

SUMMARY OF SCIENTIFIC/TECHNICAL PAPERS IN THIS ISSUE

A device for applying static loads on transtibial amputees during spiral CT examinations

Mark T. Madsen, PhD; John Haller, PhD;
Paul K. Commean, BEE; Michael W. Vannier, MD
(p.383)

Purpose of the Work. The purpose of this study was to report on a device that allows the 3D imaging of prosthetic legs on an x-ray computerized tomography (CT) scanner under weight bearing conditions. **Subjects/Procedures.** The device consists of a chair and a vertical foot plate securely mounted on an oak board positioned on the CT scanning bed. A subject can sit in the chair and apply force by pushing the foot portion of the prosthesis against the foot plate which is directly connected to a digital force gauge. The device was tested on 19 subjects with lower limb amputations. **Results.** Because the load is borne by the hips and lower back of the subject against the chair, full body weight loads can be generated and steadily maintained for the 20-45 second duration of the CT study. **Relevance to the Veteran Population.** CT studies of the prosthesis and residuum under weight bearing conditions may provide objective measures of prosthetic fit. This device provides an approach to acquire these studies.

Mark T. Madsen, PhD

Heterotopic ossification in rehabilitation patients who have had internal fixation of an acetabular fracture

Steven J. Schafer, MD; Laura Ottaviani Schafer, MD;
Jeffrey O. Anglen, MD; and Martin Childers, MD
(p. 389)

Purpose of the work. This retrospective study reported prevention of extra bone (“heterotopic ossification” or HO) growth around the hip after surgical treatment of a hip socket fracture. The growth of excess bone around the hip is a common complication of this surgery and

may limit hip motion and function of the patient. Two methods of prevention exist: six weeks of an oral medication (Indomethacin) or one radiation treatment. **Subjects/Procedures.** Charts and Xrays of 94 patients at risk were reviewed, of which 82 had preventive treatment. **Results.** Five patients had no preventive treatment ordered and 7 discontinued taking Indomethacin prematurely. Nine of these patients developed HO, of which 5 had high grade HO. In patients treated for prevention, 4/32 Indomethacin patients and 2/36 radiation patients developed high grade HO. **Relevance to the Veteran Population.** Veterans who have surgically treated acetabular fractures, or other procedures with a risk of HO formation (e.g. total hip replacement) should be treated adequately to prevent HO.

Steven J. Schafer, MD

Assessment of spinal movement reduction by thoraco-lumbar-sacral orthoses

Peter JCM van Leeuwen, MD; Renate PMJ Bos, Msc;
José CM Derksen, Msc; Jaap de Vries, PhD, MD
(p.395)

Purpose of the Work. The purpose of the study was to evaluate movement reduction properties of two spinal orthoses. **Subjects/Procedures.** Two studies were carried out. Both dealt with healthy male individuals. The first study was to determine the movement reduction in gross spinal movement. A noninvasive continuous measuring device was used. The second study evaluated reduction in segmental mobility using X-rays. **Results.** The movement reduction in the flexion\extension plane was 42.9%—82.4%. In lateral bending reduction was up to 51.4% and in the rotational plane up to 73.3%. Large differences were found between individuals. There were no statistical differences between both orthoses. **Relevance to the Veteran Population.** Risk of falling and the risk of fracturing a vertebra increases with increasing age. Bracing is a common modality in managing these fractures. This study gives us some insight in the movement reducing properties of two spinal orthoses, this helps us in a better brace prescription.

Peter JCM van Leeuwen, MD

Experimental and numerical predictions of the ultimate strength of a low-cost composite transtibial prosthesis

Jill C. Hahl, MS; Minoru Taya, PhD (p.405)

Purpose of the Work. The purpose of this study was to optimize the design of a simple lower limb prosthetic leg to increase the breaking strength and reduce the production costs. The cost of the prosthesis was minimized to allow for affordability since the prosthesis was designed primarily for donation purposes. **Subjects/Procedures.** Numerical analysis (computer simulation) was used to analyze the composite prosthesis. Many different designs were investigated and the optimum design was determined. A replica of the optimum design was built and tested according to ISO standards. **Results.** Modification of the prosthesis allowed for increased ultimate strength and reduced production costs. **Relevance to the Veteran Population.** The composite prosthesis is a low-cost alternative to the current lower-limb prostheses on the market. Its design is simple yet allows for high strength, great durability, and smooth walking.

