Orthopaedic Section Abstracts: Platform Presentations OPL1-OPL64

The abstracts below are presented as prepared by the authors. The accuracy and content of each abstract remain the responsibility of the authors. In the identification number above each abstract, OPL designates an Orthopaedic Section platform presentation.

OPL1
PRELIMINARY EXAMINATION OF THE VALIDITY OF A PROPOSED CLASSIFICATION SYSTEM FOR PATIENTS WITH NECK PAIN RECEIVING PHYSICAL THERAPY
Fritz JM, Brennan GP
Physical Therapy, University of Utah, Salt Lake City, UT; Rehabilitation Agency, Intermountain Health Care, Salt Lake City, UT
PURPOSE/HYPOTHESIS: Patients with neck pain are frequently managed in Physical Therapy. Development of valid classification methods for matching interventions to particular subgroups of patients may improve the outcomes of care. The purpose of this study was to examine the validity of a proposed classification system by comparing clinical outcomes when interventions matched the system versus the outcomes when interventions were unmatched to the system.
NUMBER OF SUBJECTS: Subjects were 274 patients (78% female; mean age, 44.2 years; SD, 12.7) with neck pain receiving physical therapy over a 1-year period.
MATERIALS/METHODS: Standardized methods for collection of baseline variables and interventions were used. Outcomes variables collected were the neck disability index (NDI), numeric pain rating, number of visits, and cost of therapy. Duration and nature of the treatment provided were left to the discretion of the Physical Therapist. Each patient was classified using baseline variables, and the interventions received by the patient were categorized as matched or unmatched to the classification. Outcomes of patients receiving matched or unmatched interventions were compared. Interrater reliability of the system was examined using 50 patients. Outcomes within each classification were examined to identify additional interventions associated with better outcomes for patients in the classification.
RESULTS: The most common classification was centralization (34.7%), followed by exercise and conditioning (32.8%), mobilization (17.5%), headache (9.1%), and pain control (5.8%). Interrater reliability for classification decisions was high (kappa = 0.86, 95% CI, 0.87-1.0). One hundred thirteen patients (41.2%) received interventions matched to their classification. Those receiving matched interventions experienced greater improvement in NDI (mean difference, 5.5 points; 95% CI, 2.6-8.4) and pain scores (mean difference, 0.75 points; 95% CI, 0.23-1.3) than those receiving unmatched interventions. Receiving matched interventions was also associated with higher median physical therapy cost. Examining the classifications separately, receiving matched interventions was associated with greater improvement in either NDI or pain scores in the mobilization and centralization classifications, and in the exercise and conditioning classification when only patients under age 65 were considered. Within each classification, additional interventions were identified that were associated with better outcomes for patients in the classification.
CONCLUSIONS: Results of this study generally support a previously proposed classification system for patients with neck pain receiving physical therapy. Receiving interventions matched to the classification system was associated with better outcomes then receiving unmatched interventions. The results also suggest opportunities for revision of the proposed system and topics for future research.
CLINICAL RELEVANCE: Development of valid classification methods for patients with neck pain may improve the outcomes of physical therapy management.

OPL2
SHORT-TERM RESPONSE OF THORACIC SPINE THRUST VERSUS NONTHRUST MANIPULATION IN PATIENTS WITH MECHANICAL NECK PAIN: A RANDOMIZED CLINICAL TRIAL
Cleland J, Glynn P, Whitman JM, Eberhart SL, MacDonald C, Childs JD
Franklin Pierce College, Hillsboro, NH; Rehabilitation Services, Concord Hospital, Concord, NH; Newton Welsley Hospital, Boston, MA; Regis University, Denver, CO; Meric, Colorado Springs, CO; Baylor University, San Antonio, TX
PURPOSE/HYPOTHESIS: Evidence supports the use of manual physical therapy interventions such as thrust manipulation, directed at the thoracic spine in patients with neck pain. However, it is unclear whether thoracic spine thrust manipulation is more beneficial than nonthrust, lower velocity mobilization techniques. The purpose of this study was to compare the effectiveness of thoracic spine thrust versus nonthrust manipulation in patients with a primary complaint of mechanical neck pain.
NUMBER OF SUBJECTS: Consecutive patients 18 to 60 years of age with a primary complaint of neck pain who satisfied eligibility criteria were invited to participate. All patients received a standardized history and physical examination. Self-report outcome measures included the Neck Disability Index (NDI), a pain diagram, and the Numeric Pain Rating Scale (NPRS).
MATERIALS/METHODS: Following the baseline evaluation patients were randomized to receive either thoracic spine thrust or nonthrust manipulation. Patients in both groups also completed a range of motion exercise immediately following the manual intervention. Patients were re-exam-
Preliminary Study of 2 Factors That Predict Improved Outcome in Patients with Neck Pain Using Thoracic Manipulation

Brennan GP, Frits JM, Hunter SJ, McGaw S

Rehabilitation Division, Intermountain Health Care, Salt Lake City, UT; Division of Physical Therapy, University of Utah, Salt Lake City, UT

Purpose/Hypothesis: Several factors have been identified that predict a positive clinical outcome using treatment with thoracic manipulation for patients with neck pain. Two factors with the highest positive likelihood ratios for predicting success with thoracic manipulation were duration of symptoms less than 30 days and patient report that looking up did not aggravate symptoms. The purpose of this study was to examine the relationship between these 2 factors and outcomes of treatment using thoracic manipulation in a new sample of subjects.

Number of Subjects: Patients with neck pain who were less than 60 years old, did not have signs of nerve root compression, and attended at least 2 visits were included (n = 172). Patients’ average age was 38.7 years (±10.1), 75% were women, 70% had no symptoms distal to the shoulder, and 54% had no prior history of neck pain.

Materials/Methods: Two subgroup analyses were performed on this sample of patients based on whether the duration of their symptoms was less than 30 days (n = 76; 58 women) or the patient reported that looking up did not aggravate symptoms (n = 96; 72 women). Differences in clinical outcomes and number of physical therapy visits were compared on the basis of whether or not patients were treated with manipulation of the thoracic region. Clinical outcomes included the Neck Disability Index (NDI) and a numeric pain score. Comparisons were made between patients who received thoracic manipulation during treatment and those who did not. Baseline variables were compared between the groups to determine equivalence. Analysis of covariance (ANCOVA) was used to examine differences between the groups in change scores for the NDI and pain.

Results: Of the patients who had symptoms less than 30 days, 28 (20 women) received manipulation and 48 did not (38 patients). Patients receiving manipulation experienced greater improvement in NDI (mean difference, 6.7 points; 95% CI, 0.72-12.6). Their improvement in pain scores approached significance (mean difference, 0.98 points; 95% CI, −0.02-2.0). Receiving manipulation was associated with a greater number of visits (7.2 versus 5.1, P = .046). Ninety-seven patients reported that looking up did not aggravate symptoms, 32 were manipulated (22 women) and 64 were not (50 women). Those receiving manipulation experienced greater improvement in NDI (mean difference, 4.7 points; 95% CI, 0.86-9.3); however, the change in pain scores was not significant. Receiving manipulation was associated with a greater number of visits (6.2 versus 4.4, P = .002).

