Clinical Relevance for the Veteran

SUMMARY OF SCIENTIFIC/TECHNICAL PAPERS IN THIS ISSUE

Peak Foot Pressures Influence the Healing Time of Diabetic Foot Ulcers Treated with Total Contact Casts.

David G. Armstrong, DPM;
Lawrence A. Lavery, DPM, MPH;
Tod R. Bushman, DPM. *(p. 1)*

Purpose of Work. The aim of this project was to describe the progression of healing of foot wounds using total contact casting and to evaluate potential factors that might prolong that healing. **Subjects/ Procedures.** We enrolled 25 persons with foot wounds and casted them until healing using the total contact cast, which is a special type of casting that uses minimal padding in an effort to spread force over a uniform area. Prior to casting, we measured their peak plantar foot pressure using a gait analysis system. **Results.** We found that persons with high peak plantar pressures took longer to heal. Furthermore, we found that subjects with longer ulcer durations prior to treatment took longer to heal. **Relevance to the Veteran Population.** The results of this study lend further credence to the clinical importance of elevated peak plantar pressures which, when combined with lack of sensation, can not only help cause a diabetic foot wound, but can hamper its healing. This is a matter of concern to the growing number of veterans facing the sequelae of diabetes.
David G. Armstrong, DPM

Videofluoroscopic Evaluation of Prosthetic Fit and Residual Limbs Following Transtibial Amputation.

Christian Bocobo, MD; Juan M. Castellote, MD, PhD;
Dougal MacKinnon, MD, PhD;
Ann Gabrielle-Bergman, MD *(p. 6)*

Purpose of the Work. Evaluation of prosthetic fit can be subjective. The purpose of the study was to develop a technique to better understand the movement of the residual limb and its relationship to the inner prosthetic socket while walking. **Subjects/Procedures.** The movement of the limb within the socket was examined using a dynamic X-ray technique and recorded (videofluoroscopy) while persons with amputation walked on a treadmill. **Results.** Movement of the limb forward and backward, piston action, rolling of soft tissues, and relationships between the socket and limb were identified. **Relevance to the Veteran Population.** This technique has the potential for diagnosing causes of residual limb problems, poor prosthetic fit, and abnormal walking patterns among veterans with amputation. It also has the potential for assessing the effectiveness of prosthetic adjustment or modification.
Christian Bocobo, MD

Experimental Development of a Sensory Control System for an Upper Limb Myoelectric Prosthesis with Cosmetic Covering.

Andrea Tura, MS; Claudio Lamberti, MS;
Angelo Davalli, MS;
Rinaldo Sacchetti, MS. *(p. 14)*

Purpose of the Work. Our goal was to develop a sensorial system for a commercial myoelectric hand prosthesis. The system does not compromise the appearance of the prosthesis. **Subjects/Procedures.** We have used force sensors to automatically control the strength of the grip on the object. Moreover, we have applied a slipping sensor to recognize the possible beginning of slippage of the object from the grip. If that happens, the control system rapidly increases the strength of the grip. **Results.** The system was tested on everyday objects, in particular delicate ones (a glass, a plastic bottle, an egg). The performance of the prosthesis was satisfactory, except for the case of very delicate objects (paper cups). **Relevance to the Veteran Population.** The use of a prosthetic hand without a sensorial system requires considerable attention by the wearer. A sensorial system allows optimization of grip actions and a more natural control of the prosthesis.
Andrea Tura, MS

Accuracy and Precision of Volumetric Determinations Using Two Commercial CAD Systems for Prosthetics: A Technical Note.

Swen Johansson, CPO, BSc and
Tommy Oberg, MD, PhD. *(p. 27)*

Purpose of the Work. The study evaluates systematic and random errors in volume determinations with the Seattle ShapeMaker CAD/CAM system for production of prosthetic sockets, and compares it with the CAPOD® system. **Procedures.** Three reference objects were used: steel tubes, plaster-of-Paris casts, and residual limb models. Volume measurements with the two CAD/CAM systems were compared with volumes obtained by different types of reference measurements. **Results.** In this study, the data showed that the Seattle ShapeMaker has systematic and random errors in volume determinations. The CAPOD has random errors but no systematic errors in volume determinations. In our opinion, both systems have sufficient precision for routine clinical practice in prosthetics. **Relevance to the Veteran Population.** The results of this study fulfill the need of evaluating CAD/CAM systems for prosthetics and orthotics for accuracy and precision. The results will assist in improving the quality of prosthetic and orthotic applications with CAD/CAM.
Swen Johansson, CPO, BSc

Three-Dimensional Evaluation of Lumbar Orthosis Effects on Spinal Behavior.
Ngoc Huynh Tuong, MASc, Eng;
Jean Dansereau, PhD, Eng;
Gilles Maurais, MD, FRCS(c);
Rony Herrera, OPD.
(p. 34)

