HIGHLIGHTS OF OTHER VA RESEARCH PROGRAMS

PROSTHETICS

Edited by

Eugene F. Murphy, Ph. D., Chief
William M. Bernstock, A.M., Assistant Chief

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

Committee on Prosthetics Research and Development
National Academy of Sciences-National Research Council
Washington, D.C. 20418
Colin A. McLaurin, D. Sc.

For progress during this report period see "Committee on Prosthetics Research and Development, Division of Engineering—National Research Council, National Academy of Sciences—National Academy of Engineering, Annual Summary Report, Activities for Year Ended June 30, 1971" appearing elsewhere in this issue of the Bulletin.

Committee on Prosthetic-Orthotic Education
National Academy of Sciences-National Research Council
Washington, D.C.
Herbert E. Pedersen, M.D.

Reorganization of CPOE

At the annual meeting of the Committee on Prosthetic-Orthotic Education, held in Washington, D.C., May 18, 1971, a proposal for reorganization of the Committee was presented to the members. The proposal read, in part:

> In order that the Committee on Prosthetic-Orthotic Education (CPOE) may more effectively and efficiently accomplish its mission, it is proposed that its organizational structure be changed to one that is more adaptive and more readily responsive to changing needs.

It can be seen that certain drawbacks are inherent in an organization strongly supported by subcommittees, and that a major contributing factor is the permanent nature of the subcommittees. It appears that the formation of transient committees to accomplish specific tasks would offer certain advantages and that a project- or problem-oriented organization should be considered.

In view of these [and other] considerations, it is proposed that:

1. The Subcommittee on Prosthetics Clinical Studies, the Subcommittee on Orthotics, the Subcommittee on Publications and Educational Materials, and the Subcommittee on Special Educational Projects in Prosthetics and Orthotics be dissolved.
2. The parent Committee assume responsibilities currently assigned to the subcommittees, unless otherwise delegated.
3. Task forces or project teams be formed, as required, to pursue specific major endeavors, and that
   (a) The task force leader be directly responsible to CPOE;
   (b) The *ad hoc* group be disbanded upon completion of its task.

The proposal was unanimously approved by the members of CPOE. The Chairman, Herbert E. Pedersen, pointed out that CPOE members must now assume increased responsibility in planning and guiding the program of activities, and he expressed appreciation to the subcommittees and their chairmen for the splendid contribution they had made to the CPOE program.

Following is a summary of CPOE activities for the period January 1—June 30, 1971.

Standardization of Prosthetic-Orthotic Terminology

CPOE, in cooperation with several other groups, has initiated a project directed toward standardization of prosthetic and orthotic terminology. Development of terminology lists has been attempted by many separate groups at different times, but none has been universally accepted as standard. In the meantime, disparity in the use of terms has led to misunderstanding and confusion in clinical situations, in educational endeavors, and in the area of costs and payments for various devices, particularly in connection with Medicare, Medicaid, and similar programs. This situation, along with the prospective publication of a rewritten *Orthopaedic Appliances Atlas* by the Committee on Prosthetics and Orthotics, American Academy of Orthopaedic Surgeons, created an urgent need for a solution to this dilemma.

A Task Force on Standardization of Prosthetic-Orthotic Terminology, with Jacquelin Perry, M.D., as Chairman, was established this spring. Represented on the Task Force are the American Orthotic and Pros-

thetic Association-American Board for Certification, the Veterans Administration, the University Council on Prosthetic-Orthotic Education, the American Academy of Orthopaedic Surgeons, the Social and Rehabilitation Service of HEW, the Committee on Prosthetics Research and Development, and the Committee on Prosthetic-Orthotic Education.

At the first Workshop, held in Dallas, March 28-30, 1971, Dr. Perry proposed the following goals in development of standard terminology:

1. To establish a master prosthetic and orthotic nomenclature system with a functional and anatomical orientation designed for current use, but sufficiently flexible to allow for future development.

