

### **Phase I design and evaluation of an isometric muscle reeducation device for knee osteoarthritis rehabilitation**

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**Purpose of the Work.** Our long-term goal is strengthening of the muscles around the knees for people with “wear and tear” arthritis of the knees (osteoarthritis), since pain tends to decrease as strength increases. **Subjects and Procedures.** To build strength, we introduced a machine called the Isopad™ to provide the user with continuous and immediate feedback of strength in lights and sounds to make strengthening more enjoyable. Within the Isopad is a novel-force sensor. This sensor was very accurate and reliable in laboratory tests. Five subjects completed an 8-week progressive strengthening program based on an Arthritis Foundation booklet, supervised at all times by a physical therapist. **Results.** Subjects used the Isopad successfully and their symptoms seemed to decrease. However, no conclusions could be drawn from five subjects only. Many more subjects will test the next-generation Isopad in a home-based program. **Relevance to the Veteran Population.** Pain from osteoarthritis is a common problem among aging veterans.

*Robert J. Goldman, MD*

### **The effect of a shock-absorbing pylon on the gait of persons with unilateral transtibial amputation**

Steven A. Gard, PhD; Regina J. Konz, MS

**Purpose of the Work.** This study investigated the effect of shock-absorbing pylons (SAPs) on the gaits of persons who walk with transtibial prostheses. SAPs are components that are designed to decrease prosthetic stiffness and to provide shock absorption during walking, running, and other high-impact activities in persons with leg amputations. **Subjects and Procedures.** Two gait analyses were performed on each of 10 subjects with unilateral transtibial amputations who walked with and without Endolite TT (Telescopic-Torsion) Pylons in their prostheses. **Results.** The data indicated that many subjects experienced a reduction in the magnitude of an isolated ground reaction force event that occurred during the prosthetic loading response phase when walking with the SAP, an

effect that was more evident at higher speeds. Overall, few measurable changes were found in the way subjects walked with and without the SAPs. Results from a questionnaire indicated that subjects generally preferred walking with the SAP because of comfort. **Relevance to the Veteran Population.** SAPs may provide significant benefit for transtibial amputees who are active and who routinely walk at moderate to fast speeds.

*Steven A. Gard, PhD*

### **The effects of wheelchair-seating stiffness and energy absorption on occupant frontal impact kinematics and submarining risk using computer simulation**

Gina Bertocci, PhD, PE; Aaron L. Souza, MS;  
Stephanie Szobota, BS

**Purpose of the Work.** Many wheelchair users travel in motor vehicles seated in their wheelchairs. In these cases, the wheelchair must serve as a motor vehicle seat, offering occupant stability and protection in a motor vehicle crash. Wheelchair seat design may influence the response of an occupant in a crash. In particular, seat design may influence the risk of submarining or the tendency of the occupant’s pelvis to slip under his or her lap belt, thereby increasing the risk of injury. **Procedures.** This study used computer crash simulation techniques to investigate the effect of seat design characteristics on occupant crash response and injury risk in a frontal crash. **Results.** Our study found that wheelchair-seating design influenced the risk of submarining in a frontal motor vehicle crash. **Relevance to the Veteran Population.** Findings of our study will alert wheelchair and seating manufacturers as to key design issues that they should consider when developing transit wheelchairs.

*Gina Bertocci, PhD, PE*

### **Failure analysis of composite femoral components for hip arthroplasty**

Chaodi Li, PhD; Christopher Granger, MS;  
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John M. Kennedy, PhD; Robert A. Latour Jr., PhD

**Purpose of the Work.** This study evaluated fatigue strength of composite hip stem with computational simulations. **Procedures.** A numerical methodology was developed to analyze failure of laminated composites. Numerical

modeling was conducted to design test methods to simulate in vivo loading conditions for composite stem fatigue tests. The numerical model was then adjusted to accurately represent the actual damage development in the experimental tests. The method was then applied to analyze simulated in situ composite femoral components to compare a variety of implant designs. **Results.** The developed methodology was suitable for locating the critical region within the composite femoral component, providing three-dimensional ply-level stress distributions, and predicting damage initiation and propagation efficiently and accurately. **Relevance to the Veteran Population.** The methodology can be used as a design optimization tool for laminated composite implant components to improve their performance and decrease the occurrence of fatigue failure.