Purpose of the Work. This study describes the use of a radiographic-based technique to evaluate the effects of a semi-rigid spinal orthosis. **Subjects/Procedures.** Twenty-eight subjects have participated in the study. Stereoradiographs of the spine were taken on the subjects in different postures with and without the lumbar orthosis. Thereafter, the radiographs were used to reconstruct the spine in 3-D in order to evaluate the effects of the orthosis on the spine. **Results.** The data indicated that the intervertebral motions and the discal deformations were decreased at some levels with the use of a semi-rigid orthosis but increased at other levels. **Relevance to the Veteran Population.** The findings of this study lead to the development and appropriate use of a 3-D and precise technique to assess the efficiency of lumbar orthoses; further, the technique could be used for the design of more efficient lumbar orthoses.
Huynh Tuong Ngoc, MASc, Eng

A Neural Net Representation of Experienced and Nonexperienced Users during Manual Wheelchair Propulsion.
Patrick E. Patterson, PhD, PE and
Scott Draper, MS. *(p. 43)*

Purpose of the Work. This study describes a neural net approach to classifying wheelchair riders by utilizing a combination of physiological and kinematic information. **Subjects/Procedures.** Fifteen subjects (7 experienced, 8 inexperienced) propelled a wheelchair at 3 different velocities on a dynamometer. The physiological and kinematic information from 10 of the subjects (5 experienced, 5 inexperienced) was used to develop and train a series of neural nets. **Results.** A minimally configured net consisting of peak VO_2 at the high velocity, hand force on the rim at the low velocity, and push angle at the high velocity, accurately represented the differences between these groups. The resulting net was able to correctly classify all 10 training subjects and the remaining 5 test subjects. **Relevance to the Veteran Population.** The findings of this study imply that a neural net approach could be developed and refined into a useful tool for evaluating training and skill progress, provide an aid to wheelchair prescription, and evolve into an method for classifying athletes.
Patrick E. Patterson, PhD, PE

Development of a Simple Approach to Modify the Supporting Properties of Seating Foam for Pressure Relief.
Tommy E.T. Kang, BEng, MPhil and
Arthur F.T. Mak, PhD. *(p. 52)*

Purpose of the Work. Custom cushion designs are often associated with high costs. The purpose of this study is to develop a simple and economical approach to producing custom modifications in regular seating foams for pressure relief. **Subjects/Procedures.** Holes were drilled on the surface of polyurethane foams, locally lowering the effective foam stiffness to provide a more compliant supportive surface at specific sites. For bench evaluation, foam blocks with various combinations of hole sizes and densities were tested. The stiffnesses measured were compared to those before the drilling. They were also evaluated to see if such hole-drilling affects their static and dynamic degradation behaviors. **Results.** Reduction in stiffness was

apparently proportional to the surface area removed by drilling. Up to 46% reduction in stiffness was reported for about 28% surface reduction. Such modifications apparently have no dramatic impact on the static and dynamic degradation life of the foam. **Relevance to the Veteran Population.** This approach is simple and effective in altering foam properties in a controlled manner. Custom pressure relief cushions could be produced much more economically.
Arthur F.T. Mak, PhD

Three-dimensional Kinematics of the Shoulder Complex during Wheelchair Propulsion: A Technical Report.
Jaime L. Davis, BA; Eric S. Growney, BS; Marjorie E. Johnson, MS, PT; Brian A. Iuliano, BS; Kai-Nan An, PhD. *(p. 61)*

Purpose of the Work. Chronic shoulder problems are prevalent in wheelchair users. Studies of the shoulder movement during wheelchair propulsion could provide useful information to better understand the potential mechanisms leading to shoulder injury. The purpose of this study is to develop a technique for measuring a true 3-D motion of the shoulder joint. **Subject/Procedures.** Ten subjects propelled two different wheelchairs while the motion of the left arm and trunk were measured using a video tracking system. **Results.** Optimum placement of the markers for tracking and description of the joint movement was validated. The shoulder joint movements throughout the course of propulsion were documented. **Relevance to the Veteran Population.** The method developed could be used for comparison of shoulder joint motion when using various types and designs of wheelchair and also the method of propulsion. The potential movement or joint position that may cause shoulder problems could hopefully be identified.
Jaime L. Davis, BA

Crash Simulations of Wheelchair-Occupant Systems in Transport.
Weize Kang, PhD and Walter D. Pilkey, PhD *(p. 73)*

Purpose of the Work. More and more disabled individuals ride vehicles while sitting in mobility aides, such as wheelchairs. To develop a wheelchair tiedown and occupant restraint system that can withstand high impact forces and protect the occupant effectively from injury during a vehicle crash, the dynamic responses of such systems under crash loading need to be studied. **Subject/Procedures.** A nonlinear multi-rigid body dynamic computer model has been developed. The occupant, a Hybrid III dummy, is restrained by safety belts in a wheelchair, which is in turn tied down in a crashing vehicle. The simulations were validated by crash sled tests in different automobile safety laboratories. **Results.** Crash responses of wheelchair tiedown and occupant restraint systems have been predicted. The sensitivities of several key design factors, such as tiedown stiffness, wheelchair wheel stiffness, tiedown height, and crash test corridors, were given. **Relevance to the Veteran Population.** The computer model and the simulation results are useful for the effective design of wheelchair tiedown and occupant restraint systems.
Weize Kang, PhD