2. To classify and define basic prostheses and orthoses.

3. To develop subclassifications for the purpose of identifying differences in function, materials, and design.

4. To define terminology as derived from the master system and its subclassifications.

5. To incorporate terms and definitions in a prosthetic-orthotic glossary.

Members of the Task Force who participated in the Dallas Workshop were:

Panel on Prosthetics Terminology

Frank W. Clippinger, Jr.
Robert G. Thompson
Cochairmen
Joseph M. Cestaro
John E. Eschen
Henry F. Gardner
Frederick L. Hampton
Warren Springer
Keith Vinnecour

Panel on Orthotics Terminology

Arthur Guilford, Chairman
Norman Berger
Clauson F. England
Robert E. Fannin
Charles Fryer
William J. McIlmurray
Paul R. Meyer, Jr.
Clyde L. Nash, Jr.
Harold W. Smith

Review Group

E. E. Harris
Herbert E. Pedersen
James E. Smith
Anthony Staros
A. Bennett Wilson, Jr.

Recorders

Herbert B. Warburton
Barbara R. Friz

Arthur Guilford, Harold Smith, Robert Fannin, William McIlmurray, and Clauson England, members of the Panel on Orthotics Terminology, met again for 3 days' work in Minneapolis, Minnesota, May 22-24. It is anticipated that the entire Task Force will reconvene in early fall 1971.

Educational Program for General Surgeons

Richard Warren, M.D., who heads an *ad hoc* committee on an educational program for surgeons, reported that efforts to bring general surgeons up-to-date on the management of amputees, particularly geriatric amputees, have resulted in several talks being presented on the subject at both national and regional meetings of surgical societies, publication of articles in surgical journals, and editorials in the *Archives of Surgery*.

At a meeting in New York, June 10, 1971, the *ad hoc* committee considered the feasibility of offering a short course in prosthetics for general surgeons and discussed the curriculum for such a course. Dr. Warren reported increased interest in amputations by general surgeons since the advent of immediate postsurgical fittings and believed the time was right to offer short instructional courses.

Literature Retrieval System

Chairman Warren Springer and members of the Task Force on Literature Retrieval have continued work on development of a list of prosthetic and orthotic terms for inclusion in the dictionary of orthopedic terms. Since this project also includes definitions of terms, it relates closely to the project on standardization of terminology.

Amputee Census

The survey study implemented 10 years ago and known as the "Amputee Census" will be repeated as a joint effort of CPOE and AOPA. Representatives of these two groups have been appearing at AOPA regional meetings throughout the country to encourage participation in the survey.

The Geriatric Amputee—Principles of Management

This monograph, a consolidation of papers developed from the proceedings of a workshop sponsored by CPOE, was published this spring. It outlines the basic principles in management of geriatric amputees, starting with the preoperative period and continuing through the rehabilitative process, and makes a strong argument for saving the knee joint in most amputations for gangrene. With this monograph, CPOE hopes to reach surgeons who perform amputations on elderly patients with vascular disease.

Annotated Bibliographies

A total of 521 articles on prosthetics and orthotics was abstracted and published in two separate bibliographies: *Amputees, Amputations, and Artificial Limbs, 1969-1970,* and *Braces, Splints, and Assistive Devices, 1969-1970.* These bibliographies supplement previously published bibliographies which covered the years 1956-1968. The supplementary bib-

liographies, as were the originals, were distributed to schools of medicine, physical therapy, occupational therapy, social work, prosthetics and orthotics, and, upon request, to responsible users.

Newsletter . . . Amputee Clinics

Newsletter . . . Amputee Clinics (published bimonthly since December 1969) has proved to be an effective means of communication among amputee clinic chiefs. It has served to expose clinical problems, furnishing answers to some and identifying areas in need of investigation in others. Circulation has increased to approximately 3,600.

Amputee Clinics in the United States and Canada—1971

Amputee Clinics in the United States and Canada—1971, published in April 1971, lists a total of 440 clinics—406 in the United States and 34 in Canada. The roster includes the name of the clinic, type of clinic (teaching, child, adult), location, name of the clinic chief, clinic schedule, and identifies the specialties represented or available at clinic sessions. The arrangement of clinics is by state or province.

Complete List of Publications, 1970-1971

Davies, E. J., B. R. Friz, and F. W. Clippinger, Amputees and Their Prostheses. Artificial Limbs, 14:19-48, Autumn 1970.

Perry, J., The Use of External Support in the Treatment of Low Back Pain. Artificial Limbs, 14:49-57, Autumn 1970.

Perry, J., The Use of External Support in the Treatment of Low Back Pain. Report of the Subcommittee on Orthotics of the Committee on Prosthetic-Orthotic Education, National Research Council. Journal of Bone and Joint Surgery, 52A:1440-1442, October 1970.