Conclusions: Results of this study generally support the consideration to use thoracic manipulation to improve patients’ neck pain when the duration of symptoms is less than 30 days and/or patients report that looking upward does not aggravate symptoms.

Clinical Relevance: These 2 factors are readily obtained in the clinical examination process and can facilitate an important treatment decision process that appears associated with significant clinical improvement.
Purposes were (1) to determine if there was a difference in number of visits, duration, change in functional status (FS) or pain intensity (PI). ANCOVA results supported time-dependent PPC and FABQ data could be used to differentiate patients by PI and FS at intake. Analyses of variance supported PPC and FABQ data at intake predicted change in FS and PI, number of treatment visits, treatment episode duration, while intake FABQ-PA predicted change in FS and PI. Pain pattern was a stronger prognostic factor for all outcome measures at time of rehabilitation discharge compared to fear-avoidance belief of physical activity.

Conclusions: Classifying patients with NSSS by pain pattern and fear-avoidance beliefs discriminated patients with NSSS well. Classifying methods were successfully used to direct specific treatment to appropriate patients. Classification results successfully predicted improvement in functional status and pain at discharge. PPC also predicted treatment visits and duration.

Clinical Relevance: We conducted an effectiveness study of the importance of classifying patients with NSSS by PPC and FABQ-PA methods. We managed patients under real-time clinical conditions using a priori treatment interventions dependent on a dual-level classification process. Data supported classifying patients as described will improve the clinician's ability to manage patients with NSSS and predict risk-adjusted improvement in FS and pain, as well as visits and duration used.

Effectiveness of an Extension-Oriented Treatment Approach in a Subgroup of Patients with Low Back Pain: A Randomized Clinical Trial

EORTC 2005/66

Brewer DJ, Chilcots J, Cleland J, Fritz J

Physical Therapy, Wilford Hall Medical Center, San Antonio, TX; US Army-Baylor University Doctoral Program in Physical Therapy, San Antonio, TX; Physical Therapy, Franklin Pierce College, Concord, NH; Physical Therapy, University of Utah, Salt Lake City, NV

Purpose/Hypothesis: Recent evidence suggests that the use of subgrouping classification methods for the management of patients with low back pain (LBP) results in better outcomes than management that is not classification based. One such subgroup of patients is thought to preferentially benefit from an extension oriented treatment approach (EOTA). The objective of this multicenter randomized clinical trial is to examine the effectiveness of an EOTA in a subgroup of patients hypothesized to benefit from the treatment compared to a lumbar spine strengthening exercise program at both short and long-term follow-up.

Number of Subjects: Patients with LBP and symptoms distal to the buttocks.

Effect of Time-Dependent Classification of Patients with Spinal Syndromes by Pain Pattern and Fear of Physical Activities on Functional Status, Pain, Treatment Visits and Episode Duration

Werneme M, Hart DL, Stratford PW, Reyes A

Spine Rehabilitation, CentraState Medical Center, Freehold, NJ; Consulting and Research, Focus on Therapeutic Outcomes, Inc, White Stone, VA; Clinical Epidemiology and Biostatistics, McMaster University, Ontario, ON, Canada

Purpose/Hypothesis: Patients completed pain and psychosocial questionnaires at intake and discharge and pain diagrams throughout treatment. Therapists classified patients using pain pattern (PPC) and fear-avoidance beliefs of physical activity (FABQ-PA) data at intake. Once classified, therapists applied a priori dual-level intervention strategies based on classification results. If symptoms centralized, treatment emphasized specific exercises. If fear was high, treatment emphasized graded exposure to feared-stimuli. If fear was low and symptoms did not centralize, treatment was guided by evidence-based practice recommendations for NSSS.

Results: Analyses of variance supported PPC and FABQ-PA data could be used to differentiate patients by PI and FS at intake. Analyses of covariance controlled for important risk-adjusted variables. Supported PPC identified at intake predicted change in FS and PI, number of treatment visits, treatment episode duration, while intake FABQ-PA predicted change in FS and PI. Pain pattern was a stronger prognostic factor for all outcome measures at time of rehabilitation discharge compared to fear-avoidance belief of physical activity.

Conclusions: Classifying patients with NSSS by pain pattern and fear-avoidance beliefs discriminated patients with NSSS well. Classifying methods were successfully used to direct specific treatment to appropriate patients. Classification results successfully predicted improvement in functional status and pain at discharge. PPC also predicted treatment visits and duration.

Clinical Relevance: We conducted an effectiveness study of the importance of classifying patients with NSSS by PPC and FABQ-PA methods. We managed patients under real-time clinical conditions using a priori treatment interventions dependent on a dual-level classification process. Data supported classifying patients as described will improve the clinician's ability to manage patients with NSSS and predict risk-adjusted improvement in FS and pain, as well as visits and duration used.

Clinical Sections Meeting
tosks that centralized with extension movements were included. Forty-eight patients were randomized into groups receiving an EOTA (n = 26) or a strengthening exercise program (n = 22).

MATERIALS/METHODS: Patients attended 8 physical therapy sessions and completed a home exercise program. Follow-up was obtained at 1-week, 4-weeks, and 6-months post randomization. Primary outcome measures were disability ( Oswestry) and pain (numeric pain rating).

RESULTS: Patients in the EOTA group experienced greater improvements in disability compared to treatment efficacy of trunk strengthening exercises at 1 week (8.9; 95% CI, 2.0-15.9), 4-weeks (14.4; 95% CI, 4.8-23.9), and 6-months (14.6; 95% CI, 4.6-24.6). The EOTA group demonstrated greater change in pain at the 1 week follow-up only. A greater proportion of patients in the EOTA group (26.9%) demonstrated centralization of their symptoms compared to the trunk strengthening group (4.5%) (P = .04).

CONCLUSIONS: An EOTA was more effective than trunk strengthening exercise in a subgroup of patients hypothesized to benefit from this treatment approach.

CLINICAL RELEVANCE: The results of this study support the importance of matching patients to treatments from which they are most likely to benefit to improve clinical outcomes and increase the power of clinical research.

OP8 CHARACTERISTICS, OUTCOMES AND VISIT UTILIZATION OF PATIENTS EVALUATED AND TREATED USING A TREATMENT-BASED CLASSIFICATION SYSTEM: ANALYSIS OF 6320 PATIENTS

Hunter SJ, Pierce L, Brennan GP, Fritz JM
Rehabilitation Agency, Intermountain Health Care, Salt Lake City, UT

PURPOSE/HYPOTHESIS: Several low back pain classification systems have been developed to improve treatment efficacy of trunk strengthening exercises to those most likely to benefit. Using a large database, the purpose of this study was to examine patient characteristics, clinical outcomes, and PT visit utilization of patients with LBP treated using a treatment-based classification approach.

NUMBER OF SUBJECTS: 6320 patients with low back pain from 24 outpatient clinics classified into one of 6 treatment-based categories between June 2003 and June 2006 were included in the study.

