comparative Study," by G. Varghese et al.[2] This study compared the elastic wrap, the Knit-Rite tubular elastic bandage and stump shrinker, and another brand of tubular elastic bandage. It supported some beliefs and established others:

1. Elastic wrap was the most difficult to apply.
2. Pressures exerted by elastic wrap varied widely and the results were significantly different when applied by skilled and unskilled people.
3. Elastic wrap failed to sustain constant pressures over a prolonged period of time and had a tendency to loosen with usage.
4. Both tubular compression bandage products were more easily applied by patients and/or family members.
5. More consistent pressure over a prolonged period of usage could be obtained with tubular elastic bandages.
6. The Knit-Rite tubular compression bandage, when doubled, exerted a pressure which was in the "ideal" range, between 15 to 30 mmHg as measured by a solid state pressure transducer.

Actually, many changes in the product occurred during the course of this study.[3] Finally the acceptable tubular compression bandage was made available as a 10 meter Compressogrip® roll in a range of widths and lengths and as a stump shrinker item in a range of widths and lengths. The stump shrinker item is individually packaged and labeled with care instructions.

* President, Isle Orthotic-Prosthetic Services, Kansas City, MO

Size	Length	Fits Circumferences	Approximate Single Layer Pressure mmHg at 50% Stretch†
#2	18"–45 cm 24"–60 cm	6"–8"	8–12
#3	18"–45 cm 24"–60 cm	9"–12"	8–12
#4	18"–45 cm 24"–60 cm	12"–16"	8–12
#5	18"–45 cm 24"–60 cm	15"–20"	8–12
#6	30"–75 cm	15"–20"	8–12

†Double Layer Approximately Doubles Compression Figures.

Fig. 1 Sizing Chart for Tubular Elastic Stump Shrinkers

Field Testing

At the same time that the Kansas University Medical Center was conducting their research and continuing through the present time, Isle Orthotic-Prosthetic Services, of Kansas City, Missouri, was using the tubular compression bandage in the post-operative management of its referred amputee patients. Field testing was also conducted at a private prosthetics facility in the Kansas City area and at the V.A. Hospital.

These findings, while empirical do confirm the results of the scientific researchers. The earlier a program of tubular compression bandaging is begun post-operatively, the sooner swelling will subside and tissues can be properly supported and correcly molded to a shape acceptable for prosthetic fitting. The correct size of bandage must be selected and patients or responsible family members instructed concerning the proper method of applying the tubular compression bandage and maintaining a controlled, total-contact fit throughout the period of wear. The recommendation, with the permission of the managing physician, is to wear the bandage 24 hours per day, except for bathing or during periods of muscle spasm, cramping or persistent pain. At least 2 to 3 bandages need to be supplied to the patient to allow for laundering.

Selecting the Proper Size Bandage

Care needs to be taken in fitting to insure that the width selected achieves adequate compression without overstretching the material (Fig. 1) and that the length selected allows for a double layer (Fig. 2). Optimum compression occurs when the tubular compression bandage is stretched at least 50% but not more than 100% of the original width. For a B. K. amputee it is recommended that a circumference measurement be taken 2" below the medial tibial tubercle, and for an A. K. amputee, 2" proximal to the distal end.

Example: The measured circumference is 11 inches. From the chart (Fig. 1) we see that Size #3 is the correct size. The sizes #2 through #5 are approximately 2" through 5" in flat width. Thus Size #3 is approximately 6" in circumference and would best accommodate measurements from 9" to 12" in circumference. If the differential between distal and proximal circumferences, as in extremely tapered A. K.'s, is greater than 5", then the next size larger bandage should be selected to avoid overstretching the material and to insure ease of application.

Applying the Bandage

On a below knee amputee, apply the first layer so that the material extends approximately 3" proximal to mid-patella. Slide the nylon ring (supplied with and surrounding the bandage) forward until firm distal pressure occurs, then reflect the second layer over the first to no more than ½" proximal to the superior border of the patella (Fig. 2). In this way, greater pressure is maintained distally than proximally. If necessary, excess material may be marked and cut off, folding inside the cut ends of the second layer to achieve a smooth edge; however, the cut edge may ravel. Different lengths are available to eliminate cutting as much as possible (Fig. 1).

Have the patient flex and extend the knee to check the security of the bandage. Then have the patient remove and re-apply the bandage several times until you are confident that the technique is mastered. Good follow-up is an important part of patient management. We recommend that the patient be rescheduled at 2 to 3 week intervals to check the progress of the shrinkage. Remeasuring and recording all pertinent circumference and diameter readings can then be done. When measurements have stabilized

and no appreciable changes are noted from the last visit, casting for the definitive prosthesis can be initiated.

The same basic procedure can be followed with A. K. amputees, except that some A. K. amputees will require the addition of a modified garter belt or webbing suspension to minimize the tendency of the bandage to roll proximally.

Summary

Our observations concur with recent research which suggests that the process of controlling and reducing edema is accelerated by using the Compressogrip® tubular compression bandage versus the conventional elastic wrap. Further, our experience indicates that the shaping of soft tissues is enhanced and that the post-operative period required to prepare the patient's residual limb for the definitive prosthesis is somewhat shortened when a tubular compression bandage is used. We project that patients managed in this fashion will have fewer post-fitting problems that are related to additional shrinkage occurring in the first few weeks of prosthetic wear and that the incidence and/or severity of phantom sensation will be reduced as a result of the controlled compression of the Compressogrip® tubular compression bandage.