Jill C. Hahl, MS

Equipment specifications for supported treadmill ambulation training

Michael S. Wilson, MS; Huma Qureshy, MS; Elizabeth J. Protas, PhD; S. Ann Holmes, MD; Thomas A. Krouskop, PhD; Arthur M. Sherwood, PhD (p.415)

Purpose of the work. The purpose of this study was to enumerate the necessary specifications for the equipment used in Supported Treadmill Ambulation Training (STAT). STAT is a therapy for relearning the walking pattern which involves supporting a portion of the subject's weight while walking on a treadmill. Using appropriate equipment is essential to the safety and success of this intervention. **Procedures.** These specifications were determined by applying engineering principles to clinical experience with STAT. Data from anthropometric tables (information about the length of body segments) was consulted to allow patients and therapists of all sizes to use the equipment. **Results.** Required and recommended features were determined and reported for the tread-

mill, body weight support (BWS) system, and harness. The ergonomics of the workspace were also analyzed since the therapist(s) will need access to the patient's legs during therapy. **Relevance to Veteran Population.** One of the reasons STAT has not been widely implemented in clinical practice is that there is a great deal of confusion among clinicians regarding the equipment required to train patients successfully. This technical note is presented to identify key equipment and the features needed for a successful application.

Michael S. Wilson, MS

Electromyographic and kinematic analysis of the shoulder during four activities of daily living in men with C6 tetraplegia

JoAnne K. Gronley, DPT; Craig J. Newsam, MPT; Sara J. Mulroy, PhD, PT; Jacquelin Perry, MD, DSc(Hon); Melvin Helm, MD (p.423)

Purpose of the work. The purpose of this study was to identify the shoulder motions and muscular activity required by individuals with C6 tetraplegia during basic activities of daily living. **Subjects/Procedures.** Fifteen adult men with complete C6 tetraplegia were studied as they performed arm elevation, hair combing, flipping a light switch, drinking from a cup and reaching towards the perineum. During each activity shoulder motion and activity levels of twelve shoulder muscles were recorded. **Results.** Arm elevation less than 90° required moderate levels of muscle action. Above 90° muscle activity was greater than that reported in the literature for normal subjects. **Relevance to the Veteran Population.** For individuals dependent on a wheelchair, all activities must start from a seated position. Thus, more of the daily requirements of vocation and recreation must be performed at shoulder height and overhead to interact with the environment. Two likely causes of increased muscle action for overhead activities are decreased strength of the shoulder and altered motion patterns to accommodate loss of distal upper extremity control. This emphasizes the need to include scapular rotators and shoulder elevators in a shoulder rehabilitation program for individuals with C6 tetraplegia.

JoAnne K. Gronley, DPT

A Compound sensor for biomechanical analyses of buttock soft tissue in vivo

Jue Wang, MS; David M. Brienza, PhD; Ying-wei Yuan, PhD; Patricia Karg, MS; Qiang Xue, PhD (p.433)

Purpose of the Work. The purpose of this study was to develop a compound sensor for integration into a non-invasive clinical assessment system, the Computer Automated Seating System (CASS), for in vivo biomechanical analysis of buttock soft tissue. **Subjects/Procedures.** Interface pressure, applied force, tissue deformation, and tissue viscoelastic properties were recorded simultaneously for buttock tissue over an ischial tuberosity under a controlled loading condition as a male subject sat on the CASS support surface. A quasi-linear viscoelastic (QLV) model was used for modeling the viscoelastic response. **Results.** Results indicate that the sensor has sufficient sensitivity and axial resolution for the discrimination of tissue layers, and the sensor can be used to investigate and quantify the complex relationships between biomechanical parameters of buttock soft tissues. **Relevance to the Veteran Population.** The system is to be used to help determine pressure ulcer risk for individuals with SCI by analyzing the viscoelastic properties of buttock soft tissue.

