DECEMBER 1971

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Contents

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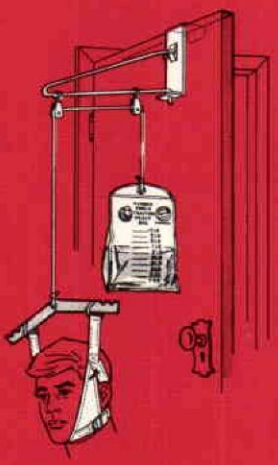

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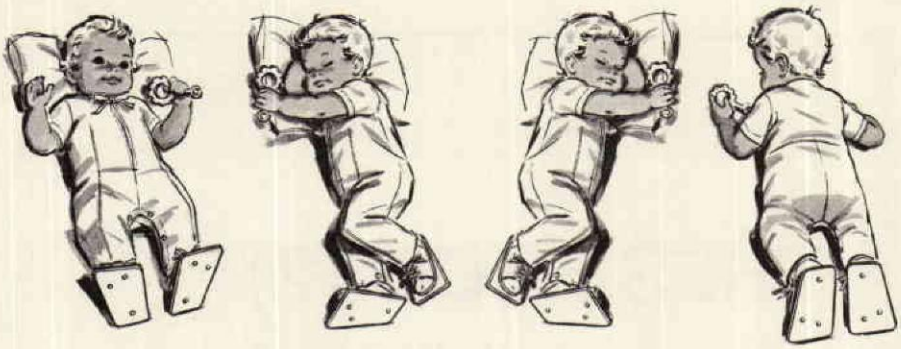

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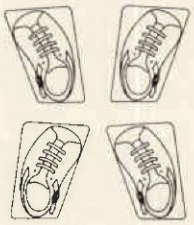

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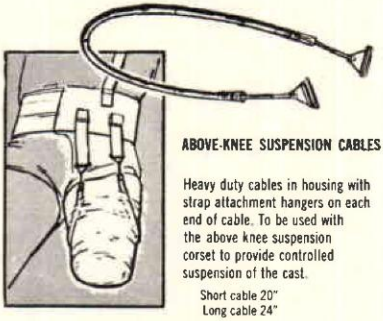

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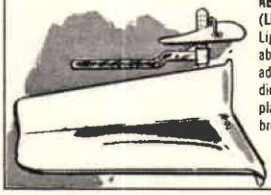

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18"	8"	6"
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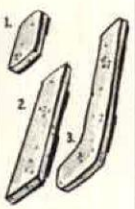

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A NEW START

This is the December, 1971 issue of the quarterly journal of the orthotic-prosthetic profession.

It has been published late for a reason.

An intensive evaluation of the entire situation involving ORTHOTICS AND PROSTHETICS has been underway, and a number of changes have been made in its set up. Their goal is to make this publication a truly worthwhile vehicle for the service of the profession.

The Association will continue as publisher and the National Office will continue to manage the production end of the journal activity. However, full responsibility for the editorial content has been turned over to the American Academy of Orthotists and Prosthetists. It will be the latter's function to stimulate certified practitioners to prepare useful articles.

Mr. Bert R. Titus, C.P.O., Duke University Medical School, and Mr. A. Bennett Wilson, Jr., Executive Director, Committee on Prosthetic Research and Development, National Research Council, will serve as Editor and Technical Editor temporarily.

A number of new policies relating to content will be introduced over the next few issues. They are based on these fundamental concepts:

1. Since ORTHOTICS AND PROSTHETICS is the only comprehensive journal in the field, it should be truly useful to the practitioners and facilities composing the practice. This means that they must take on the obligation of preparing articles that will benefit their colleagues, if the journal is to survive.

2. Anyone's article will be considered, provided it relates to orthotics and prosthetics and is co-authored by an orthotist or prosthetist.

The over-all goal is to make this journal an effective medium for the benefit of every subscriber. Whether that goal is met will depend on whether each practitioner has enough interest in his profession and its publication to contribute articles.

It's that simple.

The Orthopaedic Craft of the Federal Republic of Germany*

by Helmut Ginko,** O.M.
Translation by Siegfried W. Paul,*** C.P.O.

Note of the Translator:

Many of the terms referred to by the author are either not known in this country or have a different meaning. A mechanic, for example, has professional status in Europe and is recognized as such. The vocations of Orthopedic Merhanic and Bandagist are separate entities during the apprenticeship and journeyman's years. However, they become equally qualified professionals once the Master's examination has been passed. They are then referred to as Orthopaedic Technician, or as in Switzerland, Orthopaedist. The terms Craft and Craftsman are still status symbols in Europe.

Mr. President, Ladies, and Gentlemen:

First of all, I would like to thank you in the name of the members of the German Travel Group for the hearty reception you have extended to us.

* Translation of address given at the National Assembly, American Orthotic and Prosthetic Association, Las Vegas, Nevada, Nov. 2, 1971.

** President of the German Prosthetic and Orthotic Association.

*** Director, Orthotic and Prosthetic Department, Newington Children's Hospital.

I would like to thank one and all who helped, through their time and efforts, to make this journey a success. In particular, I would like to mention Mr. Paul and his wife, Betty, who traveled with us from New York.

I had the pleasure of becoming acquainted with your President, Mr. Snelson, when he was in Bonn in attendance of our Assembly. It was his wish that I, at this Assembly, should talk about professional organization and the situation of the Orthopedic Mechanic and Bandagist Crafts in the federal republic of Germany. I accept this opportunity with appreciation and would like to title my paper: *"The Orthopaedic Craft of the Federal Republic of Germany."*

In order to understand the position of us within our society and to understand the structure of our Organization, it will be necessary to look for a moment at the development of the German crafts.

Today's modern German organization of crafts had its origin within the foundation of guilds. The oldest historic document known to us comes from a guild in Worms-at-the-Rhine and dates back to 1106. It was around 1260 when nearly all of the crafts had been organized in guilds. Creation of guilds resulted in full acknowledgment of individual crafts as entities. Other occupations were able to concentrate on their vocation without having to bother with the fabrication of the tools used by them.

The concentration of efforts by the craftsman within his craft resulted not only in outstanding skills, but also in extensive, far-reaching moral development.

Besides being economically and politically important, the guilds also represented religious, moral, and social organizations. Each had a saint, and the churches made available special altars. Brothers of a guild would consider it an obligation to practice brotherly love.

It was not easy to obtain membership in a guild. The applicant not only had to to submit proof of his skills, but had to reveal his social and family history, as well.

This period—from about 1100-1580—was considered the climax of the German crafts. Deterioration of the guilds resulted in weakening of customs, and the power of the crafts suffered severe damage.

Wars and discord within the country furthered the complete paralysis of the political and economical influence of the crafts. In spite of this, some of the old practices survived and should, even today, not necessarily be judged negatively.

This, Ladies and Gentlemen, is a brief history of the origin of the organized crafts of Germany in general.

The Orthopeadic Mechanic of our country can also look back on a long tradition. It was in Berlin in 1656 when the first guild of our craft was founded. This means that this vocation of our country has been organized for over 300 years. Today, there are 125 crafts in the federal republic of Germany which enjoy the protection of the laws.

Also, the organizational structure of the crafts meets the requirements

of modern society and its economy.

The guilds are the smallest segment of the crafts' organizational structure. They are public institutions, anchored within the laws written for the crafts. Today, guilds can be compared with organizations of the middle ages. However, their influence and power cannot be compared even though they play a considerable, if not a deciding, role in the economy of individual companies. We shall hear more about this later on.

The guilds, as smallest and lowest group of the strict craft organization, is the basis for two separate directions of the crafts' organizational structure.

One direction is representation of the craft as an entity and is organized as follows: Local craft associations, craft chambers, regional chambers of craft, the federal chamber of craft and the Central Association of German Crafts. The other direction is the vocational classification. Local guilds are organized in state guilds and they compose the national organization, the Federal Guild Association. This organization is the highest representation of a vocation within the crafts.

The guilds have to admit to membership anyone that is listed in the Scroll of the craft, which is a registry kept by the Chamber of Crafts listing all persons who own and operate facilities practicing a craft. The Master Title is mandatory for listing in the Scroll. Having passed the master examination, an examinee has proven that he is capable of managing a business independently and that he is masterly proficient in his craft. He also is granted permission to train apprentices providing that he is older than 24 years of age.

You are probably interested in the various responsibilities of individual organizations of the crafts.

First, let us discuss the Guild. Guilds are obligated to further the professional image and the espirit de corps; to support good professional relations between Master, Journeyman, and Apprentice; to supervise the education and training of apprentices according to the guidelines of the Chamber of Crafts; to hold Journeymen's examinations with authorization of the Chamber, and appoint a Board of Examiners for this purpose; to further the knowledge of master and journeyman, and to establish or support schools for such a purpose; to function within the Administration of Professional Schools according to the provisions of local laws and regulations; to further cooperation to government or other agencies; within the Craft, and to render bipartisan evaluation and information to support other Craft organizations and establishments in their efforts.

The Guild should create and set forth media designed to improve the effectiveness of facility operation; function as non-partisan advisor to agencies for the awarding of contracts and services; and provide support to the publications of the craft. The Guild can create a committee for grievances between employers and apprentices; make contracts for pay scales as long as such a contract was not made by the Association; create foundations

for support of their members in case of illness, death, inability to work, or other needs; function as Intermediary in case of grievances between members and financing agencies.