*Chaodi Li, PhD*

#### **The globe system: An unambiguous description of shoulder positions in daily life movements**

Caroline A.M. Doorenbosch, PhD; Jaap Harlaar, PhD;  
DirkJan (H.E.J.) Veeger, PhD

**Purpose of the Work.** This study illustrates the use of the so-called “globe system,” a clear and clinically usable method to describe shoulder positions for physical examination and (clinical) studies of everyday tasks. In contrast to the commonly used way to describe shoulder positions, i.e., in terms of degrees of arm elevation in the principal planes, the globe system is a standardized method with direct visualization of the parameters by globe graphs. **Subjects and Procedures.** The globe system is illustrated for several functional and standardized tasks of the upper limb performed by a healthy subject. Arm positions were described based on the following sequence of angles: (1) plane of elevation, (2) elevation angle, and (3) axial rotation angle. **Results.** These angles are visualized as a position on a “globe” around the shoulder joint. Although not perfect, the globe system provides the most unambiguous description of thoracohumeral positions, which is easy to apply in clinical practice. **Relevance to the Veteran Population.** A standardized and clear system of description will unambiguously define shoulder motions in functional tasks to facilitate the evaluation of orthopedic interventions related to the shoulder or to document arm function in longitudinal studies.

*Caroline A.M. Doorenbosch, PhD*

#### **Guide to conducting tinnitus retraining therapy initial and follow-up interviews**

James A. Henry, PhD; Margaret M. Jastreboff, PhD;  
Pawel J. Jastreboff, PhD, ScD; Martin A. Schechter, PhD;  
Stephen A. Fausti, PhD

**Purpose of the Work.** Tinnitus Retraining Therapy (TRT) is an increasingly popular method for treating patients with severe tinnitus. The method is highly structured; it includes the use of verbal interview forms to assess patients for treatment and to assess outcomes of treatment. These interview forms are, however, difficult to administer in a standardized manner because of their abbreviated wording. In addition, clinicians may not fully understand the rationale for asking each question. A project was undertaken to expand the forms to provide exact wording for each question. This paper presents the expanded forms and explains each of the questions. **Subjects and Procedures.** We met on repeated occasions to develop scripted instructions to read to patients and develop the precise wording that should be used for each question. **Results.** The revised and expanded TRT Initial Interview and TRT Follow-up Interview forms are provided. Explanations for each of the questions are also included. **Relevance to the Veteran Population.** Tinnitus has become an increasing concern for veterans and for the Veterans Health Administration. As of September 2002, 196,541 veterans are being compensated at a rate of \$214,953,048 a year for their service-connected tinnitus conditions (Department of Veterans Affairs (VA) Office of Policy and Planning). Many more veterans suffer from tinnitus but do not receive compensation. Clinical services for these veterans are needed, but such services are inconsistent across VA medical centers. Although the interview forms presented in this paper are specific to TRT, they will be useful to VA audiologists who evaluate veterans for any method of tinnitus rehabilitation.

*James A. Henry, PhD*

#### **Evaluation of an instrumented glove for hand-movement acquisition**

Laura Dipietro, PhD; Angelo M. Sabatini, PhD;  
Paolo Dario, PhD

**Purpose of the Work.** This study investigated the feasibility of using a computerized glove, the Humanglove, to measure fingers' range of motion (ROM). **Subjects and**

**Procedures.** A series of tests aimed at investigating the repeatability of measurements taken from the glove were performed on six normal subjects. **Results.** Measurement performance of the glove is adequate to propose the instrument as a goniometric device to measure fingers' ROM. **Relevance to the Veteran Population.** With the Humanglove, ROM measurement can be easier and quicker. The glove also allows for recording patients' hand movements while they perform dynamic functional tasks; this can potentially help develop more objective methodologies for hand-function assessment and, consequently, improve planning of rehabilitative treatments. The Humanglove is also suitable as an aid for motor or vocally impaired subjects, as in controlling devices remotely or translating sign-languages into text or synthetic speech.

*Laura Dipietro, PhD*

**A digitizer with exceptional accuracy for use in prosthetics research: A technical note**

Joan E. Sanders, PhD; Stuart B. Mitchell, MSE;  
Santosh G. Zachariah, PhD; Kelvin Wu, BSE

**Purpose of the Work.** This research developed a very accurate mechanical digitizer for use in prosthetics research. **Procedures.** A novel mechanical design was used with precision controllers to achieve the desired performance. **Results.** The developed instrument had errors far less than current commercial digitizers used for socket and cast shape assessment. **Relevance to the Veteran Population.** The new digitizer has application in prosthetics research for assessing differences in shapes of sockets and differences in shapes of residuum casts (taken at two different points in time, for example), assessment of socket fabrication systems, and enhancement of prosthetic computer models.

*Joan E. Sanders, PhD*