Perry, J. Warren, and Barbara R. Friz, Manpower Survey—Salaries in the Fields of Prosthetics and Orthotics. Orthotics and Prosthetics, 24:30-32, March 1970.

Perry, J. Warren, and Barbara R. Friz, Manpower Survey—Corsetieres and Shoe Specialists. Orthotics and Prosthetics, 24:32-33, March 1970.

Perry, J. Warren, and Barbara R. Friz, Graduates of Degree Programs in Prosthetics and Orthotics. Orthotics and Prosthetics, 24:10-20, December 1970.

Committee on Prosthetic-Orthotic Education, Interim Report, Standardization of Prosthetic and Orthotic Terminology, National Academy of Sciences, 1971.

Committee on Prosthetic-Orthotic Education, The Geriatric Amputee: Principles of Management, National Academy of Sciences, 1971.

Committee on Prosthetic-Orthotic Education, Amputee Clinics in the United States and Canada—1971, National Academy of Sciences.

Newsletter . . . Amputee Clinics, Volume II, Nos. 4-6, 1970.

Newsletter . . . Amputee Clinics, Volume III, Nos. 1-3, 1971.

Mauch Laboratories, Inc., Dayton, Ohio 45439
Hans A. Mauch

For progress during this report period see "Abstract of Summary Report on Research and Development in the Field of Artificial Limbs" appearing elsewhere in this issue of the Bulletin.

New York University, New York, N.Y. 10034
Leon Bennett

For progress during this report period see "Transferring Load to Flesh: Part II. Analysis of Compressive Stress" appearing elsewhere in this issue of the Bulletin.

Northwestern University, Chicago, Ill.
Robert G. Thompson, M.D. and Dudley S. Childress, Ph. D.

The laboratory participated extensively in the Orientation Course in Upper-Extremity Powered Components which was given at Northwestern University on April 5-9, 1971, in cooperation with PSAS and CPRD. An instruction manual was prepared on the use of NU Myoelectric Below-Elbow Prosthetic System. This covered basic myoelectric theory, principles of the NU Supracondylar Below-Elbow Socket, and overall fabrication techniques. The staff of the laboratory participated actively in the preparation for the course and in the instruction.

J. N. Billock, C.P., and D. S. Childress, Ph. D., visited prosthetic research centers in Germany, Austria, and Italy during the period from April 23 to May 13, 1971. This visit was extremely useful, and various prosthetic approaches which were observed have already been put to use.

Work continues on upper-extremity socket design. Although the supracondylar below-elbow socket has proven to be more than adequate, it is still hoped that a self-suspension technique may be developed which does not involve a supracondylar trimline. Therefore, experiments are being conducted to determine the feasibiilty of using the atmospheric-pressure suspension technique, which has been successful on the above-elbow amputee, on the below-elbow amputee.

Observation of prosthetic systems in Europe has led to the reevaluation of a hybrid prosthetic system consisting of body-powered elbow and externally powered terminal device for above-elbow amputees having long stumps. The first fitting in which this approach was used proved to be excellent. Further fittings are to follow. These experiments are also

proving useful in the further development of the self-suspension socket for the above-elbow amputee.

Several above-knee sockets have been fabricated using the atmospheric-pressure suspension technique. It is still too early to ascertain the value of this approach for the above-knee socket.

Work has continued on an electric hook and on a wrist-rotator of new design.

University of California at Los Angeles
Biotechnology Laboratory
John Lyman, Ph. D.

The research activities of the Biotechnology Laboratory have been continuing along the general problem of development of high performance control systems for arm prostheses. Current efforts focus on the integration of control techniques that were developed in the laboratory into a practical patient-oriented system. This work consists mainly of the integration of a strain-gage transducer control harness and a functional prosthesis to operate with an adaptive aiding system.

The principal new aspect of the laboratory work is the availability of major components of an externally powered prosthesis which were loaned by the Veterans Administration. The components include an Otto Bock electric hand, a Northwestern electric wrist-rotator, and an AMBRL electric elbow. The components have been assembled into an experimental prosthesis. The assembly of the preliminary design is shown in Figure 1. The prosthesis has 3 deg. of freedom and will be fitted to an above-elbow amputee.