The Guild can also conduct any other business for the betterment of common industrial interests of its members.

The establishing of insurance plans or foundations can only be in accordance with the specific federal regulations.

As you can see, Ladies and Gentlemen, even such a small group like a Guild has to meet a multitude of obligations. Leadership of a guild is provided by an "Obermeister" who is supported by a board of Directors. The "Obermeister," the Board, and all of the committees are elected every three years.

Individuals can run for reelection. I, myself, have led the Orthopedic Mechanics and Bandagist Guild of Duesseldorf for eleven years now and have members on the Board who have been in office for 20 years.

It is understood that the responsibilities mentioned can only be tackled if the elected individual has the common interest at heart. A prerequisite, of course, is that their business is well-founded and without financial difficulties.

The next organization to be discussed is the District Association of Crafts. The responsibility at this level is representation of the interests of the facility owners and the overall interests of the guilds within their district; support of the guilds in their efforts and to create medias for the representation and advancement of the social interest of the guild members; giving to agencies advice, suggestion, and information pertaining to the independent facility owner; and conduct of the business of a guild when requested. The District Craft Association will also assist those members of a guild not having their place of business located within the district. Members of a district craft association are the guilds of all of the crafts within a district.

The next level of organization is the Chamber of Crafts. The responsibility at this level is to further the interest of the crafts; to equalize interests of individual groups and their organizations; to support the government agencies with advice and recommendations pertaining to demands of the craft and to give testimony about the status of the craft; to keep the scroll of the crafts, to regulate the education and training of apprentices, to issue guidelines for this purpose, and to supervise their application; to keep an apprentice Scroll; to issue rules for the Journeymen's examination for all of the crafts, and to create Boards of Examiners to conduct such examinations; to issue rules for the Master examinations; to assist local guilds in educational efforts in furthering the technical and business administartive knowledge of master and journeymen, and to maintain an agency for this purpose; to provide experts for the evaluation of quality, service, and fee structures; to further economical interests of the craft designed to support organizations created for the

crafts; to create Review Boards to settle grievances between facility owners (sellers) and their clients; to issue certificates of origin for products manufactured by the craft; to supervise guilds and district craft associations; to make available support for craftsmen and journeymen in need; to govern educational programs and examinations of apprentices employed by a craftsman but not enrolled in the particular craft of the employer. (This is done with permission of industry and the chambers of trade. The Chamber should be contacted for all matters pertaining to important issues of the craft.)

The regional and national craft conferences assemble only every three years.

We would now like to discuss the most important organization: the Central Association of German Crafts. All of the channels of our vocations lead to this organization which represents the interests of the crafts in both internal and external affairs. Its responsibilities are of global nature.

Our vocation, namely the Orthopedic Mechanic and Bandagist Craft, rests also in the lap of this strict organization. I can say that we are most comfortable in this company. Anyone in the Federal Republic of Germany who wishes to manufactrue orthopedic appliances or desires to measure or fit the human body, must meet specific prerequisites.

He must have been trained as an Orthopedic Mechanic or Bandagist. His education is an apprenticeship conducted by a qualified master. The Trainee must attend a professional school while he is in training, where he receives the fundamental and theoretical education needed for the manufacture of orthopedic appliances. Subjects included are material science, arithmetic, anatomy, pathology, and physiology. In addition, there are business administration, civics, and all of the subjects necessary in molding a good crafstman. The manual training course is carried out by the employing facility, and is governed by plans issued and regulated by the Chamber of Crafts.

The Guilds conduct additional instructional courses placing great emphasis on techniques which are not covered by the training facility.

The Orthopedic Mechanic must serve an apprenticeship of three-and-a-half years and the Bandagist three years. A Journeyman's examination is given at the end of this period of training. Excellence of performance can result in shortening of the time required.

Successful completion of this examination entitles the individual to work as a Journey Craftsman, but he is still not entitled to fit appliances to patients without supervision.

He must have passed the Masters' Examination in order to open a business of his own. Prerequisite for this examnation is uninterrupted employment as Journeyman in a qualified facility. Two Masterpieces (Meisterstuecke) have to be fabricated besides a work sample which has to made under observation of the examiners.

As a rule, a prothesis and an or-

thosis must be fabricated, and the appliances must be worn by the patient at the time of the examination by the Board. The theoretical part of the examination covers all segments related to our work in anatomy, physiology, pathology, material science, and those of orthopedic technical interest in general. Business administration, bookkeeping, taxes, banking, and all of the other fundamentals for the effective operation of a facility are also tested.

Lately, the instruction of training supervisors was added as an additional examination subject. Testing in this area demonstrates qualification for the Trainee Programs. Anyone who has passed the difficult stages of his professional career can say that *he is well able* to evaluate therapeutic requirements, at least for orthopedic problems, and render the necessary service.

Only now, Ladies and Gentlemen, is the craftsman able to open his own facility after being listed in the Scroll of Crafts. He will now become a member of the guild and will from now on have his position within the professional society. The time scheduled makes it necessary for my statements to be only sketchy —highlighting our organizational structure. However, please permit me to speak briefly about the orthopedic technical care in the Federal Republic of Germany in general.

Almost all of the cost for orthopedic appliances, regardless of type, are financed by some carrier. Only on a rare occasion will a private patient request service. The result is that the fee schedules and carry-out procedures have to be arranged with insurance companies, Welfare Agencies, Workmen's Compensation groups, the Veterans Administration, and other agencies.

These responsibilities are handled by the Guilds, to the greatest extent by the federal association. And here it is where sound organizational structure becomes evident. Here, we learn that the rewards for our work can only be as good as our representation. Earlier, I discussed the organizational direction of the craft in general. I do not want to fail to mention the other direction—namely the vocational direction.

There are 18 guilds of our profession in Germany. All of the guilds are organized in the National Association and represent a single visit. The guidelines, political discussions, and related questions are decided by the President. The Board of Directors acts in an advisory capacity and will assist in the making of decisions. The President and Board of Directors are elected by a delegation from the individual guilds for a period of three years. The election is based on democratic principles. Reelection is permissable.

The nature of our vocation places the National Association in a position where this organization plays a key role in the economical life of every self-employed orthopedic craftsman.

This organization negotiates and signs Union contracts, calculates and controls fee schedules for orthopedic appliances and makes service contracts with the government

and other cost carriers. Its tasks are reaching even further. The National Association conducted the affairs of the Frankfurt Professional School until 1970. Foundation of a support organization for this school eased the problems of maintaining this school. The professional journal, *"Orthopaedic-Technik"* is also published by this organization. Experienced and industrious coworkers are required in order to represent the interests of the entire vocation.

At present, we are staffed with two Executive Directors, Dr. Lamers and Mr. Schuette, and four secretaries. A part-time employee is in charge of mail service and duplicating.

Ladies and Gentlemen, I hope that my report gave you some understanding of the organizational structure of the German crafts. It has been only through our belonging to the German craft organization that we were able to continue our free and independent professional status.

We support any possible cooperation with the medical profession and with medical sciences. However, we refuse to be classified as a paramedical vocation or even as "HILFSBERUF."

I would like to thank you for your patience in listening to my presentation. I believe that I can speak for 1,200 independent orthopedic craftsmen of the Federal Republic of Germany and the 5,000 employees when I express our best wishes for a most successful assembly to you.

Research Efforts in Improved Prosthetic Skin for Prostheses

Maurice A. LeBlanc,* M.E., C.P.

At the Conference on Cosmesis and Modular Limb Prostheses (1) on March 3-7, 1971, sponsored by the Committee on Prosthetics Research and Development of the National Academy of Sciences, it was agreed that modular, endoskeletal prostheses offer definite advantages over conventional crustacean prostheses in many ways, but the lack of a practical method of providing a good cosmetic finish has kept the idea from being accepted widely.

* Staff Engineer, Committee on Prosthetics Research and Development, National Academy of Sciences, Washington, D.C. 20418.

To investigate this matter further, an *Ad Hoc* Committee on Cosmesis for Endoskeletal Prostheses was appointed and the following people met in Annapolis, Maryland on July 19-20, 1971:

Fred Leonard, *Chairman*
Cecil Benton
Mary Dorsch
Hector W. Kay
Kenneth C. Kingsley
Maurice A. LeBlanc
Alvin L. Muilenburg
Thomas Pirrello
William F. Sauter
A. Bennett Wilson, Jr.

At this meeting tentative specifications for a material suitable for

prosthetic skin were drafted, and plans were outlined to recruit the assistance of appropriate chemical companies in developing it.

Tenative specifications, a brief description of the problem, and samples of PVC gloves have been discussed and given to about a dozen companies. The assistance given to this project by Dr. Leonard and the Army Medical Biomechanical Research Laboratory is greatly appreciated.

It is hoped that one of the chemical companies contacted will become interested in the problem and develop a superior prosthetic skin covering for endoskeletal limb prostheses. If this can be done, both the amputee and the clinician will be happier.

The memorandum addressed to organizations that may be interested in working on this problem and the tentative specifications follow this report as Appendixes A and B, respectively.