MATERIALS/METHODS: Pain and disability measures were gathered using a numeric pain scale (NPR) and Oswestry (OSW) at initial and final visits. Change scores in OSW and NPR were calculated. Length of stay (LOS) was the number of days between the first and last treatment. Patient demographics, visit utilization and total billed charges were collected. Patients were subgrouped into one of 6 classifications based on a standard examination. These classifications included: stabilization (Stab), mobilization lumbar (Mob L), mobilization SI (Mob SI), specific exercise flexion (Ex Flex), specific exercise extension (Ex Ext), and traction (Tx). Treatment was left to the discretion of the therapist. Differences between subgroups were compared using independent t tests.

RESULTS: The percent of patients in each classification was: Stab 24%, Mob L 15%, Mob SI 18%, Ex Flex 20%, Ex Ext 15%, and Tx 8%. Stab patients realized the lowest average change in both OSW, 11.5 (±15.2) and NPR, 1.9 (±2.5), with the longest LOS at 32 (±31.9) days. Average change in mobility classifications was greatest in both OSW and NPR compared to all other subgroups, and LOS was shortest.

OSW change for Mob L was 17.2 (±18.4) and 16.9 (±16.5) for Mob SI. Change in pain for both Mob groups was the same at 2.7 (±2.7). LOS for Mob L was 24 (±29.4) days and for the Mob SI 26 (±27) days. Ex Flex patients were older at 55 (±20.1) years than all other groups combined (P = .0001) and had less change in both OSW, 13.0 (±15.9) and NPR, 2.1 (±2.5). Ex Ext patients’ OSW change was 16.1 (±17.5) and NPR change was 2.6 (±2.7). Tx patients had significantly higher intake OSW scores, 47.3 (±16.2) than all other groups combined (P = .001), required the most visits, 7.0 (±4.1), and had the highest billed charges, $814 (±$514).

CONCLUSIONS: Patients with LBP represent the most frequent clinical condition treated in these outpatient clinics. The greatest change in pain and disability was achieved in the Mob subgroup and the least change was observed in the Stab group. Patients in the Ex Ext subgroup showed greater improvements in pain and disability than those in the Ex Flex subgroup.

CLINICAL RELEVANCE: There is a great need for benchmark data using a treatment-based classification approach. Improving our understanding of expectations related to the average clinical change, cost and length of time of intervening assists communication in a shared decision process in caring for patients.
Influence of Running Shoe Type on Distribution and Magnitude of Plantar Pressures Across the Planus and Cavus Foot

Molloy JM, Yeykal NS, Tragord BS, Neal MS, Nelson ES, Christie DS, McPoil T, Teyhen DS
US Army-Baylor University Doctoral Program in Physical Therapy, Ft Sam Houston, TX; Program in Physical Therapy, Northern Arizona University, Flagstaff, AZ

Purpose/Hypothesis: Although differences in static arch height have been associated with overuse injury, the influence of running shoe type on plantar pressure or contact areas for either planus or cavus feet during gait is unknown. The main purpose was to analyze plantar pressure and mean contact area differences between the planus and cavus foot across 3 shod conditions. A second purpose was to determine the association between static arch height index (AHI) and dynamic modified arch index (MAI).

Number of Subjects: Subjects (n = 52) were identified with pes planus (n = 40; AHI, <.306) or pes cavus (n = 35; AHI, >.386) based on AHI values L.5 standard deviations above or below the mean.

Materials/Methods: Pressure-sensing insoles were secured to subjects’ feet with antiembolism stockings. Subjects walked on a treadmill at 3.0 mph under 3 conditions: nonsnosh (NS), motion control (MC), and cushioning (C) running shoes. Mean contact area and plantar pressure of the forefoot, midfoot, and rearfoot were determined over 10 steps. Modified arch index (MAI) was calculated by dividing midfoot mean plantar contact area by the entire mean plantar contact area. Modifying pressure index (MPI) was calculated similarly by substituting mean contact pressure for area values. A 2 × 3 mixed model repeated measures ANOVA (α = .05) was performed for each dependent measure (MAI, MPI).

Results: A significant interaction effect was found for MAI between shod condition and arch type (P = .007). For subjects with pes planus there was a significant difference in MAI between NS and both shod conditions (Pc < .001) and between C and MC conditions (Pc < .001). For subjects with pes cavus, significant differences in MAI were found only between NS and both shod conditions (Pc < .001). In either shod condition (MC, C), mean contact area increased in the midfoot (28% planus, 68% cavus) relative to the NS condition. There was no significant interaction effect between MPI and arch type (P = .752), nor a significant main effect for arch type (P = .110). A significant main effect existed for shod condition (Pc < .001). Overall mean contact pressure decreased (~30%) in both shod conditions relative to the NS condition. There was a moderate to good negative correlation between MAI and AHI for all conditions (NS, r = -.68; MC, r = -.70; C, r = -.72).

Conclusions: Both running shoe types tend to increase midfoot mean plantar contact area while decreasing mean pressure across the planus or cavus foot. Also, MC shoe wear resulted in a significant decrease in MAI relative to the C shoe wear for the planus foot. More research is required to determine the influence of running shoe type on foot biomechanics.

Clinical Relevance: Static AHI provides clinicians with a valid indicator of dynamic arch height and an objective, efficient method of assessing arch type.

OPL12

Evidence of Validity for the Foot and Ankle Ability Measure (FAAM) in Individuals with Chronic Ankle Instability

Careia CR, Drouin JM, Martin R, Speigle J
Physical Therapy, Duquesne University, Pittsburgh, PA; Lock Haven University, Lock Haven, PA; Slippery Rock University, Slippery Rock, PA

Purpose/Hypothesis: While there is evidence to support use of the Foot and Ankle Ability Measure (FAAM) in patients with general orthopaedic foot and ankle related disorders, the FAAM has not been studied specifically using individuals with chronic ankle instability (CAI). The hypotheses for this study were as follows: (1) FAAM scores would be different between individuals with CAI and normal individuals; (2) FAAM scores would not be different based on gender; (3) FAAM scores would be able to distinguish between those that reported a normal level of function from those that reported an abnormal level of function in individuals with CAI and (4) FAAM scores would be related to global rating of function values.

OPL11

Effect of the Airlift PTTD Brace on Foot Kinematics in Subjects with Stage II Posterior Tibial Tendon Dysfunction

Nevitt CM, Fleischer AS, Houck JR
Ithaca College Movement Analysis Laboratory, Ithaca College, Rochester, NY; School of Nursing, University of Rochester, Rochester, NY; Department of Orthopedics, University of Rochester, Rochester, NY

Purpose/Hypothesis: Conservative management for patients with Stage II Posterior Tibial Tendon Dysfunction (PTTD) includes use of foot/ankle braces to limit abnormal kinematics. The abnormal kinematics associated with PTTD includes increased hindfoot (HF) eversion, forefoot (FF) abduction, and FF dorsiflexion compared to controls. Current studies do not discriminate the effect of brace components on HF and FF control. The purpose of this study was to evaluate the effect of inflating the airbladder of the Airlift PTTD Brace (Aircast, Inc.) on abnormal foot kinematics. The hypothesis was that higher inflation of the airbladder would decrease HF eversion, FF abduction, and FF dorsiflexion.