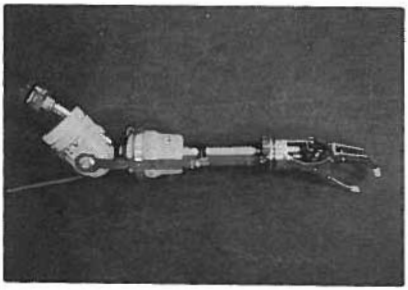

FIGURE 1.—AMBRL electric elbow, Northwestern electric wrist-rotator, and Otto Bock electric hand.

The transducer control harness will be adapted to provide the control for the prosthesis. Present efforts are directed toward the fabrication of an improved version of the transducer control harness; attempts are being made to examine the feasibility of using solid-state transducers. Other improvements which are considered include further modification of the control circuit which provides 2 deg.-of-freedom control for each control site. The present circuit converts two levels of positive force

into two negative and positive rates. It was found in the evaluation studies that the difficulty of operating this type of control is related to the specific muscle site used. Optimal control sites for the experimental prosthesis will be selected and evaluated with alternate control circuit characteristics.

Work on the integration of the experimental prosthesis to operate with adaptive computer aiding is being performed. (See Article "Adaptive Aiding for Artificial Limb Control" in this issue.) The progress of this work was recently enhanced with the award of a minicomputer by the National Science Foundation which will be fully dedicated to this research. In line with this work, plans have been made to interface the experimental prosthesis with the computer and then to evaluate the operation of the prosthesis with adaptive aiding. Under the planned configuration the amputee will control the prosthesis with his control harness while being aided by the computer. The computer will act as an Autonomous Control Subsystem and generate control inputs, thus lowering the control load of the patient. The patient would have an override option and thus can use his arm as a conventional prosthesis. Immediate work in this area includes the adaptation of the Autonomous Control Subsystem program to operate with the experimental prosthesis and the design and construction of control interface circuits.

University of California at San Francisco and Berkeley
Biomechanics Laboratory
Charles W. Radcliffe, Howard D. Eberhart, and James M. Morris, M.D.

Design of Prosthetic Devices: Upper Extremity

The Multi-Mode Arm project has culminated in a doctoral dissertation by Lawrence E. Carlson. The pneumatically powered above-elbow arm has four distinct modes of operation: wrist rotation, wrist flexion, and two different patterns of coupled wrist and elbow motion. Mode selection is accomplished with two humeral nudge switches; position servo control of the selected mode is by flexion and extension of the stump. Effective control over the almost silent prosthesis was quickly learned by the test subject, with substantial gains in versatility and little or no increase in control complexity. The new computer data acquisition system reported on below was used extensively in this project. A motion picture of the arm in operation has been prepared.

Dr. Carlson is leaving the Biomechanics Laboratory to join the staff of the University of Illinois and will continue his work on the Multi-Mode Arm at the Northwestern University Prosthetics Research Center. At the Biomechanics Laboratory in Berkeley work will continue on design of simple spatial linkages to provide useful coordinated wrist and elbow motions.

Design of Prosthetic Devices: Lower Extremity

Complete detail drawings for a practical and producible version of the functionally proven UC-BL 4-Bar Polycentric Knee have been sent to the Veterans Administration Prosthetics Center. A small initial production of 12 units is planned to permit final checkout of the design and development of fabrication and alignment procedures compatible with industrial practices.

Two prototype 6-Bar Polycentric Knees have been produced, and a third is in the design stage. These units offer the functional advantages of polycentric action in a device suitable for use on a true knee-disarticulation amputee. Reduction in size and improvement in function were substantial between prototypes 1 and 2; present efforts are concentrated on further reductions in size with maintenance of desirable polycentric action and improvement in cosmetic treatment.

Design of Orthotic Devices: Spinal Orthotics

Inflatable components of various sizes and shapes are being used to improve fixation of back braces to the pelvis and to support the spine by control of intra-abdominal pressure. These components have been used in standard lumbosacral braces as well as in body jackets made of Royalite and the new, more pliable Prenyl. Three patients with chronic back problems are now wearing devices; preliminary results are very favorable. Technical problems with valving and the construction of inflatable components have recently been solved, and several more fittings are anticipated in the near future.

Biomechanical Studies of Locomotion

To facilitate efficient handling of the large amounts of information required for valid statistical examination of a highly variable process such as human walking, a computer-based data acquisition system was obtained in November 1970. Adaptation of this system to the specific requirements of biomechanical studies has proceeded well. The system was used extensively in the collection of experimental data in the Multi-Mode Arm project, and is now being used in a more thorough examination of the fundamental time and distance parameters of gait. Work continues on the construction of specialized input instrumentation and computer programs which will increase the versatility and usefulness of the system.