APPENDIX A

October 18, 1971

Memorandum

From: Committee on Prosthetics Research and Development

Subject: Research in Prosthetic Skin for Endoskeletal Prosthesis

Cosmetic gloves and leg covers for artificial limbs are presently made of polyvinyl chloride. This material has been used for many years, and while it is satisfactory in many respects, it has the disadvantages that it stains easily, discolors in sunlight, and lacks sufficient elasticity.

Efforts to Date

The Army Medical Biomechanical Research Laboratory at Walter Reed Medical Center, under the guiding influence of Dr. Fred Leonard, has pioneered the research to date on the prosthetic skin material for artificial limbs. This work has centered around polyvinylchloride with different stabilizers and plasticizers as well as plasticizer-free, inherently flexible elastomers. To date no satisfactory material has been found. It is time to explore other materials, and to undertake basic research, if necessary, to develop a more ideal product.

Until now, our efforts have been "in-house" within the prosthetics field. At this point we feel we need to go out-of-house because our own manpower and technology are inadequate for the task.

State of the Art

Current limb prostheses are exoskeletal in construction; they are made of rigid, laminated plastic shells integrated with metal joints. We are trying to replace these with newly developed endoskeletal prostheses, which have an internal skeletal structure covered with a soft foam and skin in an anatomical manner. These new prostheses are more acceptable to patients because they are soft and look more cosmetic in appearance with the mechanical parts covered.

We have the necessary components for the new endoskeletal prostheses, except for an acceptable prosthetic skin covering. This is the crucial link for the whole system and is where we need help.

Amputee Population

There are about 300,000 amputees in the United States. Of this number, aproximately 32 per cent are upper-limb losses.

Our Proposal

Until now, we have been unable to interest major chemical companies in working on the prosthetic skin problem understandably because the commercial market is small. This project has become increasingly important, however, and we would like to solicit the assistance of chemical companies or other capable research facilities to undertake this work by supporting it with federal government funds available through this office.

A copy of the tentative specifications for the prosthetic skin, a sample of polyvinyl chloride cosmetic glove now in use, and other information are available for further study.

APPENDIX B

October 18, 1971

TENTATIVE SPECIFICATIONS FOR PROSTHETIC SKIN FOR ENDOSKELETAL LIMB PROSTHESES

Ad Hoc Committee on Cosmesis for Endoskeletal Prostheses
Committee on Prosthetics Research and Development
National Research Council-National Academy of Sciences

I. SCOPE

These specifications are for a material to be used as the outer cover of an endoskeletal artificial limb, i.e., to serve as the artificial skin. (An endoskeletal artificial limb is comprised of the prosthetic skeleton —a metal tube and joints, the prosthetic soft tissue—a flexible plastic foam, and the prosthetic skin.)

II. REFERENCE DOCUMENTS

A. "Tentative Specifications — Glove, Cosmetic, Adult-Size—for Use with Mechanical Hand for Upper Extremity Amputees," VA-PSAS Specification NO. U58-2T, December 31, 1958.

B. Report of the CPRD Conference on Cosmesis and Modular Limb Prostheses held on March 3-7, 1971.

C. Various ASTM Standard Tests.

III. REQUIREMENTS

A. *Appearance*

1. The material shall be capable of being formed to exhibit:

a. Realistic texture and appearance of human skin.

b. No evidence of mold-parting lines or other unnatural areas such as bubbles, flaws, nicks, and cuts.

2. The material shall be translucent and capable of being colored by incorporation of colors into it and tinted by external application of colors.

3. The colors shall not rub off or migrate from their point of application.

B. *Mechanical Properties*

1. The ultimate tensile strength shall be not less than 5,000 pounds per square inch. Refer to test method ASTM D412-66.

2. The tensile strength at 100-per cent elongation shall be no

greater than 50 pounds per square inch. Refer to test method ASTM D412-66.

3. The elongation at break shall be not less than 800 per cent. Refer to test method ASTM D412-66.

4. The material shall exhibit a knotty-type of tear. The tear resistance shall be not less than 200 pounds per inch. Refer to test method ASTM D624-54, Die "C".

5. The fatigue life when the material is in tension from 0 to 300 per cent elongation shall be at least 300,000 cycles without physical change.

6. The material shall have no creep for a period of 24 hours under a load equivalent to 5 per cent of the ultimate tensile strength. Refer to test method ASTM D674-56 (1961).

7. The material shall exhibit resistance to abrasion as specified in the test method in Section IV.

C. *Physical Properties*

1. The material shall exhibit only slightly visible color change over a period of 72 hours under an S-1 mercury arc lamp. Refer to test method ASTM D795-65T, Procedure A.

2. The resistance to stain shall meet the criterion specified in the test method in Section IV.

3. The material shall exhibit a permanently dry feel.

4. The material shall not have an offensive odor after preparation for use.

5. When delivered, the material shall be nontoxic and non-allergenic and shall not cause dermatitis.

6. The material shall be self-extinguishing and shall not support combustion. Refer to test method ASTM D1692-59T.

D. *General*

1. The material shall be capable of being formed rapidly, economically and without shrinkage into thin, hollow shapes—such as a hand containing all skin details—by low pressure casting or dipping techniques.

2. Exposure to water or recommended cleaning solutions — e.g., soaps and detergents, alcohol, acetone, and petroleum hydrocarbons —shall not cause whitening or other change in color or change in mechanical and physical properties during the first year of wear.

3. The material shall not lose any of its mechanical or physical properties or otherwise deteriorate when stored in unsealed cardboard cartons at temperatures of — 20 to + 120 deg. F. and ambient humidities for one year. For example, there shall be only slightly visible color change and no evidence of exudation under these circumstances.

4. The mechanical and physical properties shall not change when the material is exposed to temperatures up to 180 deg. F. for 24 hours.

5. The material shall be chemically compatible with materials normally in contact with it.

IV. TEST METHODS NOT OTHERWISE SPECIFIED

A. *Abrasion Resistance Test*

Abrasion resistance shall be determined by placing a piece of the material approximately 2 in. by 8 in. on a Gardner single-brush washability machine (Gardner Labora-

tory, Inc., Bethesda, Maryland) or similar device. The brush assembly shall be modified to accommodate the abrading material over a slightly curved surface with a total weight of one pound. The abrading material shall be various fabrics of Dacron, nylon, wool, and cotton as well as the skin material itself. The skin material in contact with the abrading material shall be cycled 10,000 times with no deleterious effects, e.g., tear, holes, or tackiness.

B. *Stain-Resistance Test*

Stain resistance shall be determined by applying a stain to a swatch of the material for a period of 24 hours. The stain shall then be removed by a recommended cleaning solvent. There shall be no visual evidence of stain remaining or discoloration of the material. The stain shall be any one of which the wearer might be expected to encounter during a day, e.g., ball-point ink, food, carbon paper, etc.

Note: All tests shall be conducted at 75 $\pm$ 2 deg. F. and 50 $\pm$ 2 per cent relative humidity unless otherwise specified.

Reference

1. Committee on Prosthetics Research and Development, *Cosmesis and Modular Limb Prostheses—A Report of a Conference,* National Academy of Sciences, Washington, D.C. 1971.

Engineering Principles and Fabrication Techniques for the Scott-Craig Long Leg Brace for Paraplegics

by Bruce A. Scott, C.P.O.

(Ed. Note: The accompanying article was almost completed by Bruce Scott, C.P.O., Denver, Colo., prior to his death. The introductory section describes the circumstances of development of The Scott-Craig Long Leg Brace for Paraplegics.

Dr. Harry R. Hahn, a member of the developmental team, said in a recent letter to the National Office:

"I am extremely pleased that you are planning to publish the article and dedicate it to Bruce. He, as you undoubtedly well know, was the true brains behind the concept of the fixed ankle, and to my way of thinking it is the most significant basic change in lower extremity bracing concept since the Germans made the first caliper.")

The engineering principles of the Scott-Craig long leg brace can best be described by saying that it takes advantage of Newton's Third Law of Motion—that for every action there must be an equal and opposite

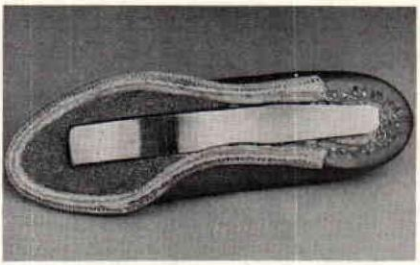

Fig. 1

A longitudinal plate of spring steel is imbedded in the insole.

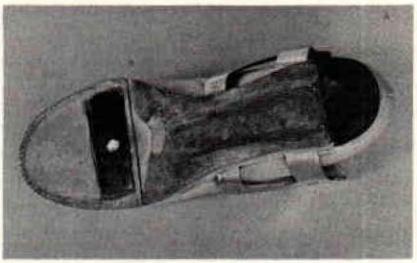

Fig. 3

A wedge-shaped leather soling is installed to cover the bottom of the reinforced stirrup.

reaction—in that the shoe attachment is designed so that the hip joint can be left free and the center of gravity of the patient can be used to provide control of balance during standing.

The Scott-Craig long leg brace was developed by a group at the Craig Rehabilitation Center over a period of about ten years in an effort to provide the paraplegic patient who has a complete neurological level above L1 with more function and comfort than is possible with previously known braces (1).

