VETERANS ADMINISTRATION PROSTHETICS CENTER RESEARCH

INTRODUCTION

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A spectrum of prosthetics and orthotics research activities is treated in this tissue. Noted is the continuation of the work discussed in the previous report, particularly on evaluations of powered artificial hands and on classification of lower-extremity hardware.

Several of the powered hands discussed previously were not then available to us. We have since obtained the later version of the Beograd hand which is discussed in this report. Eventually we should like to test all in a like manner, primarily using laboratory measurements but also including limited patient fittings.

Similarly, the report on the orthotics hardware being used by the VA shops follows the work reported in the last issue on functional classifications for such items. This is another step in accumulating information needed in establishing a sensible nomenclature for orthotics.

The upper-extremity control system discussed in this issue can soon produce the strategic introduction of powered elements into otherwise standard artificial arms. Unilateral above-elbow and shoulder-level amputees can benefit significantly from the reasonably simple addition of externally powered elbow flexion and extension, with other functions, especially terminal device operation, remaining directly linked to body (biomechanical) power and control sources. This simple control system makes this first step in "hybridization" clinically feasible; moreover, a significant number of (unilateral) amputees can benefit. We will therefore put emphasis on this item so that as soon as possible a good electrically powered elbow and a control mechanism like the one described in this issue will be available to our VA clinics for testing and eventually to the market. In the meantime, increased levels of hybridization will be undertaken; probably the control problem of rotation around the long axis of the forearm will be considered next.

Another major theme of this issue is covered in the work reported on the employment of pressure transducers in prosthetics and orthotics. It has seemed to us that an excessive program effort has gone into the development of pressure or force transducers with attempts being made to achieve a

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degree of perfection that is perhaps not indicated. It is now timely to use the instrumentation available and get down to the business of studying the prosthetics and orthotics problems requiring such instrumentation.

New York University under a VA research contract has, unlike any group in this country, made some measurements on the stump-socket interface even though they used bulky gages which required the cutting of openings in the socket wall. Nevertheless, their laboratory studies are the only ones that have been done on the problem. It seems now that with the use of the smaller transducer mentioned in this report, New York University can proceed with socket studies without the major socket wall alterations and thus with more flexibility in locating gages. We propose to assist them in this work.

Simultaneously the same type of pressure transducer can be employed in studies of the shoe-foot interface probably in conjunction with the barograph which gives the pattern of pressure on the shoe-floor and foot-floor interfaces. We believe that we can now begin to obtain information about this very critical problem in orthotics. It is therefore anticipated that orthopedic shoes and shoe modifications will be studied using these instruments in attempts to develop a rationale for the prescription and use of different orthopedic configurations around the foot. To us in the Veterans Administration, the shoe is a major problem. We have a great number of veteran beneficiaries requiring either arch supports, shoe modifications, custom-formed innersoles, or complete orthopedic shoes. The VAPC alone is responsible for thousands of such cases. Therefore it is logical for us to spend some time and money in research on the principles underlying designs of this type of appliance. Fortunately for this project we will have available the consultation of Dr. Herbert Elftman of Columbia University.

Pressure measurements on patients using elastic hose are also significant. We have repeatedly questioned the design of these items, particularly their effectiveness in providing the kind of pressure gradients for effective venous return. Studies of the pressures applied to the lower extremity using the type of transducers discussed in this report should be followed eventually with the introduction of a pressure gage which can be used in the clinic to check the effectiveness of an appliance in providing the necessary pressure pattern. Hopefully such a pressure gage could be used for other purposes, at the foot-shoe interface and in limb and brace sockets.

The same VAPC-Sensotec pressure transducer will also be employed in telling us more about the parameters in immediate fitting of prostheses. We should, for example, like to know more about the pressures applied between rigid dressing and stump. At the same time we should like to record other data about temperature and muscle activity. But important is the fact that this type of pressure transducer will now permit us, with the cooperation of

one or more VA projects such as the one in Seattle, to learn more about the nature of the rigid-dressing interface in the immediate fitting regimen.

This is but a first step, for more needs to be learned about immediate fitting especially including studies of other biomechanical and physiological variables. For example, election of levels of amputation in ischemic cases appears to be a function of the type of surgery and the mode of rehabilitation such as immediate fitting. How do in fact the surgical technique and the prosthetic activities soon after amputation affect healing with lower and lower amputation levels? And it is important not only to know how but to estimate why.

I. LOWER-EXTREMITY PROSTHETICS
- A. Basic Studies
  1. Compression of the Lower Extremity
  2. Gait Patterns of the Aged
- B. Development (Components)
  1. Adjustable Below-Knee Standard Prosthesis
  2. Adjustable Standard Above-Knee (Multiplex) Prosthesis
- C. Development (Techniques)
  Direct Forming of Below-Knee Sockets
- D. Evaluation (Components)
  Revised UC–BL Pneumatic Above-Knee Swing Control Mechanism
- E. Evaluation (Techniques)
  None

II. UPPER-EXTREMITY PROSTHETICS
- A. Development
  VAPC Upper-Extremity Control System
- B. Evaluation (Components)
  1. AIPR (American Institute of Prosthetic Research) Externally Powered System
  2. Evaluation of Externally Powered Hands
  3. Fillauer Low Friction Transmission System
  4. Humeral Rotator
- C. Evaluation (Techniques)
  Direct Forming of Below-Elbow Sockets

III. LOWER-EXTREMITY ORTHOTICS
- A. Development
  1. Survey of Brace Components
  2. Arch Supports
- B. Evaluation (Components)
  1. VAPC Modular Single-Bar Brace
  2. AMBRL Fiberglas-Epoxy Drop-Foot Brace
- C. Evaluation (Techniques)
  Measurement of Foot Parameters

IV. ORTHOPEDIC AIDS
A. Development
None
B. Evaluation (Components)
1. Home Stairway Lift
2. Revised Model Power Aid
3. Wheelchair Pads
4. Howmet Wheelchair
C. Evaluation (Techniques)
None
V. TESTING
A. Standards Development Program
1. Elastic Hosiery
2. Comparative Analysis of Eight Wheelchairs
B. Compliance Testing
1. Stump Socks
2. Upper-Extremity Components
3. SACH Feet
VI. OPERATIONS REPORT FOR FIRST HALF, FISCAL YEAR 1968
A. The Orthopedic Shoe Service
B. The Prosthetics-Orthotics Service
C. The Restorations Service
D. Special Clinic Team

REPORT

I. LOWER-EXTREMITY PROSTHETICS

A. Basic Studies

1. Compression of the Lower Extremity. In continuation of our efforts to develop adequate methods for measuring pressures applied to the lower limb by elastic hosiery and other orthopedic devices, we have employed two new methods. Both the "Komprit," a pneumatic pressure gage of German manufacture, and an electronic pressure transducer have been used to measure pressures applied by elastic hosiery to the lower leg. The results of these studies are reported in Section V.A.1. Of special interest, however, is the electronic pressure transducer and its potential value in other studies of pressure applied by orthotic and prosthetic devices.

The basic transducer consists of a metal capsule 0.5 mm. thick and 6.35 mm. in diameter. One face is a diaphragm incorporating a full wave, temperature-compensated, semiconductor strain gage bridge. The output is 20 millivolts at full scale pressure, with ± 0.5 percent full scale linearity and hysteresis. The gage is compensated for temperature at .05 percent full scale per degree Fahrenheit. The basic Sensotec transducer manufactured by Scientific Advances, Inc., of Columbus, Ohio, was modified