Number of Subjects: Ten stage II PTTD subjects (52 ± 5.9 years) were included in this study.

Materials/Methods: Kinematic Data were collected from the shank, calcaneus (HF), and first metatarsal (FF) using an Optotak Motion Analysis System (Northern Digital, Inc, CAN) and Motion Monitor Software (Innosport Training Inc, USA). The airbladder of the Airlift PTTD brace was inflated to 3 levels (0 psi, 4 psi, and 7 psi) using an Ashcroft pressure gauge measured non-weight bearing. After inflation, subjects completed at least 5 successful walking trials. Kinematic data were collected (sampled at 60 Hz, filtered at 6 Hz) and used to calculate Cardan angles (x-y-z sequence) including HF inversion/eversion, FF dorsiflexion/plantar flexion, and FF abduction/adduction. The midstance phase of gait, immediately following foot flat was analyzed. Statistical comparisons between inflation levels during midstance were made using a repeated measures ANOVA model. The repeated factor was inflation of the airbladder with 3 levels (0 psi, 4 psi, 7 psi). Comparisons were made for each kinematic variable of interest including HF inversion/eversion (INV/EV), FF abduction/adduction (ABD/ADD) and FF plantar flexion/dorsiflexion (PF/DF).

Results: There was a significant difference (P = .009) in HF INV/EV between inflation levels with both 4 psi (P = .02) and 7 psi (P = .007) demonstrating decreased HF eversion over the 0 psi condition (range, 0.1°-5.8°). Inflation of the airbladder was found to have no effect on FF PF/DF (P = .26) while it had a significant effect on FF ABD/ADD at the P = .057 level. Inflation of the airbladder increased FF abduction at the 4 psi level in 7 of the 10 subjects and at the 7 psi level in 4 of the 10 subjects (range, -2.5°-3.5°).

Conclusions: Inflation of the airbladder reduced HF eversion in patients with stage II PTTD at midstance. FF abduction significantly increased although the effect was negligible (mean, 0.2°). FF PF/DF was not significant. These findings suggest FF control was not altered with the inflation of the airbladder. Relocating the airbladder more posterior and lateral may improve the abnormal kinematics associated with PTTD.

Clinical Relevance: This study suggests inflating the airbladder of the Airlift PTTD Brace enhances HF control, protecting secondary ligamentous supports and enhancing muscle function in subjects with PTTD.

OPL10

Influence of Running Shoe Type on Distribution and Magnitude of Plantar Pressures Across the Planus and Cavus Foot

Molloy JM, Yeykal NS, Tragord BS, Neal MS, Nelson ES, Christie DS, McPoil T, Teyhen DS
US Army-Baylor University Doctoral Program in Physical Therapy, Ft Sam Houston, TX; Program in Physical Therapy, Northern Arizona University, Flagstaff, AZ

Purpose/Hypothesis: Although differences in static arch height have been associated with overuse injury, the influence of running shoe type on plantar pressure or contact areas for either planus or cavus feet during gait is unknown. The main purpose was to analyze plantar pressure and mean contact area differences between the planus and cavus foot across 3 shod conditions. A second purpose was to determine the association between static arch height index (AHI) and dynamic modified arch index (MAI).

Number of Subjects: Subjects (n = 524) were screened using AHI. Seventy-five were identified with pes planus (n = 40; AHI, c.< .306) or pes cavus (n = 35; AHI, > .386) based on AHI values L.5 standard deviations above or below the mean.

Materials/Methods: Pressure-sensing insoles were secured to subjects’ feet with antiembolism stockings. Subjects walked on a treadmill at 3.0 mph under 3 conditions: nonsnosh (NS), motion control (MC), and cushioning (C) running shoes. Mean contact area and plantar pressure of the forefoot, midfoot, and rearfoot were determined over 10 steps. Modified arch index (MAI) was calculated by dividing midfoot mean plantar contact area by the entire mean plantar contact area. Modifying pressure index (MPI) was calculated similarly by substituting mean contact pressure for area values. A 2 × 3 mixed model repeated measures ANOVA (α = .05) was performed for each dependent measure (MAI, MPI).

Results: A significant interaction effect was found for MAI between shod condition and arch type (P = .007). For subjects with pes planus there was a significant difference in MAI between NS and both shod conditions (Pc < .001) and between C and MC conditions (Pc < .001). For subjects with pes cavus, significant differences in MAI were found only between NS and both shod conditions (Pc < .001). In either shod condition (MC, C), mean contact area increased in the midfoot (28% planus, 68% cavus) relative to the NS condition. There was no significant interaction effect between MPI and arch type (P = .752), nor a significant main effect for arch type (P = .110). A significant main effect existed for shod condition (Pc < .001). Overall mean contact pressure decreased (~30%) in both shod conditions relative to the NS condition. There was a moderate to good negative correlation between MAI and AHI for all conditions (NS, r = -.68; MC, r = -.70; C, r = -.72).

Conclusions: Both running shoe types tend to increase midfoot mean plantar contact area while decreasing mean pressure across the planus or cavus foot. Also, MC shoe wear resulted in a significant decrease in MAI relative to the C shoe wear for the planus foot. More research is required to determine the influence of running shoe type on foot biomechanics.

Clinical Relevance: Static AHI provides clinicians with a valid indicator of dynamic arch height and an objective, efficient method of assessing arch type.
VARIATIONS IN FOOT POSTURE AND MOBILITY BETWEEN INDIVIDUALS WITH ANTERIOR KNEE PAIN AND CONTROLS

McPoil T, Vicenzino B, Cornwall M, Collins N

Physical Therapy, Northern Arizona University, Flagstaff, AZ

PURPOSE/HYPOTHESIS: The intent of this study was to determine if differences existed in foot posture and mobility between individuals with anterior knee pain (AKP) in comparison to age and gender matched controls (NoAKP).

NUMBER OF SUBJECTS: 88 subjects, 44 with AKP and 44 with NoAKP participated. Each group had 23 women and 21 men. The inclusion criteria for the AKP subjects included a diagnosis of nontraumatic AKP for at least 6 weeks and pain with stair walking or squatting. The NoAKP subjects had no history of lower extremity congenital or traumatic deformity, and acute injury 6 months prior to the start of the study. The mean age of 26 years were recruited to participate in this study. All subjects were asymptomatic at the time of the study.

MATERIALS/METHODS: Each subject had their dorsal arch height (AHwb) and midfoot width (MFwb) assessed at %50 of foot length while placing 50% body weight on each foot. With each leg hanging off a table, the dorsal arch height (AHwb) and midfoot width (MFwb) were again assessed at %50 of foot length. The Arch Height Ratio (AHR) was calculated by dividing AHwb by ball length. The difference in midfoot width (Diff MFW) was calculated by subtracting MFWwb from MFWnwb. The Arch Height Ratio (AHR) was calculated by dividing AHwb by ball length. The diff erence in midfoot width (Diff MFW) was calculated by subtracting MFWwb from MFWnwb. The Arch Height Ratio (AHR) was calculated by dividing AHwb by ball length. The diff erence in midfoot width (Diff MFW) was calculated by subtracting MFWwb from MFWnwb. The Arch Height Ratio (AHR) was calculated by dividing AHwb by ball length. The diff erence in midfoot width (Diff MFW) was calculated by subtracting MFWwb from MFWnwb. The Arch Height Ratio (AHR) was calculated by dividing AHwb by ball length.

