

Clinical Relevance for the Veteran

SUMMARY OF SCIENTIFIC/TECHNICAL PAPERS IN THIS ISSUE

Material Properties of Commonly-used Interface Materials and Their Static Coefficients of Friction with Skin and Socks

Joan Sanders, PhD; Joan Greve, BSBE;
Stuart Mitchell, BSME; Santosh Zachariah, PhD
(p. 161)

Purpose of Work. The purpose of this research was to measure the mechanical properties of cushioning materials used to line the insides of prosthetic limbs or the inside surfaces of orthoses. **Subjects/Procedures.** The reductions in thickness of samples of Spenco, Poron, nylon-reinforced silicone, Soft Pelite, Medium Pelite, Firm Plastazote, Regular Plastazote, and Nickelplast under known applied forces were measured using a custom-designed compression testing apparatus. Threshold normal and shear force combinations that caused slip between skin and different interface materials as well as between skin and socks were measured on 10 volunteer subjects. **Results.** Results showed that materials varied considerably in their compressive characteristics. While some materials compressed approximately linearly with the applied load, others were highly nonlinear. The ratio of shear force to normal force at which slip was initiated was higher for skin-material interfaces than for skin-sock interfaces. **Relevance to the Veteran Population.** The data reported here are needed for computer models to predict interface pressures and shear stresses for proposed prosthetic socket or orthosis designs.

Joan Sanders, PhD

Mechanical Efficiency During Gait of Adults with Transtibial Amputation: A Pilot Study Comparing the SACH, Seattle, and Golden-Ankle Prosthetic Feet.

François Prince, PhD; David A Winter, PhD, Eng;
Gary Sjonnesen, BSc, CP; Corrie Powell, MSc;
Robyn K. Wheeldon, BSc (p. 177)

Purpose of the Work. This study describes a rigorous technique to calculate the net energy stored or dissipated and then recovered during the stance phase of gait, using three different prosthetic feet. **Subjects/Procedures.** Five adults with transtibial amputations were tested with the SACH, Seattle, and Golden-Ankle prosthetic foot. The subjects walked at a self-selected cadence and stepped on a force plate while 2-D segmental kinematic and kinetic data were collected. **Results.** Net efficiency alone cannot discriminate adequately among different types of prosthetic feet. **Relevance to the Veteran Population.** The findings of this study imply that the clinician should consider the time to reach foot flat and the amount of energy recovered as additional objective criteria (weight, maintenance, cosmesis) in selecting a prosthetic foot replacement.

by the Editor, for, and in the absence of, the author

Validation of FSCAN Pressure Sensor System: A Technical Note.

Zong-Ping Luo, PhD; Lawrence J. Berglund, BS;
Kai-Nan An, PhD (p. 186)

Purpose of Work. We sought to quantitatively validate a newly developed pressure sensitive transducer system, the Fscan sensor, for dynamically monitoring the plantar pressure distribution of the foot. **Subjects/Procedures.** Systematic validation was performed over whole transducer system or individual sensor cells under simulated compression loading. Three surface conditions were tested simulating different insoles. Possible environmental effects, such as temperature and creeping, were also investigated. **Results.** The sensor system has linear response with good homogeneity throughout sensor cells. However, the sensor is sensitive to surface conditions, loading speeds, and temperature. Variations also exist from sensor to sensor. **Relevance to the Veteran Population.** Foot pressure distribution, as a part of gait analysis, is important information for veterans or their health care practitioners, which may help to monitor their training program and to decrease disability.

Zong-Ping Luo, PhD

Sensing Stability and Dynamic Response of the F-Scan In-shoe Sensing System: A Technical Note
Tadashi Sumiya, MD; Yoshitaka Suzuki, Eng; Tomio Kasahara, Eng; Hajime Ogata, MD (p. 192)

Purpose of Work. The purpose of this study was to examine the F-Scan in-shoe sensing system to determine its appropriate clinical application. **Subjects/Procedure.** Two sensor foils were attached, with adhesive tape, to the soles of both bare feet of a nonimpaired adult male. The subject walked shoeless on a Kistler force plate. Synchronous recordings by the F-Scan and the force plate were made for 2, 3, and 5 s, with a sampling frequency of 100 Hz for both devices. **Results.** It was determined that rather than use F-Scan measurement to accurately obtain actual values, it should be used for relative comparisons of the plantar pressure distributions under constant conditions. Improvement of its properties, especially dynamic response and preset range of sensor sensitivity, would help achieve a more scientific basis for foot pressure management; enhancing the clinical validity of this system. **Relevance to the Veteran Population.** Use of this device is indicated in persons with a sound sensation over the plantar surface of the feet. Improvement of in-shoe pressure-sensitive devices may give a more definite basis for the prescription and fit of foot orthoses.