Shortly after his accident, nearly every paraplegic patient wants to be fitted with orthoses immediately, so that he can "walk again." Early fitting provides psychological advantages only when the braces prove to be useful; that is 1) when they provide the necessary stability for balance without an excess of hardware, and 2) when they provide ease of donning and doffing. With these criteria in mind and with Newton's Laws to guide us, we can now try to meet these requirements.

How can the force of a body standing upon the floor, when there is no neuromuscular function below the lesion site, be harnessed in a manner so as to keep the body erect and balanced? To begin, we construct a firm, broad, flat platform, or foundation.

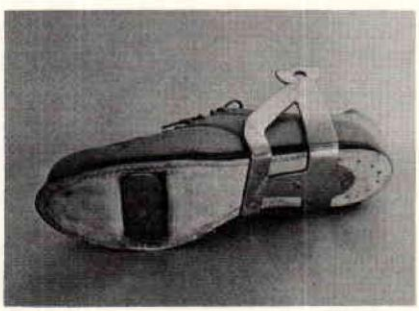

Fig. 2

View showing installation of the transverse plate and the reinforced stirrup.

Fabrication

The sole of a well constructed welt-type shoe is removed so that a piece of spring steel, approximately ⅛ inch by one inch and shaped to the contour of the bottom of the shoe, can be embedded into the insole. The longitudinal plate should extend from the heel to a line one inch distal to the metatarsal head area (Fig. 1). A full sole of firm oak-tanned leather is placed over this longitudinal plate, sewn to the welt, and nailed to the heel. This

Fig. 4

View of the lower portion of the Scott-Craig Brace. In order to show construction details more clearly, this picture was taken before the anterior tibial band was added.

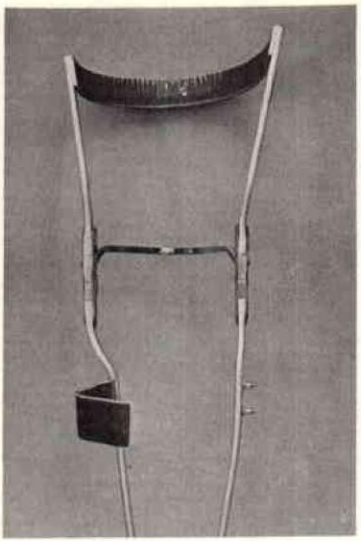

Fig. 5

View of the upper portion of the Scott-Craig Brace. Again the pads have been omitted in order to better show construction details.

arrangement contributes to antero-posterior stability.

To provide medio-lateral stability to the forepart of the foot, a piece of steel approximately ⅛ inch by ¾ inch is embedded transversely across the entire sole at the metatarsal head area, and one rivet is placed centrally through the transverse plate, sole, longitudinal plate, and insole. To provide additional support in both planes, and to provide for the attachment of the ankle joints, a standard "Becker" type double Klenzak stirrup with a strut added is used (Fig. 2). The strut, formed from ⅛ inch by ½ inch coldrolled steel, is welded to both stirrup heads and to the distal shank of the stirrup. The modified strut is then riveted to the shoe sole. The two anterior rivets pass through the strut, sole, and insole, but span both edges of the longitudinal plate. No holes should be drilled through the longitudinal plate in this area, so as not to weaken the longitudinal plate in its highly stressed area. The middle and posterior rivets, though, pass centrally through the stirrup, sole, longitudinal plate, and insole (Fig. 2).

To further establish a flat, rigid platform, sole leather is cut and formed to fit over the stirrup-strut structure from the metatarsal head area line one inch from the posterior edge of the heel, tapered in such a manner as to provide for the necessary heel build-up (Fig. 3). The last inch of wedge build-up is made of a semifirm foam rubber that acts as a cushion at heel strike. The flat wedge-type sole provides both strength and stability. To finish off the sole, a piece of Neolite top soling, ⅛ inch thick, is glued over the entire sole.

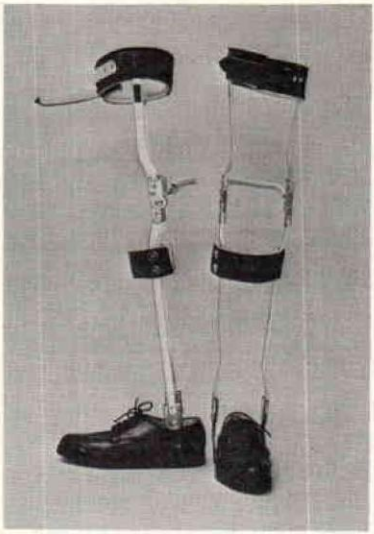

Fig. 6
The finished brace.

To provide some flexibility and adequate shoe-to-floor friction during heel strike and toe push-off, double Klenzak ankle joints are bolted to the stirrup heads (Fig. 4). The customary springs are replaced with solid rods so that by simply adjusting the cap screws upon the rods, the amount of ankle dorsiflexion required for the patient to obtain optimum control can be provided. All four cap screws must be secured tightly during each adjustment to eliminate the slightest amount of motions about the ankle joint.

The medial and lateral below-knee uprights are now cut from ¼ inch by ⅝ inch 2024 ST4 aluminum stock with a ⅝ inch posterior offset at the knee joint. The distal end of the uprights are riveted to the ankle joint and the proximal ends riveted to the lower half of the knee joints. A pre-tibial, hinged, half band consisting of a sturdy gate hinge and a piece of ⅛ inch by 1½ inch 2024 ST4 aluminum stock is riveted to the medial upright at a position immediately below the tibial tubercle (Fig. 5). No posterior cuff is necessary because all forces below the knees are applied anteriorly. Care must be taken to pre-shape the anterior band for relief over the tibial ridge. Two convertible automobile top fasteners are riveted to the lateral upright to provide ease of closure and unlatching after the cuff has been applied. The anterior tibial band must, of necessity, be shallow in order to keep the knee extended, and must be well contoured and padded in order to avoid excessive skin pressure. The above-knee medial and lateral bars are cut from ¼ inch by ⅝ inch 2024 ST4 aluminum stock, and riveted to the upper section of the "Becker" spring loaded, bale-lock knee joint. The knee joint is offset ⅝ inch posteriorly for two reasons: 1) the forces involved tend to keep the knee joint extended, thus allevi-

Fig. 7
Patient standing in the Scott-Craig Brace.

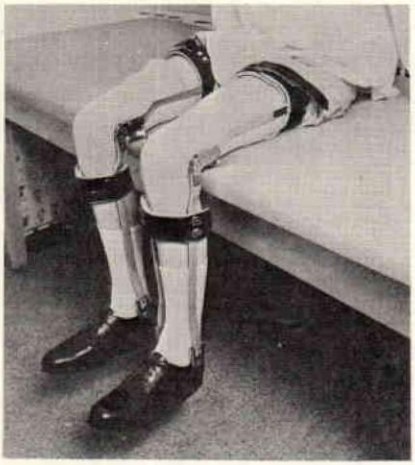

Fig. 8

Patient sitting while wearing the Scott-Craig Brace. Note the effects of the offset knee joints.

ating stress on the locking mechanism, and making it easier to unlock, and 2) there are no sharp, protruding edges when the knees are flexed during sitting, thus, saving wear and tear on trousers (Fig. 6).

The above-knee uprights are made shorter than is customary in order to allow freedom of hip joint hyperextension. In addition, use of the "shorter-than-usual" medial upright, when upper motor neurological involvement is present, lessens the possibility of pressure spasticity of the adductor longus muscle.

The proximal-posterior band is contoured to provide total contact and is more shallow than is customary. The proximal-posterior band, as well as the pretibial-anterior band, must be shallow enough so that the forces applied by the bands will hold the knee in full extension. A leather cuff covers the proximal posterior band and completely encircles the thigh. A one strap ring-slide, loop-back, Velcro closure is used.

Training

In a typical case, gait training starts approximately seven weeks post-injury with a Jewett-type hyperextension back brace, Scott-Craig long leg braces, and Canadian-type crutches. About six weeks later the Jewett brace is exchanged for a padded Hoke corset. In lower neurological lesions the corset is discontinued as soon as possible. The physical therapist determines the proper amount of dorsiflexion by altering the setting of the screws and length of the pins in the Klenzak ankle joints while the patient is standing in parallel bars, a procedure that requires a good deal of patience. When the proper amount of dorsiflexion is found, the patient stands relaxed and is able to maintain balance without arm support. A swing-through gait with Canadian-type crutches is taught as the therapist walks behind and pushes anteriorly at the hips to insure hip hyperextension at heel strike. A pelvic band is never required.

Wheelchair transfers are taught immediately. The knee joints are locked in extension, and the patient is taught to come straight out of the chair, with a postero-inferior force on each of the crutches, into a balanced, hyperextended stance. Sitting down is exactly the reverse, the bale locks becoming disengaged upon coming in contact with the anterior edge of the wheelchair seat.

When the patient has gained confidence in his ability to "walk" alone, training is given for negotia-

tion of all types of terrain, ramps, curbs, stairs, etc. under various conditions, and for recovery after a fall. Swing-to, side steps, and turns are taught also. A four-point gait is demonstrated only to show that this technique is slow and requires more energy than is necessary.