Jue Wang, MS

Quantifying ataxia: Ideal trajectory analysis—a technical note

Michael D. McPartland, PhD; David E. Krebs, PhD, PT; Conrad Wall III, PhD (p.445)

Purpose of the work. The purpose of this study was to analyze the capability of a new technique called Ideal Trajectory Analysis (ITA) to quantify the balance and ataxic behavior of subjects as they performed a simple repeated stair-stepping protocol. **Subjects.** Nine healthy subjects and six with vestibular labyrinth hypofunction were analyzed in this study. **Procedure.** Estimated displacement trajectories of the center of mass during the stepping protocol were analyzed via ITA and scalar instability indices were calculated for each subject for their medio-lateral and antero-posterior directions. **Results.** This produced numerical values defining the instability of each subject. ITA showed that subjects with vestibular

hypofunction are significantly less stable than subjects with intact vestibular systems. **Relevance to the Veteran Population.** This analysis technique can be used to quantify and monitor changes in balance due to disease progression and can be used to validate rehabilitative modalities for balance disorders.

Michael D. McPartland, PhD

The Effectiveness of neurological rehabilitation in multiple sclerosis

Alan J. Thompson, MD, FRCP, FRCPI (p.455)

Purpose of this work. This article reviewed recent studies which evaluated the effectiveness of neurological rehabilitation in patients with multiple sclerosis. **Subjects/Procedures.** Sixteen studies were reviewed which covered inpatient and outpatient rehabilitation in this condition. Only three studies adhered to a prospective randomised controlled trial (RCT) design (all published within last 3 years) and only two studies included health-related quality of life as an outcome. **Results.** The early studies suggested a potential benefit from inpatient rehabilitation and this was supported by two RCTs which demonstrated benefits in disability, handicap, and some aspects of quality of life. **Relevance to the Veteran Population.** This paper supports the use of rehabilitation in MS, and highlights the need for further well designed studies. This is undoubtedly important to veterans who become disabled as a result of this condition.

Alan J. Thompson, MD, FRCP, FRCPI

Microstructural and mechanical characterization of Human tissue at and adjacent to pressure ulcers.

Laura E. Edsberg, PhD; Renee Cutway, PT; Shirley Anain, MD; Joseph R. Natiella, DDS (p.463)

Purpose of the Work. The purpose of this study was to evaluate the microstructural and mechanical properties of human skin at and adjacent to pressure ulcers. **Procedures.** The tissue was tested in uniaxial tension and histomorphometrically analyzed. Healthy breast and leg tissue served as control tissue. **Results.** The pressure ulcer tissue had significantly fewer fibers, but the fibers present were significantly wider and longer than those found in the healthy control tissue. Pressure

ulcer tissue tested in tension had significantly lower strains at peak stress, versus the control tissue. **Relevance to the Veteran Population.** The findings of this study suggest that tissue at and adjacent to pressure ulcers has undergone significant adaptation or remodeling, as a result of the pressure sustained by the tissue. The precursor to pressure ulcer formation may be microstructural alignment. Prevention of pressure ulcers might be more successful if the earliest pressure-induced microstructural changes in the tissue can be identified.

Laura E. Edsberg, PhD

**Fitting hearing aids with the articulation index:
Impact on hearing aid effectiveness**

Pamela E. Souza, PhD; Bevan Yueh, MD; Margaret Sarubbi, MS; Carl F. Loovis, PhD (p.473)

Purpose of the work. Hearing aids are intended to make speech more audible. In general, the more audibility is improved, the more the hearing aid is expected to

improve communication. The purpose of this study was to determine how audibility measured with standard clinical tests relates to how satisfied the veteran is with his hearing aid under everyday conditions. **Subjects/Procedures.** Hearing aid audibility was measured using standard clinical tests in 115 veterans with hearing loss. The same veterans completed questionnaires rating how helpful their hearing aids were in everyday situations and how satisfied they were with the hearing aids. **Results.** There was no systematic relationship between the amount the hearing aid improved speech audibility and either the veteran's rating of how much the hearing aid improved communication or their overall satisfaction with the hearing aid. However, veterans whose hearing aids provided better audibility did use their hearing aids more frequently. **Relevance to the Veteran Population.** These measurements will help us understand the relationship between standard clinical tests and how helpful veterans find their hearing aid, and to develop clinical tests that better predict the usefulness of the hearing aid in everyday life.

Pamela E. Souza, PhD