VA Hospital
Seattle, Wash.
Ernest M. Burgess, M.D.

We are presently conducting a study on unilateral below-knee amputees to ascertain the relationship between active phasic muscle activity

and efficiency of prosthesis function as well as general socket comfort. The study involves stumps with conventionally unstabilized muscles as well as stumps both recently stabilized and those with long-term muscle stabilization. Electrical muscle activity during gait on both the amputated and non-amputated sides, gait deviations, socket fit and comfort, and general comments from the patients are being recorded.

Present facts that can be ascertained from accumulating data indicate that all patients studied, regardless of whether or not surgical muscle stabilization was performed, have some ability to excite muscle contraction actively in phase during gait. The myoplasty muscle-stabilized stump is capable of much more functional muscle bulk. These contracting muscles are used for socket suspension as well as for controlling the line of progression of the prosthesis, providing the patient with an improved sense of stability and security. Many clinically relevant questions regarding stump muscle activity remain unanswered. The influences of available surgical techniques and new surgical innovations in the area of stump muscle stability are under investigation.

Improvements in the technique of rigid-dressing application and suspension for hip disarticulation are being evaluated.

1. In place of using a split above-knee Orlon/Lycra sock and bias stockinet, a hip-disarticulation sock made of the Orlon/Lycra material is used. These are being made in two sizes. The amount of stretch allows fit for a wide range of hip measurements.

2. To provide increased fixation and stability between the end plate and the immediate postsurgical rigid dressing, the attachment plate is now being incorporated into the suspension harness.

Two new "single concept" 16 mm. motion pictures have been prepared and are available on loan from the Prosthetic and Sensory Aids Service, Veterans Administration, Washington, D.C. These are: 1. Below-Knee Amputation for Peripheral Vascular Disease, and 2. Rehabilitation Management of the Below-Knee Amputee. The Prosthetics Research Study will similarly prepare teaching films for the knee-disarticulation and above-knee amputations as well as selected levels of amputation in the upper extremity.

Surgical research continues on an improved knee disarticulation incorporating muscle stabilization and at a distal transcondylar level to permit the use of intrinsic knee-joint mechanisms without significant bilateral knee asymmetry.

Five articles were published and several additional papers were prepared for publication. In addition, a number of lectures, instructional courses, and conferences were accomplished.

The Seattle Veterans Administration Hospital, as a designated VA Prosthetics Treatment Center, will open its new prosthetic laboratory in

December 1971. With the opening of this facility, an increase in regional referrals of complex prosthetic fitting cases is expected.

VA Hospital, San Francisco, Calif.
Wesley L. Moore, M.D., and Albert D. Hall, M.D.

The Prosthetics Research project at the Veterans Administration Hospital, San Francisco, during the past 6 months has continued to occupy itself with the clinical evaluation of the immediate postoperative fitting prosthesis.

Cumulative statistics that have been compiled are as follows: 64 amputations with immediate postoperative prostheses have been performed; 53 at the below-knee level, six knee-disarticulation amputations, five above-knee amputations.

In analyzing the results of below-knee amputation, the primary healing rate was 85 percent and the secondary healing rate was 4 percent for a total successful healing of below-knee level of 89 percent. Six patients failed to heal at the below-knee level and required a higher revision, usually at the above-knee level, for a total of 11 percent. There were no postoperative deaths in this group of patients. Pulmonary complications occurred in only one patient for a total of 2 percent. All patients stood on the first postoperative day, and the average time from below-knee amputation to a permanent prosthesis was 26 days. Of the patients who were ambulatory prior to the need for amputation, 100 percent were rehabilitated on the below-knee prosthesis.

Research into the correlation of skin blood flow as measured by $Xenon^{133}$ clearance at the level of proposed amputation with success or failure of healing at the proposed amputation level is continuing. At the present time 22 patients with $Xenon^{133}$ blood flow determinations have been studied. The range of skin blood flow has been from 0.55 to 2.94 cc./100 grams of tissue/minute, with a mean of 1.4 cc./100 grams of tissue/minute. In the group of patients studied there have been three failures of healing due to inadequate blood supply and these three patients had Xenon flow determinations of 0.55, 0.56, and 0.59. These three measurements were the three lowest of the series and would appear to correlate well with the figures to date.