Because balance is achieved easily parallel-bar work is eliminated, and gait training and expensive hospitalization time are reduced susbtantially. The average time for a typical case to "solo" is two weeks, and for complete training is four to six weeks. In addition the rapid physical progress is physchologically beneficial to the patient.

Prescription

Criteria for prescription are very simple. The upper extremities and shoulder girdle must be adequate for handling crutches, and motivation on the part of the individual to "have-a-go-at-it." The average patient, during his first six weeks post-injury, should be on a training frame in the gym doing exercises to strengthen the upper limbs and is usually motivated when he observes the progress of other patients who are further along in the program.

A Note of Caution

The apparent simplicity of the brace design must not lead one to believe that the fit and force factors are equally simple. To obtain application of the correct forces every step in fabrication must be strictly adhered to; otherwise, one must expect failure in structure, balance, mobilization, or combinations thereof.

A Note

A Super-8mm movie of gait training is available on loan from Craig Rehabilitation Hospital, 1599 Ingalls Street, Denver, Colorado 80214.

Acknowledgments

My thanks go to Drs. John Young, Robert Jackson, and Harry Hahn, to Miss Pat Rogge, and to Messrs. Harold Norwood, and Ralph Noell for help in the development of the brace, and for their critique of this paper, and to Mrs. Chris Marlowe for her secretarial assistance.

Reference

1. Hahn, Harry R., Lower-extremity bracing in paraplegics with usage follow-up, Paraplegia, 8:3: 147-53, November 1970.

A Single-Bar Above-Knee Orthosis

Robert O. Nitschke,* C.P.O.

I would like to present a different approach to the design of above-knee, or "long leg", orthoses. When weight-bearing is not necessary, I have been using a single-bar orthosis almost exclusively for three years.

The single-bar orthosis (Fig. 1) has been fitted successfully to patients with a variety of diagnoses. It is intended to exert slight to moderate forces in order to maintain knee stability during standing, and to maintain proper alignment of the leg during walking. It is contraindicated when large corrective forces are necessary for "heavy-duty" application and for weight-bearing.

* Rochester Orthopedic Laboratories, Rochester, New York.

DESIGN

The orthosis must be designed to meet the specific needs of each patient. For the orthosis to be made so that it will function effectively, an understanding of the bio-mechanical principles is required.

A simple experiment demonstrates that with a load of 150 lbs. on metal uprights when the knee joint is flexed 7°, a force of 20 lbs. is required to prevent the knee from buckling. When the knee joint is flexed 30°, however, the force required to prevent the knee from buckling is 80 lbs. Therefore, if

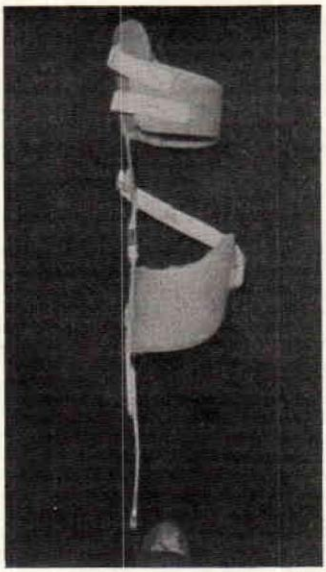

Fig. 1

Posterior view of the above-knee orthosis.

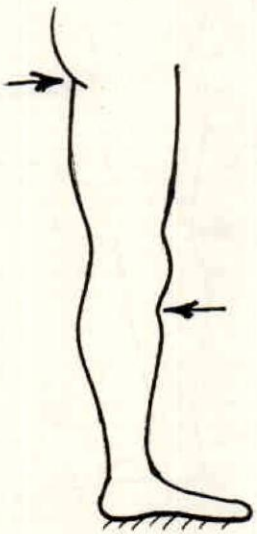

Fig. 2

Application of forces needed to control buckling of the knee.

the leg can be passively returned to near normal alignment, only small horizontal forces are required to maintain that position, and a single-bar orthosis can be used.

The fundamental supporting area common in each application is the foot. A half-stirrup is attached either to the shoe or to a shoe insert. The other two supporting areas necessary for a three-point force system are placed according to each individual's needs.

The single bar, which may be of either aluminum or stainless steel, runs on the lateral side from the ankle joint to a pre-tibial cuff, through a knee joint with a lock, to a thigh cuff (Fig. 1). This type of construction reduces the weight and bulk of the orthosis. A bar can be used on the lateral side when additional strength is required.

The pre-tibial cuff is made of synthetic balata (Polysar) and is carefully formed on the patient into a PTB shape with high medial or lateral portions, as desired, for control of valgus or varus. It is reinforced with a strong aluminum band. The thigh cuff is made of metal covered with leather, and may be either the open or closed type.

A unique feature of this orthosis is the 1-inch wide dacron strap which closes the posterior part of the pretibial cuff. It is fastened at the lateral bar 3 or 4 inches below the knee joint, runs diagonally across the popliteal area through a metal loop at the pre-tibial aluminum band and laterally upward to the side bar again, making a three-point attachment which loosens when sitting and tightens when standing (Fig. 1). This provides comfort when sitting, as well as control during the stance phase of gait.

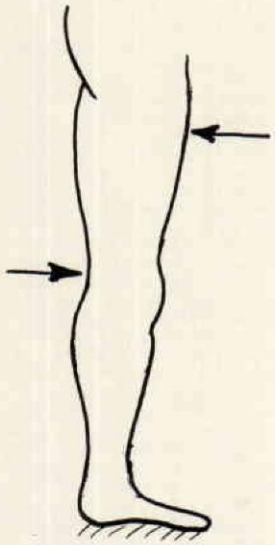

Fig. 3
Application of forces needed to control genu recurvatum.

Another unique feature is the optional use of a Silesian belt that goes around the hip and attaches to the side bar. By attaching the belt below or above a trochanter pad, control of hip abduction or adduction is obtained if needed. The patient sometimes objects to the belt and the initial feeling of restriction, but, in most cases, the patient has more control and unweighting of the orthosis is made possible.

Another benefit of the single-bar design is that placement of the ankle and knee joints is simplified, and changes or modifications can be made easily.

APPLICATION

To control buckling of the knee, the force system as shown in Figure 2 is used. The most effective area to prevent knee flexion is the anterior-proximal tibia, not the patella. The posterior counterforce should be just below the gluteal fold and somewhat lateral, where the femur is located.

The force system to control genu recurvatum is shown in Figure 3.

The orthosis must be designed to force the knee into flexion, and the patient must be trained not to force the knee into hyperextension. It is not always possible to use the single-bar orthosis for this condition because the Dacron strap does not provide solid support posteriorly. In the case of severe recurvatum it is necessary to use the conventional double-upright orthosis with forces applied on the posterior femoral condyles and anterior thigh.

The force system for control of valgus of the knee is shown in Figure 4. The support areas should be the medial aspect of the femoral condyles and the lateral thigh just distal to the greater trochanter.

The force system to control varus of the knee is shown in Figure 5. The support at the lateral side must be shaped accurately so there will

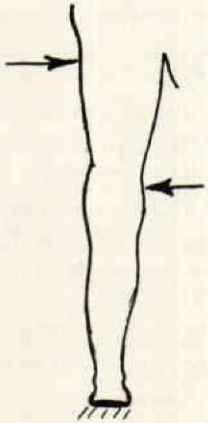

Fig. 4
Application of forces needed to control valgus of the knee.

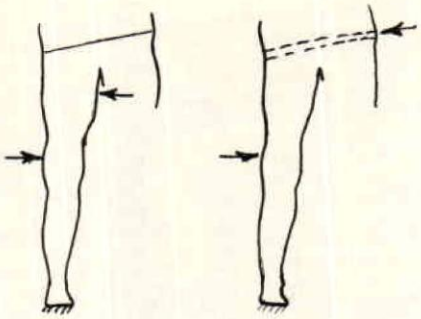

Fig. 5

Application of forces needed to control varus of the knee. Left, when a Silesian belt is not used; right, when a Silesian belt is used.

be no pressure points. To apply the counter-force at the medial aspect of the proximal thigh is not very effective or comfortable because this is a soft and most sensitive area. A Silesian belt can be used effectively to pull the side bar against the lateral aspect of the thigh and leave the medial aspect free.

EXAMPLES OF APPLICATION

The patient shown in Figure 6 is

Fig. 6

A 70-year-old female patient with Charcot knee.

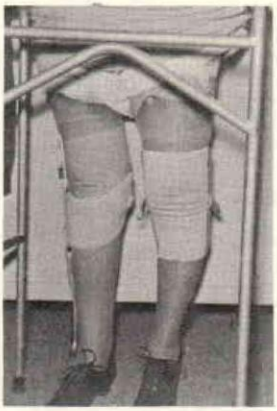

Fig. 7

The patient shown in Figure 6 fitted with a single-bar above-knee orthosis.

a 70-year-old female with a Charcot knee. When bearing weight her right knee goes into 45-50° of valgus. For 15 years she wore elastic knee cages but could walk only a few steps even with the aid of a walker. Her leg can be brought into natural alignment passively.