RESULTS: ADL subscale scores were diff erent (F1,28 = 36.4; P < .0001) between those with CAI (mean, 88) and normals (mean, 100). Sports subscale scores were diff erent (F1,28 = 84; P < .0001) between those with CAI (mean, 76) and normals (mean, 99). ADL scores were not diff erent (F1,28 = .34; P = .57) between males (mean, 95) and females (mean, 93). Sports subscale scores were also diff erent (F1,28 = 84; P < .0001) between those that reported normal level of function (mean, 88) and those that reported an abnormal level of function (mean, 72). Within this group, ADL subscale scores were not diff erent (F1,28 = 3.1; P = .05) between those that reported normal level of function (mean, 90) from those that reported an abnormal level of function (mean, 87). Using all subjects, signifi cant relationships were found between ADL subscale scores and the ADL global rating (r = .55; P < .0001) and Sports subscale scores and the sports global rating (r = .78; P < .0001).

CONCLUSIONS: The results of this study provide evidence of validity thereby supporting the use of the FAAM for individuals with CAI.

CLINICAL RELEVANCE: The FAAM can be used to assess self-reported level of function in individuals with CAI.
Bone Mineral Density of the Tarsals and Metatarsals after Immobilization and Non-weight-bearing Followed by Reloading

Hastings MK, Commean PK, Gelber JR, Sinacore DR
Physical Therapy, Washington University School of Medicine, St. Louis, MO; Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, MO

Background and Purpose: Loss of bone in the hip and calcaneus during periods of non-weight-bearing or weightlessness and persistence of this reduction after reloading has been documented. The purpose of this case report is to describe the changes in bone mineral density (BMD) of the tarsals and metatarsals of the foot in an individual post nonweight-bearing (NWB) immobilization and after activity reloading.

Case Description: The subject was a 24-year-old female (66 cm, 58 kg) with right talocalcaneal arthrodesis placement of 2 cartilage growth stimulation pick in the talus and modified Brostrom reconstruction. She was NWB for 6 weeks in a boot. Volumetric BMD of all tarsals and metatarsals was measured with quantitative X-ray computed tomography (QCT) (Somatom Sensation 16, Siemens Medical Systems, Inc, Iselin, NJ) 9 weeks after surgery with 3 weeks of resuming weight-bearing activity. Repeat measures were taken 31 weeks after surgery with 25 weeks of weight-bearing activity. The gradual return to sport activity included walking progressing to running, plyometric, and sport-specific activities. Percent differences were calculated for the total foot (all tarsals and metatarsals) and for 4 regions of the foot; tarsals, metatarsals (1-5) and lateral column (navicular, cuneiforms 1-2, metatarsals 1-2) and lateral column (cuboid, cuneiform 3, metatarsals 3-5).

Outcomes: The average BMD of the total foot was decreased 11% (range across tarsals and metatarsals, 2-23%) on the involved side compared to the involved side. Post reloading, total BMD increased an average of 24% on the involved side and 22% on the uninvolved side. The greatest increase in BMD post reloading occurred in the metatarsals bilaterally (involved: mean, 31%; range, 20%-36%; uninvolved: mean, 30%; range, 22%-34%). BMD of the tarsals increased 19% and 15% for the involved and uninvolved respectively. BMD of the medial column increased 19% and 20% (involved and uninvolved respectively) compared to the lateral column which increased 30% and 27% (involved and uninvolved respectively). Post reloading the BMD of the tarsals and metatarsals increased 3% less than the uninvolved side.

Discussion: QCT measures demonstrate a decrease in BMD throughout the foot with immobilization and non-weight bearing. Additionally, the BMD values indicate a relatively quick and substantial increase in bilateral pedal BMD in response to reloading. Increases in BMD with reloading were not uniform across tarsals and metatarsals. We observed greater increases in BMD in the metatarsals and in the lateral column of the foot. Though an increase in BMD occurred bilaterally with reloading, there remained a persistent BMD deficit on the involved side compared to the involved side. Funded by NIH NIDDK DK 59224-05, R21 HD036895-04A1, and IR21 HD048972-01.

Hyaluronan in Human Synovial Fluid: Relationship to Osteoarthritis

Dunn SL, Marino AA
Physical Therapy, LSUHSC, Shreveport, LA; Orthopaedics, LSUHSC, Shreveport, LA

Purpose/Hypothesis: Hyaluronan (HA) is a ubiquitous glycosaminoglycan with pleiotropic functions in health and disease. HA participates in joint health through its rheologic properties in synovial fluid (SF) and its ability to participate in biologic signaling through receptors and soluble proteins. Osteoarthritis (OA) is a progressive joint disease of multifactorial etiology that is propagated by a low-level inflammatory process. Low-molecular-mass-HA is proinflammatory in some cell populations and disease states, but exogenous high-molecular-mass-HA is a bene-
CONCLUSIONS: Eccentric resistance training, implemented 3 weeks after anterior cruciate ligament reconstruction, induced quadriceps and gluteus maximus structural changes that greatly exceeded those following standard rehabilitation. The success of this intervention was attributed to the gradual and progressive exposure to negative work via eccentric exercise, ultimately leading to high muscle force production.

CLINICAL RELEVANCE: Focused eccentric training may safely assist in mitigating persistent muscle impairments commonly observed after anterior cruciate ligament reconstruction.

OPL18

EFFECTS OF EARLY PROGRESSIVE ECCENTRIC EXERCISE ON MUSCLE STRUCTURE AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

Gerber JP, Marcus RL, Dibble Le, LaStayo PC, Greis PE, Burks RT

PURPOSE/HYPOTHESIS: The hypothesis was that discomfort/fatigue and Txtime (treatment time/session) would be less in the GISTM group.

RESULTS: Discomfort/fatigue and Txtime were significantly lower in the TISTM group, indicating that the GISTM instruments were more efficient than the TISTM instruments.

CLINICAL RELEVANCE: The results of this study suggest that the use of specially designed ISTM instruments, the Graston Technique (GISTM), with a traditional instrument, the reflex hammer, on therapist discomfort/fatigue and treatment time/session (Txtime). The hypotheses were that discomfort/fatigue and Txtime would be less in the GISTM group.

OPL19

A COMPARISON OF 2 INSTRUMENT-ASSISTED SOFT TISSUE MOBILIZATION TECHNIQUES: EFFECTS ON THERAPIST DISCOMFORT/FATIGUE AND TREATMENT TIME

Hayes D, Loghmcri MT, Lubitz R, Moore E

PURPOSE/HYPOTHESIS: The purpose of this study was to compare the effects of specially designed ISTM instruments, the Graston Technique (GISTM), with a traditional instrument, the reflex hammer (TISTM) on therapist discomfort/fatigue, and treatment time/session (Txtime). The hypotheses were that discomfort/fatigue and Txtime would be less in the GISTM group.