During the past few months, an exhibit has been prepared documenting the San Francisco VAH's immediate-fitting program. The exhibit consists of a narrative description supplemented by photographs outlining the advantages of immediate postoperative prostheses, the technique, and results of the series. In addition there will be two short film strips on continuous loops in Fairchild projectors, one illustrating the operative technique, and the other illustrating the application of the immediate postoperative prosthesis. The second half of the exhibit will

be a live portion with demonstrations of the immediate postoperative prosthesis by the hospital's prosthetist.

The first meeting at which this exhibit is scheduled to be shown will be the American College of Surgeons meeting, October 1971.

Harvard Medical School
Boston, Mass.
Richard Warren, M.D., Ronald B. Kihn, M.D., and Leon Sheplan, M.D.

Survey of Lower-Extremity Amputations of Ischemia

Since the last report, 6 months, January 1 to June 30, 1971, have been occupied in correlating and arranging the data for publication.

Although it was felt that the job would have been completed by July 1, 1971, an additional few months will be necessary. It was hoped that a short paper presenting the highlights of the findings could be written up and published by now, but it has been discovered that it would be better to write a large monograph first and then the short paper taking extracts from that. The list of tabulations that will be used has finally been completed and the tables are now being arranged in readable form.

Cambridge Hospital
Cambridge, Mass. 02139
Richard Warren, M.D.

Immediate Postamputation Prosthetic Fitting

Since the inception of the study, 50 lower-extremity amputations have been managed by the collaborative team. The study has become more widely recognized in the community and although there have been periods of inactivity, they are then followed by periods of great activity.

Most surgeons agree that the rigid dressing is advantageous and that convalescence can be shortened by the technique. One of the main challenges before the community is the continuation of the early success through the intermediate period from 3 weeks to 3 months postoperatively and outside the hospital away from medical supervision. Attempts will be made to produce some practical answers to this problem during the next report period.

The Johns Hopkins University
Silver Spring, Md. 20910
Woodrow Seamone and Gerhard Schmeisser, M.D.

For progress during this report period see "Development and Evaluation of Externally Powered Upper-Limb Prosthesis, Summary of Research Project Activities July 1970–July 1971" appearing elsewhere in this issue of the Bulletin.

University of Miami, Miami, Fla. 33152
Augusto Sarmiento, M.D.

For progress during this report period see "Development of Refined Fitting Procedures for Lower-Extremity Prostheses" appearing elsewhere in this issue of the Bulletin.

VA Hospital, Richmond, Va. 23219
Charles L. McDowell, M.D.

During the period July 1, 1970, through June 30, 1971, nine experimental orthoses were constructed and applied to patients. The orthoses were designed for patients rendered tetraplegic. The patients were measured for their braces prior to surgery, and braces were applied where possible at the time of initial dressing in the operating room. Some of the orthoses were designed for patients with problems other than tetraplegia for whom surgery was planned and for whom the braces could be applied at the time of surgery.

The braces have been designed to conform to the following concepts:

1. Achieving some function during the recovery phase or preserving some function during the recovery phase, i.e., immediately after surgery.

2. Replacing the cast ordinarily applied following surgery. The reason for this work is concern for maintaining function, where possible, in all parts of the upper extremity being operated upon which are not directly involved in surgery. The braces are designed to allow active and passive motion everywhere possible, and still control the stress applied to the operated site. This concept is applied in the areas of tendon transfer, tenodesis surgery, and even arthrodesis of joints. It is also hoped to achieve, by brace design, a shorter period of convalescence and a reduction in the amount of time required to rehabilitate the patient following surgery.

Figure 2 shows an earlier design which is essentially a tenodesis splint without the felt applied. Absence of the felt allows sterilization and leaves room, so the splint can be applied directly over dressings immediately following surgery. The solid and nonadjustable bar controlling the wrist and metacarpophalangeal joints has been found unsatisfactory because the position desired cannot be set at the time of surgery. Therefore, an adjustable bar, seen in Figure 3, is being used. The patient seen in Figure 3 has just had a tenodesing operation where the flexor tendons of the thumb and all the fingers are attached to the distal radius. In this instance, if the patient allows his wrist to drop by gravity, there is very little extension of the metacarpophalangeal joints and no extension of the thumb or index interphalangeal joints. This keeps stress at the tenodesis site to an absolute minimum, but it does allow for some motion. This motion, which is preserved by the splint, helps to avoid

stiffening of the joints and improves postoperative rehabilitation. If that same patient were to actively dorsiflex his wrist, it can be seen that further flexion of his metacarpophalangeal joints would serve to keep the stress on the tenodesis site at a minimum.