A single bar orthosis was fitted to her (Fig. 7). The pre-tibial shell was made high medially, and an aluminum knee joint and side bar were used. Quite small forces were

Fig. 8

A male patient, veteran of World War II.

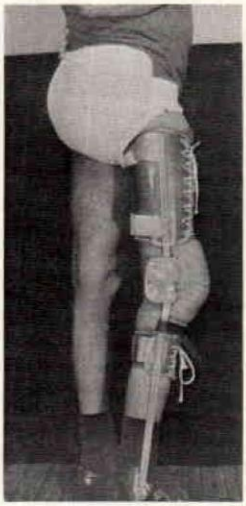

Fig. 9

Patient shown in Figure 8 with orthosis that forced hip and knee into flexion.

required to hold her knee in position, and she is now walking with the aid of only one cane.

The patient shown in Figure 8 is a veteran of World War II. His

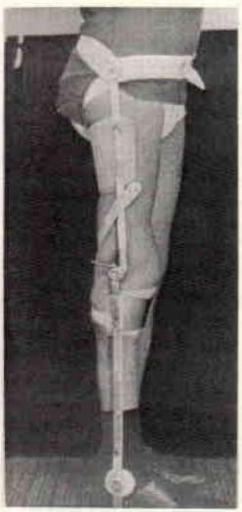

Fig. 10

Lateral view of patient shown in Figure 8 with single-bar orthosis.

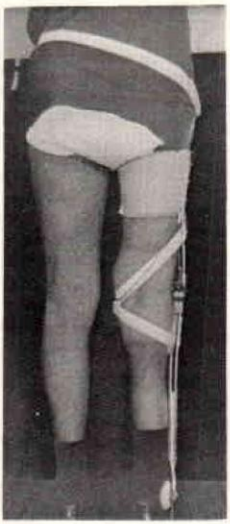

Fig. 11

Posterior view of patient shown in Figure 8 with single-bar orthosis.

previous orthosis (Fig. 9) forced his knee and hip into flexion causing pressure boils in the gluteal area and effective shortening of the limb. He was fitted with a stainless steel dual-bar orthosis as shown in Figures 10, 11, and 12. Note particu-

Fig. 12

Lateral view of patient shown in Figure 8 with single-bar orthosis sitting, with the knee in extreme flexion.

larly the natural alignment and comfort in sitting.

A 15-year-old male paraplegic patient, who sustained a spinal cord injury at the L1-L2 level and who had about 15 per cent of hip flexor and extensor power remaining, was fitted with two single-bar aluminum orthoses. The Silesian belts permitted effective control of hip motion without need for cumbersome pelvic bands and metal hip joints. Medial uprights were not needed, resulting in greater freedom of motion and more comfort.

SUMMARY

It is not necessary, except in severe cases, to enclose the complete leg from top to bottom with metal bands, leather straps, and knee-pads in order to give sufficient support for stability and ambulation. I am convinced that the much simpler designs are more effective and will be welcomed by patients, physicians, and orthotists alike.

A Patellar-Tendon-Bearing Socket With A Detachable Medial Brim

Carlton Fillauer,* C.P.O.

Following our initial exposure to the German idea of supracondylar suspension of BK Prostheses (1), we have fitted a large number of amputees; first, with custom-made wedges, then with a standardized set of three which evolved eventually into a selection of eight sizes. The experiences of these four years have resulted not only in some minor changes in the initial concept of the wedge, per se, but also in casting and fabrication techniques. Sockets with and without sponge rubber (Kemblo) liners can use the wedge principle equally well. Fortunately, a liner is not required for successful application of the wedge system of suspension.

The introduction of the detachable wedge (Fig. 1) should not be considered a refutation of any claims previously made for the supracondylar wedge suspension. The hundreds of successful fittings that have been carried out to date testify to the soundness of this approach, and it is anticipated that the plastisol wedges, as such, will

* Fillauer Surgical Supplies, Inc., Chattanooga, Tennessee.

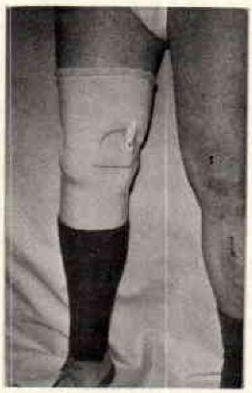

Fig. 1

Antero-medial view of a patellar-tendon-bearing socket with a detachable medial brim.

continue to be used for the forseeable future.

However, donning problems in cases where patients have extreme discrepancies between the mediolateral dimensions at the supracondylar (A) and epicondylar (B) levels, usually in the range of 1⅛ inches to 1⅜ inches (Fig. 2), prompted the search for a new approach. In the past these unusual cases were accommodated in a fashion by wedges of extra thickness, but not always successfully.

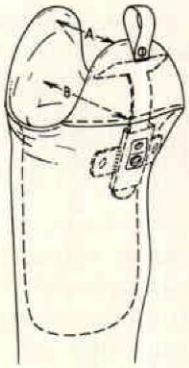

Fig. 2

Some details of the detachable medial brim.

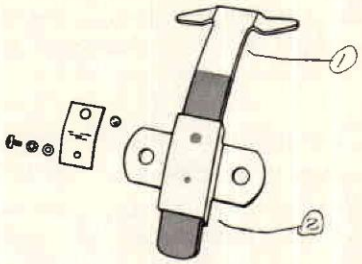

Fig. 3

Hardware required for the detachable medial brim.

It seemed logical that if the medial wall above the epicondylar level could be made so that it could be detached and replaced easily, donning would be simplified. The thickness of the proximal-medial brim then could be quite thin, ⅜-½ inch resulting in less bulk than when a Kemblo or some other removable liner is used.

The design we advocate is a PTB supracondylar socket with provisions for separation of the medial brim from the socket at the epicondylar level (the widest part of the knee, usually about midpatella level). Upon replacement of the medial section, the socket is intact without interference or influence from the related hardware.

The hardware necessary (Fig. 3) consists of an upper, Teflon coated, stainless steel bar formed to match the convexity of the medial tibial condyle and a lower unit which consists of a flanged retangular steel channel formed with a radius to match the upper bar. Included with the channel is a spring-ball assembly for retention of the upper bar.

Both units, fitted together, are sandwiched into the center of the lamination of the socket at a level

so that the proximal edge of the channel will be ¼ inch below the line where the cut in the socket will be made.

Anatomical Considerations in Supra-Condylar Suspension

The use of the supracondylar areas of the knee for suspension of the PTB type prosthesis has received considerable impetus since its introduction to clinical use via the wedge and the PTS prostheses. When these techniques are used, suspension and comfort depend upon the correct positioning of the contact area, or wedge, in the proximal socket in relation to the surface of the medial femoral condyle and upon the forming of the socket to obtain counter pressure from an area above the lateral femoral condyle.

The medial femoral condyle is more prominent than the lateral, its most prominent part being the epicondyle. The *adductor tubercle* forms the uppermost part of the condyle, and is the insertion point for the *adductor magnus muscle.*

On the posterior aspect of the femur the medial lip of the linea aspera extended to the adductor tubercle forms the medial supracondylar line.

Above the lateral condyle is the origin for the lateral head of the gastrocnemius muscle. Below this point close to the articular surface is the origin and groove for the tendon of the popliteus muscle. On the posterior aspect of the femur there is a continuous, well defined line from the lateral lip of the linea aspera to the lateral condyle known as the lateral supracondylar line. The space between these two ridges is the popliteal surface.

The surfaces of the lateral and medial condyles are not parallel but form an oblique angle somewhat in the shape of a segment of a concave cone. These angles are not completely reflected on the outer surface of the knee but are reduced by muscles and tendinous fibers attached to the femur and the condyles.

On the medial aspect of the femur, anteriorly and just superior to the condyle, the vastus medialis muscle reduces the effective angle considerably. The sartorius crosses the medial femoral condyle and inclines forward to be inserted into the upper part of the medial surface of the shaft of the tibia, above and in front of the insertions of the gracilis and the semitendinosus. Posteriorly on the condyle the adductor magnus tendon attaches to the adductor tubercle. The gracilis, semitendinous, and semimembranous tendons cross this area to their insertions on the postero-medial surface of the tibia.

The *iliotibial band* is dominant on the lateral surface of the femoral condyle extending from the tubercle of the iliac crest to the lateral condyle of the tibia and the capsule of the knee joint. The lateral ligament of the knee is attached to the lateral epicondyle of the femur and attaches to the head of the fibula.

The undercut proximal lip of the medial wall of the socket must be positioned rather accurately over the proximal aspect of the medial femoral condyle. When the lip is positioned too far distally, constant pressure between the lip of the sock-

et and the medial femoral condyle produces pain. When the knee is flexed, excessive pressure is produced between the anterior lip of the brim and the anterior medial aspect of the condyle. When the knee is extended fully the posteromedial lip of the brim tends to produce pressure in the area of the adductor tubercle.