RESULTS: Discomfort/fatigue and Txtime were significantly lower in the TISTM group, indicating that the GISTM instruments were more efficient than the TISTM instruments.

CLINICAL RELEVANCE: The results of this study suggest that the use of specially designed ISTM instruments, the Graston Technique (GISTM), with a traditional instrument, the reflex hammer, on therapist discomfort/fatigue and treatment time/session (Txtime). The hypotheses were that discomfort/fatigue and Txtime would be less in the GISTM group.
LONG-TERM EFFECTS OF INSTRUMENT-ASSISTED CROSS-FIBER MASSAGE ON HEALING MEDIAL COLLATERAL LIGAMENTS
Department of Physical Therapy, Indiana University, Indianapolis, IN

PURPOSE/HYPOTHESIS: Ligament injuries are a common clinical condition often resulting in significant patient morbidity. We previously showed instrument-assisted cross-fiber massage (IACFM) to accelerate early ligament healing. The aim of the current study was to determine whether this early acceleration results in improved ligament healing long-term.

NUMBER OF SUBJECTS: Controlled animal study (25 female Sprague-Dawley rats [age, 6 months; weight, 280-300g]).

MATERIALS/METHODS: 20 animals underwent bilateral surgical transection of their medial collateral ligaments (MCL). Five animals were used as cage controls. Animals were allowed to resume normal activity upon surgical recovery. IACFM using a rigid tool fabricated from stainless steel (Graston Technique) was initiated 7 days post-operatively. IACFM was delivered for 1 minute to the left MCL while the animal was under isoflurane anesthesia, 3 times/week for 10 weeks for a total of 30 sessions. The contralateral limb served as an internal control and did not receive IACFM. All animals were euthanized 12 wks postoperatively and both MCLs were harvested for mechanical testing on an electromagnetic material testing device. Ligaments were pulled to tensile failure while force and displacement data were collected. Energy to failure (mJ), ligament stiffness (N/mm), and ultimate force (N) were determined for all ligaments. Paired t-tests were performed to compare IACFM-treated and contralateral untreated injured ligaments. In addition, mean percentage differences and their 95% confidence intervals (CIs) between treated and untreated ligaments were determined.

RESULTS: mean ± SD percentage difference in stiffness between IACFM-treated and contralateral untreated ligaments was 15.4% (95% CI, 0.1%-30.70%; P<.05). No differences were observed in energy to failure or ultimate force (all P>.05). Biomechanical properties in injured ligaments remained lower than in intact ligaments from cage controls.

CONCLUSIONS: This controlled animal study found IACFM to improve biomechanical properties of ligament healing. IACFM treated ligaments were stiffer than within-animal control ligaments after 12 wks of healing. The methodology used in this study was identical to our prior study which demonstrated accelerated ligament healing, except treatment was administered over a longer period in this study (10 weeks instead of 3). All biomechanical properties remained inferior to those of normal ligaments.

BIOJECTIVE RELEVANCE: The results of this animal model study indicate that IACFM is a beneficial intervention for providing mechanical stimulation to repairing ligaments to improve ligament stiffness. IACFM has been shown to accelerate ligament healing (prior study) and to improve ligament stiffness. Future research will need to investigate whether improved MCL stiffness decreases ligament laxity and improves joint stability. Additional studies are needed.


**CONCLUSIONS:** The HOS is a responsive and reliable self-reported outcome instrument for individuals with the diagnosis of a labral tear who undergo arthroscopic hip surgery. Clinical Relevance: The results of this study allow HOS scores to be interpreted when describing patient-centered outcomes. This work was supported by the Steadman-Hawkins Foundation and a grant from the Orthopaedic Section of the American Physical Therapy Association.

**EVIDENCE OF VALIDITY FOR THE HIP OUTCOME SCORE (HOS) IN THE OUTCOME ASSESSMENT OF HIP ARTHROSCOPY**

**Martin RL, Philippon MJ**

Physical Therapy, Duquesne University, Pittsburgh, PA; Steadman-Hawkins Foundation, Vail, CO

**PURPOSE/HYPOTHESIS:** The objective of this study was to provide evidence for the usefulness of the HOS as a self-reported instrument in the outcome assessment of hip arthroscopy. It was hypothesized that HOS scores would relate to measures of physical function while not unduly relate to measures of mental functioning. It was also hypothesized that HOS scores would be different based on current activity level, surgical outcome, and degree of preoperative arthritis.

**NUMBER OF SUBJECTS:** 116 subjects.

**MATERIALS/METHODS:** Subjects completed the HOS and SF-36 and returned them via mail. Diagnostic imaging was used to determine the degree of arthritis according to the Kellgren-Lawrence scale. Pearson correlation coefficients were used to assess the relationship between the SF-36 and HOS. As evidence for validity one-way ANOVA was used to determine if HOS scores differed according to reported level of function, outcome, and degree of arthritis.

**RESULTS:** Subjects consisted of 61 (53%) males and 55 (47%) females with an average age of 41 (18-79) and average time to follow-up 3 years (range, 0.8-4.6 yr). The following procedures were performed: labral debridement and/or repair (91%), osteochondral plasty for femoral acetabular impingement (60%), chondral debridement-microfracture (51%) and/or capsular tightening (37%). Subjects were given the HOS to complete during pre and postoperative clinic visits. The time between surgery and the second completion of the HOS averaged 7 months for both the group that changed (range, 55-420 days, SD, 96) and the group that remained stable.

**MATERIALS/METHODS:** Subjects had mean age of 41 (range, 13-80; SD, 16) with 47% being male and 53% being female. All subjects had the primary diagnosis of an acetabular labral tear and underwent arthroscopic hip surgery. The following procedures were performed: labral debridement and/or repair (91%), osteochondral plasty for femoral acetabular impingement (60%), chondral debridement-microfracture (51%) and/or capsular tightening (37%). Subjects were given the HOS to complete during pre and postoperative clinic visits. The time between surgery and the second completion of the HOS averaged 7 months for both the group that changed (range, 55-420 days, SD, 96) and the group that remained stable (range, 55-399 days, SD, 99). Responsiveness was assessed using 2-way repeated-measures ANOVA, Gyatt’s Responsiveness Index (GRI), and ROC analysis. Test-retest reliability was assessed with intraclass correlation coefficient (ICC) using the group that remained stable.