The Editor

Methods of Reducing Energy Dissipation in Cosmetic Gloves.

Just L. Herder, MSc; Dick H. Plettenburg, MSc;
Jan C. Cool MSc (p. 201)

Purpose of the Work. Due to the material characteristics of the cosmetic covering of hand prostheses, energy is wasted every time the hand is opened. The work aimed to minimize this energy dissipation during finger movement. **Subjects/Procedures.** Two methods were developed. One method is to modify the glove itself by melting grooves into the inside wall; the other is to optimize finger movement with minimal energy loss and acceptable cosmesis as combined criteria. Both methods have general application capacity. **Results.** It was found that glove modification halves energy dissipation and that movement optimization performs even better. In combination, a reduction by a factor of

six can be attained. **Relevance to the Veteran Population.** Glove counteraction results in excessive operating effort for body-powered hand prostheses and in heavy motors for externally powered prostheses. As these features often lead to nonusage in all populations, this study has relevance within and beyond the veteran population.

Just L. Herder, MSc

Characterization of Wheelchair Propulsion Stroke Patterns.

Sean D. Shimada, PhD; Rick N. Robertson, PhD;
Michael L. Boninger, MD; Rory A. Cooper, PhD
(p. 210)

Purpose of the Work. The purpose of this study was to characterize wheelchair propulsion stroke patterns by investigating joint accelerations, joint range of motions, wheelchair propulsion phases, and stroke efficiency. **Subjects/Procedures.** Seven experienced wheelchair users were filmed using a three-camera motion analysis system. Elbow and shoulder motions in three dimensions were analyzed during two speeds of propulsion. **Results.** Three different stroke patterns were identified from the motion analysis. It was hypothesized that the subjects with the semi-circular stroke pattern were more biomechanically efficient when compared with the other stroke patterns. **Relevance to the Veteran Population.** The repetitious nature of wheelchair propulsion has been associated with the high incidence of injury among manual wheelchair users. The investigation of the wheelchair propulsion stroke pattern may provide insight into the mechanisms that cause musculoskeletal injury in the manual wheelchair user.

Sean D. Shimada, PhD

Polyurethane Foams: Effects of Specimen Size when Determining Cushioning Stiffness

Beth A. Todd, PhD (p. 219)

Purpose of the Work. The purpose of this study was to investigate the effects of specimen size on the results of mechanical testing of polyurethane foams. Polyurethane foams are commonly used in seating and positioning applications. **Procedures.** Compression tests following the ASTM standard for testing flexible cellular materials were used to determine properties of three different

types of polyurethane foams cut into four different sizes. **Results.** The relative size of the specimen and the test indenter affects the results of the testing. It is recommended that designers select sizes that simulate their application. **Relevance to the Veteran Population.** Greater understanding of the material properties of polyurethane foams will improve the design of wheelchair cushions and supporting devices. The devices will aid in the reduction of pressure sores.

Beth A. Todd, PhD

Assessment of Alternating Air Mattresses Using a Time-Based Interface Pressure Threshold Technique.

Shyam V.S. Rithalia, PhD; Mahendra Gonsalkorale
MD (p. 225)

Purpose of the Work. This study was designed to develop equipment and software to provide a time-

based threshold technique to measure performance criteria of alternating pressure mattresses (APAMs) and cushions (APACs). **Subjects/Procedures.** Using 15 nonimpaired adult volunteers, four different commercially available dynamic support surfaces were examined for their pressure relief (PR) characteristics. **Results.** Measurements indicated significant differences ($p < 0.001$) between products, showing some devices were only capable of momentarily relieving pressure. Results also indicated that PR was sensitive to the design of the support system, principally inflation pressure, cycle time, and inflation sequence. **Relevance to the Veteran Population.** Pressure sores, or decubitus ulcers, are a serious problem for the disabled and elderly, including veterans. An important aspect in their prevention and treatment is the use of appropriate support surfaces. Evaluation of parameters, such as pressure relief, can be extremely useful in making an informed choice of a mattress or cushion.

Shyam V.S. Rithalia, PhD