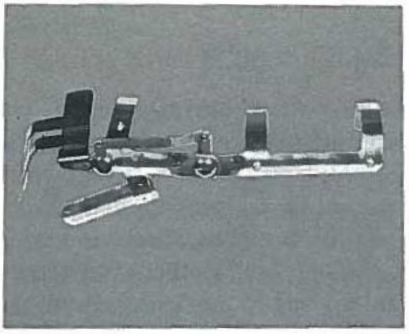

FIGURE 2.—Pre-surgical brace.

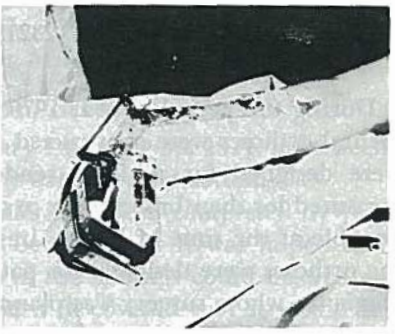

FIGURE 3.—Brace applied during surgery.

Other experimental orthoses have been devices to assist in accommodating specific problems peculiar to the tetraplegic which would have application to other problems. Figure 4 shows a modified platform splint which is helpful in positioning the hand of the tetraplegic with severe rheumatoid arthritis. This positioning splint is designed to assist in controlling ulnar drift as well as in preventing intrinsic contracture. We have found in the rheumatoid, as well as in many instances in the tetraplegic patient, that it was better to have the metacarpophalangeal joints held by the splint in a position of approximately 0 deg. of flexion, allowing active and passive range of motion of the interphalangeal joints, thereby stretching the intrinsic mechanisms and maintaining them in a slack condition. Thus, it is seen that this position assists in controlling or preventing intrinsic contracture.

FIGURE 4.—Patient with modified platform splint.

Texas A&M University
Biomedical Engineering Program
College Station, Texas 77843
P. H. Newell, Jr., Ph. D., and L. A. Leavitt, M.D.

The orthotic and prosthetic research project at Texas A&M University, initiated November 2, 1970, is continuing to strive for improved cosmesis in lower-extremity prostheses. This program is being conducted by an interdisciplinary team of engineers, physicians, and prosthetists. Prosthetic cosmesis is a function of many variables; viz., comfort, function, static and dynamic appearance, feel, odor, and sound are among the factors that contribute to overall cosmesis. In addition, the period of acceptable appearance and function during active use will affect the cost and convenience of continuing prosthetics services. During the past 6 months, the research program has focused on material feasibility studies, fabrication of a hip-disarticulation prosthesis, a comprehensive literature survey of present prosthesis technology, and a review and tabulation in consistent units of available kinesiologic data.

In order to develop an endoskeletal, modular lower-extremity prosthesis, studies have been performed to ascertain the material characteristics that each component of the prosthesis must have. Preliminary mechanical tests have been carried out to evaluate possible materials for use in a goniometric compensator, a thermoplastic socket, an adjustable but uniform pressure liner for above-knee sockets, and a hip-disarticulation girdle.

A hip-disarticulation prosthesis which incorporates exoskeletal joints, endoskeletal pylons, and flexible girdle has been fabricated and evaluated by the clinically oriented members of the research team. The results of the evaluation have been used to develop goals for the current research. The cosmesis of the appliance will be improved this year by focusing on the following areas:

1. Incorporation of the VA endoskeletal knee into the design,
2. Modification of the SACH foot keel to eliminate bearing failure and to improve the life by reducing the stress concentration at the toe end of the keel,
3. Development of an anatomically correct endoskeletal hip joint for improved cosmesis,
4. Establishment of design criteria for the hip-disarticulation girdle that are comparable to those used for quadrilateral above-knee sockets as well as revision of the hip-disarticulation girdle to improve methods for specifying the variable flexure properties and,
5. Refinement of the adjustable but uniform pressure liner for sockets or girdles.