**RESULTS:** Two-way repeated-measures ANOVA found the ADL and Sports subscales were responsive to change in status (P<.0005). GRI values were 3.1 (95% CI, 2.5-3.6) and 2.6 (95% CI, 2.1-3.1) for the ADL and Sports subscales respectively. These 95% CIs did not contain zero indicating the subscales were responsive to change in status. The area under the ROC curves for the ADL and Sports subscales were .88 (95% CI, .80-.95) and .90 (95% CI, .83-.97). These 95% CIs did not contain 0.5 indicating the subscales were responsive to change in status. The ROC analysis for the ADL subscale found a minimal clinically important difference (MCID) value of 9 points to be associated with a sensitivity and specificity of .82 and .89, respectively. For the Sports subscale, a MCID value of 6 points was associated with a sensitivity and specificity of .85 and .87, respectively. The ICC values were .98 and .92 for the ADL and Sports subscales respectively. Minimal detectable changes (MDC) based on 95% CI were ±3 points for both the ADL and Sports subscales.

**CONCLUSIONS:** The HOS can be used as a self-report instrument to assess the outcome of hip arthroscopy. This project was supported in part by a grant from the Steadman-Hawkins Foundation.
The long road: Rehabilitation and functional recovery from latissimus dorsi transfer after 3 failed rotator cuff repairs

Hunter-Giordano AO, Snyder-Mackler L

Physical Therapy, University of Delaware, Newark, DE

Background and purpose: Rotator cuff repair surgeries are continuously improving and becoming less invasive, but in the case of multiple failed rotator cuff repairs, latissimus dorsi transfer is a salvage procedure that may result in a functional recovery. The purpose of this case is to present an intervention that helped to improve the quality of life for an older gentleman who was unable to lift his arm for activities of daily living such as eating, after 3 failed rotator cuff repairs and therefore underwent a latissimus dorsi transfer.

Case description: A 69-year-old retired delivery man was referred to our clinic by a local physical therapist for a 1-visit consultation 6 months after his third rotator cuff repair. At this time, he had gone through extensive physical therapy and was still unable to use his involved (dominant) arm even to feed himself. The consultation resulted in referral to a tertiary care shoulder service and he subsequently underwent a latissimus dorsi transfer. Initial evaluation occurred 3 months after the transfer surgery. He had nearly full PROM, but AROM of flexion and abduction was extremely limited and involved shoulder shrugging and other substitution maneuvers. His rotator cuff weakness was profound with only Trace external rotation and Poor minus abduction. The disability of the arm, shoulder and hand (DASH) score was 73% (lower is better). He had moderate pain at all times (even at night) and expressed frustration that he had not improved his function since the surgery and was actually in more pain. He was seen for 35 visits over a 5-month period. Rehabilitation that focused on isolation of the latissimus dorsi and retraining to fire during abduction (including FES triggered to the active posterior anchors) and substitution maneuvers. His rotator cuff weakness was profound with only Trace external rotation and Poor minus abduction. The disability of the arm, shoulder and hand (DASH) score was 73% (lower is better). He had moderate pain at all times (even at night) and expressed frustration that he had not improved his function since the surgery and was actually in more pain. He was seen for 35 visits over a 5-month period. Rehabilitation that focused on isolation of the latissimus dorsi and retraining to fire during abduction (including FES triggered to the active posterior anchors) and substitution maneuvers. His rotator cuff weakness was profound with only Trace external rotation and Poor minus abduction. The disability of the arm, shoulder and hand (DASH) score was 73% (lower is better).

Outcomes: At discharge, he had isolated flexion and abduction AROM of 90° and 75° with isolated abduction MMT grade of Poor plus. He had no pain with rest or activities and was able to return to cooking, cleaning of 90° and 75° with isolated abduction MMT grade of Poor plus. He had moderate pain at all times (even at night) and expressed frustration that he had not improved his function since the surgery and was actually in more pain. He was seen for 35 visits over a 5-month period. Rehabilitation that focused on isolation of the latissimus dorsi and retraining to fire during abduction (including FES triggered to the active posterior anchors) and substitution maneuvers. His rotator cuff weakness was profound with only Trace external rotation and Poor minus abduction. The disability of the arm, shoulder and hand (DASH) score was 73% (lower is better).

Discussion: Latissimus dorsi transfer surgery has been shown to improve pain and function in those with irreparable rotator cuff repair. This salvage procedure that may result in a functional recovery. The purpose of this case is to present an intervention that helped to improve the quality of life for an older gentleman who was unable to lift his arm for activities of daily living such as eating, after 3 failed rotator cuff repairs and therefore underwent a latissimus dorsi transfer.

Does rehabilitation intensity affect the prognosis of a functional recovery in a skeletally immature female elite gymnast with a nonreduced type-2 manubriosternal dislocation?

Pidcoe P

Physical Therapy, Virginia Commonwealth University, Richmond, VA

Background: A 15-year-old female Elite gymnast suffered a type II manubriosternal dislocation while attempting a Takachev drill on the uneven parallel bars. The precipitating event occurred when she released the high bar prematurely and made contact with the low bar in a “chest-first” fashion. Bar contact was at the level of the xyphoid process with the arms overhead in 180° of shoulder flexion. Rapid deceleration caused cervical flexion, shoulder extension, thoracic flexion, and hip flexion. This resulted in a type II manubriosternal dislocation with sternal fracture and an inferior overlap of superior components by approximately 1 cm. A decision was made to monitor the defect and implement progressive physical therapy in hopes of achieving a stable union. Based on clinical judgment, the prognosis of return to previous levels of activity was poor.

Purpose: To describe the successful treatment of this injury using progressive loading techniques that stimulated bone growth and union of the dislocated structures.

Case description: Rehabilitation began postinjury week 2 and included a LE maintenance program to maintain a base-level of conditioning. Upper extremity rehabilitation began in week 4. Progression was determined by radiographic evaluation and the patient’s reported comfort during therapeutic activities. UE closed-chain activities began in week 7, placing the nonunion in compression. Dynamic loading activities (tension and compression) began in week 9 with evidence of bone remodeling by week 13. Outcomes: Type II dislocations are rare and often life threatening. This nonunion nonreduced fracture-dislocation was treated successfully using techniques that included traction induced osteogenesis and progressive mechanical loading. The athlete returned to her previous level of gymnastics competition.

Discussion: The 13-week rehabilitation process included approximately 200 contact hours (4 to 5 days per week, 3 to 4 hours per day) and was guided by a biomechanical hierarchy. Patient prognosis for return to Elite gymnasium activities shifted from poor (in week 2 to very good by week 13). During the therapeutic progression, the manubriosternal joint was subjected to compressive and tensile forces ranging from 34 to 78, which is roughly 100 to 200 Newtons. A conservative estimate of cyclical loading during a 4-hour session would be in excess of 100 cycles. If return to previous level of activity is used as the benchmark, the rehabilitation process was a success when evaluated at a 1-year follow-up.

Interrater reliability of a behaviorally anchored lift task evaluation

Phillips HJ, Samples B, Iden L, Manns A, Wilk T

Doctor of Physical Therapy Program, Seton Hall University, S. Orange, NJ; Bergen P. T. Associates, Elmwood Park, NJ

Purpose/hypothesis: The purpose of this study was to determine the interrater reliability of 2 physical therapists using a newly developed lift task evaluation that is based on patient kinesiophysical signs of exertion and pain behavior anchors. Assessment of patients’ ability to perform safe, maximal lifting tasks are often used to determine physical and functional ability, and form the basis of many functional capacity evaluation protocols. However, studies looking at the reliability of evaluations purported to measure patient effort and pain reports are lacking.