Hard Socket

When well-fitted, rigid, non-yielding, medial and lateral walls are provided, very little piston action can take place within a below-knee socket. Some practitioners feel that soft supracondylar pads or yielding lateral and medial walls provide more comfort, but this is not consistent with the experience many have had with "hard" sockets, where interface pressures in other areas of the socket are much higher than those required for suspension. Our experience over the past 5 to 10 years in fitting hard sockets has consistently supported the position that the inclusion of soft liners contribute a negligible amount to comfort of the amputee. Perhaps an ill fitting socket is less uncomfortable with a soft liner, but the real problems remain unsolved. We feel that the average below-knee stump is provided with adequate natural padding by the soft tissues. Other factors such as cosmesis and financial costs, both short and long term, overwhelmingly favor the clean, maintenance-free hard socket.

M-L Dimension

Regardless of the stump-casting procedures used, it is important that an impression of the supracondylar area of the knee in a narrowed state must be obtained. Our experience has shown that even though the reduced M-L dimension may appear severe, no more than a comfortable reduction is required. When the patient stands in the prosthesis, he should not have the conscious feeling of a tight grip, but rather a feeling of snug contact between the socket and the soft tissues immediately above the epicondyles.

Success in the proper shaping of the medial wall is related to casting and formation of the area over and proximal to the condyles.

Casting Theory

For checking the male mold during modification certain measurements of the stump and condylar areas of the femur are required. The M-L diameters of the femoral epicondyles and of the supracondylar thigh are determined with calipers. The supracondylar M-L dimension of the thigh is measured with either a modified Ritz stick or a combination square with two heads.

The casting procedure we advocate now was developed independently of the change over to the new supracondylar suspension design. As a result of several problems that we encountered, it became obvious that conventional plaster wrapping procedures failed to provide an accurate reproduction of the critical areas of the stump. We contend that circumferential wrapping tends to "round" the usual triangular cross-section of the stump, and at the same time displaces soft tissues to the weight-bearing areas. More specifically, the M-L dimensions of

the stump are increased as much 3/8 inch depending on the density of the soft tissues. Other casting techniques, such as pouring plaster around the stump, and the use of negative and positive pressure bags, create distortion.

Before describing the new technique we would like to establish a few basic points we consider essential to acceptable fitting of a BK stump. Let us think of the BK stump in terms of its anterior and posterior halves. The major weight-bearing areas are in the anterior half. Intimate contact medio-laterally is critical for comfortable weight-bearing and stability against lateral forces. The bony structure is almost completely in the anterior half of the stump. Bony prominences in this area such as, crest of the tibia, the lateral tibial prominence, the tibial tubercle and the head of the fibula, require accurate reproduction and a sculptured shape in the socket as they are not tolerant to high pressures. Finally, and not least in importance, is the necessity to copy the true shape of the anterior distal tibia, because it is uniform socket contact, not an exaggerated relief cavity, that provides comfort in this area.

The posterior half contains the bulk of the soft tissues, where volume changes occur and contours generally are less critical. Other than at the proximal margin the A-P dimensions are not related to skeletal size and shape.

In summary it seems that the major objectives of a casting technique for the below-knee socket are to capture (a) the M-L skeletal outlines and bony prominences of the anterior half (b) the A-P dimension at the level of the tibial tubercle and (c) the soft tissue volume of the posterior half. Heretofore, efforts to obtain a reduced A-P dimension in the wrap usually result in distortion of the M-L dimension at the level of the tibial tubercle.

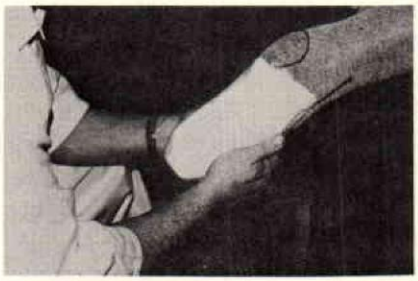

Fig. 4

Step one of the casting procedure: Formation of the pre-tibial shell.

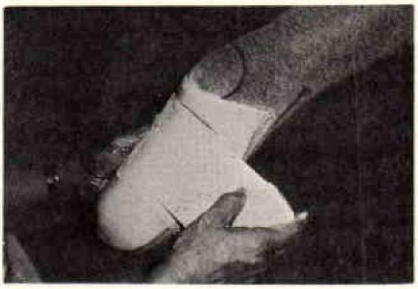

Fig. 5

Step two of the casting procedure: Application of the circumferential wrap below the level of the patella.

A two-step procedure is recommended when cuff-suspension is to be used; a three-step procedure, when supracondylar suspension is to be used. The three-step procedure is described here.

The three-step casting technique consists of forming a rigid splint cast of the critical, bony anterior half of the stump (Fig. 4), a circumferential wrap below the patellar (Fig. 5), and splint casting of

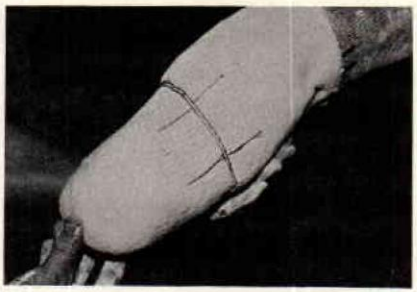

Fig. 6
Step three of the casting procedure: Application of the supracondylar shell.

the anterior, medial and lateral supracondylar areas (Fig. 6).

Given a model which presents a reliable reproduction of the weight tolerant areas of the stump, the prosthetist will find that the preparation of the model will be simplified. No longer will gross reductions of plaster be required to obtain medio-lateral weight-bearing and lateral support along the shaft of the fibula.

The key steps in the procedure for measuring and cast taking and steps for lamination of the socket and placement of the hardware follow. A list of supplies needed is given in Appendix A.

Casting Procedure

1. Measure and record the M-L diameter of knee at the widest point (Epicondylar Level).

2. Measure and record the M-L diameter immediately above the condyles (Supracondylar Level).

3. Apply a loose fitting double layer of tubegauze, #5 or #78, over the stump up to the middle of the thigh. A soft, elastic waist belt should hold the tubegauze lightly in place so that contact between the tubegauze and the stump in the undercut area is maintained.

4. Define on the stump with an indelible pencil the median line between the anterior and posterior halves, and other conventional marks.

5. Make a paper pattern of the anterior half of the stump below the distal edge of the patella.

6. Cut out simultaneously 8 or 9 layers of 8 inch wide, fast-setting plaster bandage to the pattern of the anterior half.

7. Dip all layers of plaster as one unit in tepid water.

8. Lay plaster as a unit over the anterior portion of the stump.

9. Smooth out all wrinkles, stroking the plaster from anterior to posterior. Light thumb impressions should be made on each side of patella tendon.

10. Allow the plaster to set until hard (about 10 minutes).

11. Starting proximally, wrap circumferentially with elastic plaster bandage all of the stump below the distal patella level.

12. Narrow the A-P dimension by flattening the posterior wall using conventional finger pressure. The M-L dimension will not spread because of the anterior splint.

13. On the tubegauze, mark a line anteriorly 1 inch proximal to the superior edge of patella. Outline with longitudinal marks the adductor magnus tendon medially and the iliotibial tract laterally.

14. Measure off a sufficient length of 6-inch wide, regular fast-setting plaster bandage to cover me-

dial, anterior, and lateral areas of knee. Make an 8- or 9-layer splint of this length.

15. Lubricate the proximal third of the previously made wrap with oil or petrolatum. Avoid getting the lubricant on the tubegauze.

16. Dip all layers of the plaster splint as one unit in tepid water.

17. Drape plaster over the knee. Be sure to cover the area to a point 1 inch proximal to the patella.

18. When plaster begins to set, form the M-L, supracondylar area with firm pressure. Place both thumbs on the medial side, straddling the adductor tendon. Then place second and ring fingers above lateral condyles straddling the iliotibial tract. (For left BK the right hand is anterior, the left hand is posterior; vice-versa for right BK).

19. Determine the M-L dimension by making a mark medially on the plaster in the area between the thumb impressions and then measure the distance from one to the other with outside calipers.

20. Make indelible marks across the proximal knee-plaster section and the stump-plaster section.

21. Loosen knee-plaster section from stump-plaster and remove both from the stump as a single unit. No cutting is necessary.

22. Replace the knee-plaster section to the lower stump section and check the M-L dimension with outside calipers. Close the posterior opening with several plaster splints while maintaining the recorded M-L dimension from step 19.

Model Rectification and Lamination of the Socket

1. Make the plaster model hollow to facilitate breakout.

2. Smooth the surface of the model to remove irregularities and marks caused by the sock.

3. Supracondylar M-L dimension of the model should correspond to the patient's measurements. Plaster is removed from the medial side unless more than ¼ inch is to be cut away, in which case the extra amount should be cut from the lateral side.

4. Maintain the epicondylar M-L dimension of the model ⅛ to ¼ inch more than the stump dimensions.

5. Form the patellar-tendon bar in the same manner as is normally used for the standard PTB hard socket.

6. For mature stumps, only a slight reduction of model size is required to produce a snug fit with one stump sock. In other situations where edema or excessive soft or hypermobile tissue is present, ¼ to ⅜ inch reduction in circumferences may be required in order to obtain an acceptable fit with one stump sock.

7. A minimum amount of spotting or build-up should be applied to the distal anterior tibia, head of fibula, and lateral tibial prominence for pressure relief.

8. A posterior popliteal shelf ½-⅝ inch thick, at the mid-level of the patella tendon is added to the posterior wall.

9. Drill vacuum holes in the popliteal area, in the mid-level area of the patella tendon, and in the supracondylar areas.