Notes

1. Kansas City, Missouri 64141.
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3. Field, M., Manager, Textile Research and Development, Knit-Rite, Inc., Kansas City, MO 64141.

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1. Mooney, V.; Harvey, J.P.; McBride, E.; and Nelson, R.S., "Comparison of Post-Operative Stump Management: Plaster vs. Soft Dressings", *Journal Bone and Joint Surg.*, 53-A, March 1971.
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3. Puddifoot, P.C.; Weaver, P.C.; Marshall, S., "A Method of Supportive Bandaging for Amputation Stumps", *Br. J. Surg.*, 60: 729–731. 1973.
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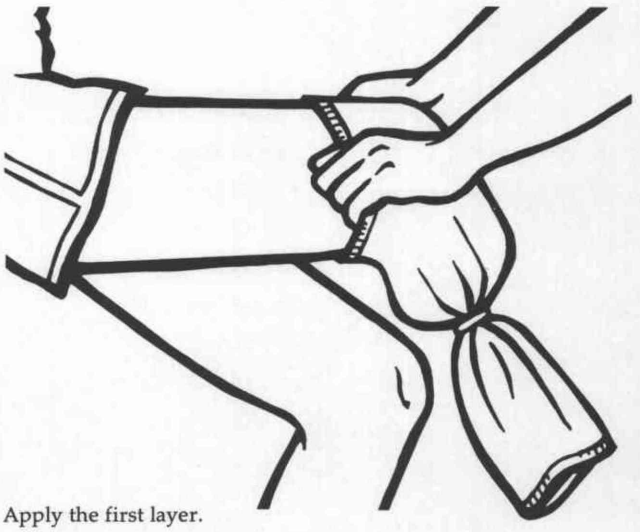
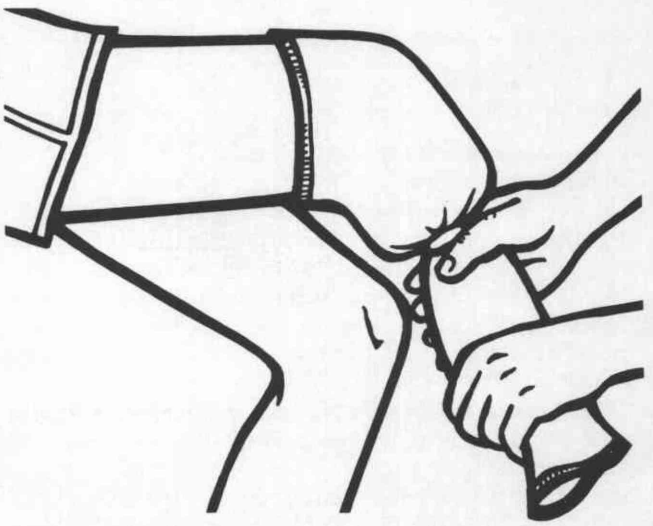
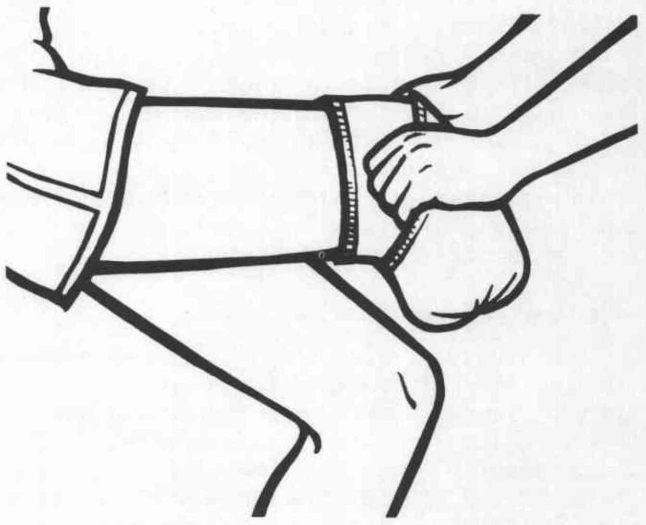
6. Holloway, G.A., Jr.; Daly, Colin H.; Kennedy, D.; Chemosky, J., "Effects of External Pressure Loading on Human Skin Blood Flow Measured by 133 Xe Clearance", *Journal of Applied Physiology,* 40 April 1976.



Apply the first layer.



Position the ring snugly.



Apply the second layer to a point 2" to 3" below the first.

Fig. 2 Application Technique

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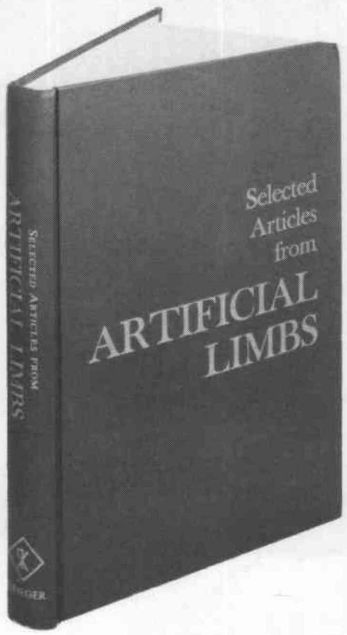

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