10. Apply a parting agent.

11. Fit a distal pad to the size of the distal stump.

12. Apply petrolatum.

13. Pull a PVA (polyvinyl alcohol) sleeve over the model.

14. Heat and insert the distal pad in the PVA sleeve. Form the pad to the distal stump contour by tying off the sleeve close to the model.

15. Apply a layup consisting of:

a. Two ½ oz. Dacron sleeves.

b. Extra padding in popliteal, patella tendon, and medial and lateral supracondylar areas.

c. Two nylon stockinette sleeves.

d. Four short nylon stockinette sleeves above the MPT.

e. On the medial side sandwich the bar and channel between the short sleeves, being sure to:

(1) Wrap upper third of bar with Dacron.

(2) Place T (on end of bar) in supracondylar depression. N.B. The proximal ⅓ or the bar may require shaping to fit closely the model, but under no circumstances should the distal ⅔ of the bar be altered from its preformed radius.

(3) Position top of channel ¼ inch below the mid-patella level, or large M-L diameter of the knee. Replace the spring-and-ball assembly with the laminating block.

(4) Add Dacron felt to blend the channel to the socket wall.

f. Three pieces of glass fabric 2 inches x 3 inches on the proximal area of the lateral side.

g. Two or three nylon stockinette sleeves over all.

h. Add outer PVA sleeve, apply vacuum, puncture inner sleeve, and tie off around pipe.

16. Use an 80-20 rigid-flexible polyester resin mixture; 400 grams for short to medium stumps, 500 grams for medium to long stumps, and 600 grams for long and large stumps.

17. Before pouring the resin, insure that the bar-channel assembly is at the proper height, is parallel to the long axis of the stump, and is on the mid-line of medial side.

18. After the resin is cured and partially cooled, trim and remove excess laminated material in the proximal area. Then expose the laminating block over the channel, and remove it.

19. After the laminate is cooled further, make the horizontal cut in the medial wall with a cast saw. The best level is usually at the widest diameter of the knee, about mid patella level. The inner socket cannot be cut through until the plaster model has been removed from the socket.

APPENDIX A

SUPPLIES AND TOOLS NEEDED FOR THREE-STAGE CASTING OF BK STUMPS

Measurement Chart

Tubegauze #5 (#78 if stump is extra large)

Elastic strap, 1 inch, light

Yates Clamp, 2 each

BK stump length gauge

Pattern paper

Indelible pencil

Yardstick

Bandage scissors

1 roll, 8″ fast-setting plaster-of-Paris bandage

1 roll, 6″ fast-setting plaster-of-Paris bandage

1 roll, 3″ or 4″ elastic plaster-of-Paris bandage

Lubricating oil (Nivea) or petrolatum

Outside diameter calipers

Tape measure

References

1. Fillauer, Carlton, *Supracondylar wedge suspension of the PTB prosthesis,* Orthotics and Prosthetics, June 1968.

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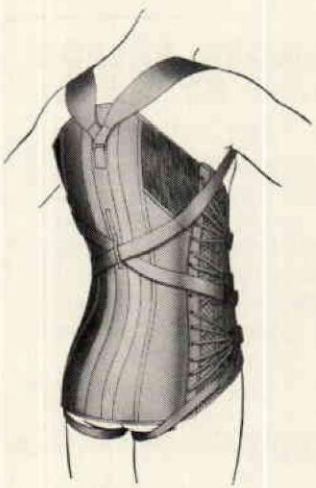

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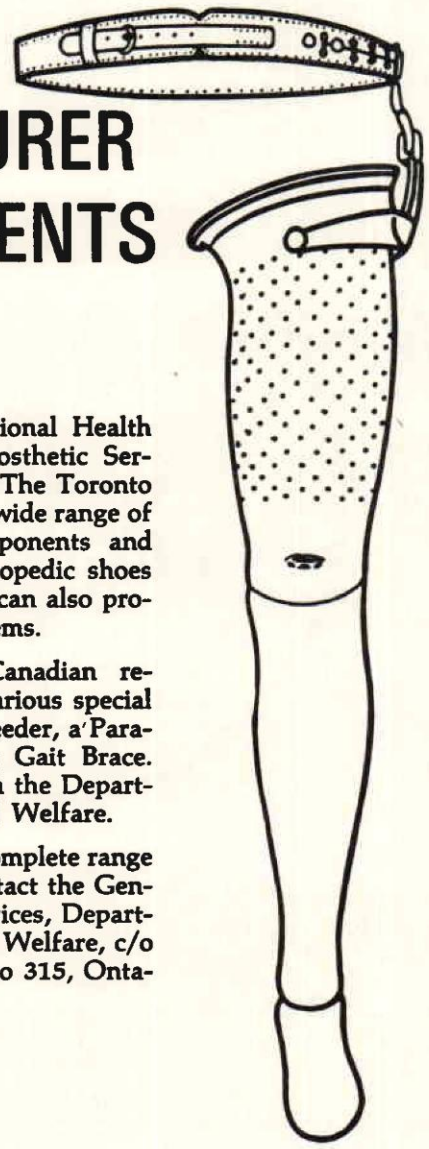

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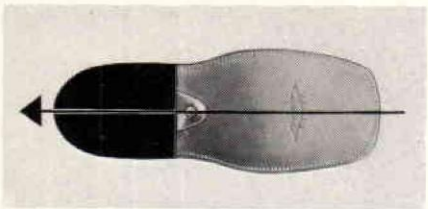

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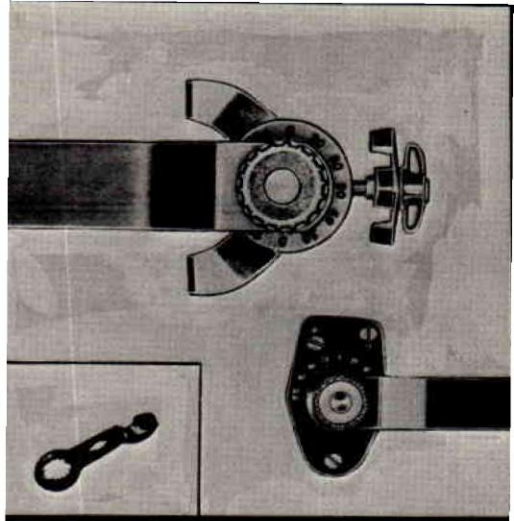

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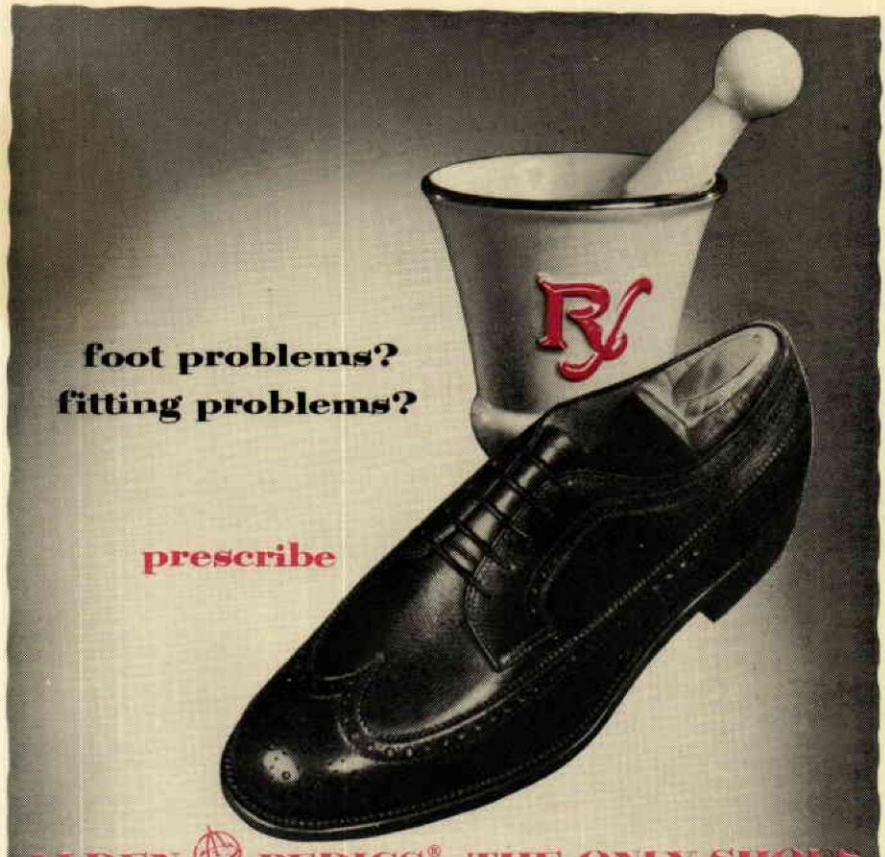

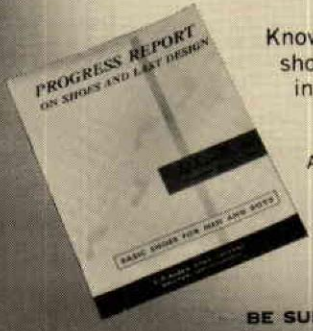

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