Number of subjects: A sample of 30 consecutive patients seen for functional capacity testing were drawn from an outpatient physical therapy office over a 3-month period.

Materials/methods: Patients performed twelve-inch-to-waist, waist-to-shoulder, and shoulder-to-overhead lifting tasks, using incrementally heavier boxes. Each evaluator selected 1 of 2 choices in each of 10 categories based on behavioral descriptors of subject exertion and pain behaviors on a tabled form. Evaluators alternated role of test administrator and observer, and independently recorded their results for each subject.

Results: Percentage agreement ranged from 76% to 93% for individual categories, with an overall kappa coefficient of 0.81, showing excellent agreement between the raters.

Conclusions: A newly developed, behaviorally-anchored lift task evaluation protocol demonstrated excellent interrater reliability in determining patient levels of exertion and pain behaviors.

Clinical relevance: Studies that examine the reliability of safe maximal lifting tasks are limited. This study demonstrated excellent reliability of a lift task assessment protocol based on patient exertion and pain behavior anchors. Further studies are needed to validate the utility of this protocol as a patient assessment and management tool.
OPL28

EFFECT OF AN IN-HOUSE COMPREHENSIVE MANAGEMENT PROGRAM ON INJURY RATES AND HEALTHCARE COSTS
Ojofeitimi S, Bronner S
ADAM Center, Long Island University, Brooklyn, NY

PURPOSE/HYPOTHESIS: Work-related injuries strain the finances of many dance companies. The financial strain is particularly evident in modern companies, which tend to have smaller budgets than ballet companies. Several companies have implemented in-house medical and therapy services to reduce the financial impact of such injuries (Bronner, Ojofeitimi, and Roe, 2003; Garrick and Requa, 1993; Solomon, Solomon, Micheli, and McGary, 1999). Previously, we published our findings on the effectiveness of our on-site case management and intervention program with regard to injury incidence, time loss, and patterns of musculoskeletal injury in a professional modern dance company. The program reduced annual workers’ compensation (WC) cases from 81% to 17%, and decreased lost workdays by 60% over a 3-year period (Bronner et al, 2003). However, effect of this program on healthcare costs was not examined. The purpose of study is to examine the effects of our comprehensive management program on injury rates, workers’ compensation claims, experience modification ratio (EMR), and healthcare costs, comparing the preintervention (2 years) and an extended postintervention period (3 years).

NUMBER OF SUBJECTS: n = 42.

MATERIALS/METHODS: Preintervention injury related data were collected retrospectively from the New York Compensation Insurance Rating Board (NYCIRB) and cross checked with data from the company controller, stage manager reports and individual dancer files. Postintervention data were collected prospectively by physical therapists from the same sources. Preintervention (2 years) and postintervention (6 years) number of injuries, WC claims, WC premiums per payroll dollar, experience modification ratios (EMR) and direct (medical and indemnity) injury-related costs were analyzed for this study. Total number of injuries and number of days lost due to injury were compared across the 8 years in a multivariate analysis of variance (MANOVA) design with 2 between factors, group (first and second companies) and gender (male and female), and 1 within factor, year (years 1 to 8). Differences were considered significant at the P<0.05 level.

RESULTS: The EMR was 0.92 and 1.09 in preintervention years 1 and 2, respectively, and increased to a high of 1.46 in postintervention year 3. The EMR began to decline in postintervention year 4 and remained less than 1.00 in years 5 and 6. Worker’s compensation premiums as percent of payroll decreased from 3.05% in preintervention year 1 to 2.36% in postintervention year 6. Preintervention and postintervention injury rates, new workers’ compensation claims, and days lost will be reported.

CONCLUSIONS: The effectiveness of this program is substantiated by reduction in new workers’ compensation claims, EMR, and healthcare costs.

CLINICAL RELEVANCE: This study highlights the benefits for practitioners of understanding both medical and financial issues when establishing in-house dance medicine programs.

OPL30

INJURY PATTERNS IN ELITE ADOLESCENT PREPROFESSIONAL BALLET DANCERS AND THE USE OF SCREENING DATA TO DESCRIBE AND PREDICT INJURY CHARACTERISTICS
Gambou JM, Roberts LA, Mahrer J, Andrea F
Body Dynamics, Inc, Ar lington, VA; LAR Physical Therapy, Ellicott City, MD; Physical Therapy, George Washington University, Washington, DC; Physical Therapy, Shenandoah University, Winchester, VA

PURPOSE/HYPOTHESIS: The purposes of this study were to describe the frequency and distribution of injuries, the differences between noninjured and injured, and possible risk factors for injuries in elite adolescent ballet dancers.

NUMBER OF SUBJECTS: 207.

MATERIALS/METHODS: 207 dancers, aged 9 through 20 years, were included in preseason screenings over 3 years (2001-2004). Screening data were collected at the beginning of each year in 6 categories. Injury data were collected at the end of the school year and classified by region, side, nature, and month.

RESULTS: Injury rates increased each year (1.26, 1.34, 1.44 injuries per injured dancer) although the percentage of dancers injured (40.0%, 45.1%, 49.9%) remained similar. The order of most to least common area of injury was: foot/ankle (45.8-55.6%), hip (11.5%-45.8%), knee (4.2%-20%), and back (4.2%-9.3%). Few significant differences were identified among screening variables between injured and noninjured dancers. Due to the high incidence among this population, FHL tendinitis is commonly referred to as “dancer’s tendinitis.” Symptoms of FHL tendinitis include pain and swelling posterior and inferior to the medial malleolus, crepitus and triggering of the first toe, range of motion limitations, and pain with resisted plantar flexion of the first toe. The FHL stretch test is useful diagnostically, with a positive test yielding complaints of discomfort or pain at the tendon with palpation. FHL tendinitis can often be painful, disabling, and detrimental to a dancer’s career. It is important for those involved in the treatment of dancers to have a thorough understanding of this problem and the different treatment options available to facilitate a timely recovery. This case report describes the clinical evaluation, differential diagnosis and treatment approaches for FHL tendinitis.

CASE DESCRIPTION: A 17-year-old female dancer presented with complaints of bilateral ankle and calf pain. Her symptoms included tenderness at the posterior ankle, medial to the Achilles tendon, and pain with initiation of jumps. Increased pain was elicited with resistance to great toe plantar flexion and with a stretch to the FHL tendon. Physical therapy interventions included: modalities for pain, massage, strengthening exercises to improve dance technique, modifications to class, and recommendation of supportive shoes for nondance activities. She was given a home exercise program for stretching and strengthening. At her follow-up visit, she reported a decrease in symptoms. Treatment focused on further evaluation of her dance technique.
CONCLUSIONS: The nature and location of injuries found in this study was similar to other studies. The injury rate, however, was considerably lower. Few differences were found between injured and noninjured dancers, which is counter to many dance medicine assumptions.

CLINICAL RELEVANCE: The practicality of screening programs should be carefully considered until more specific, reliable and valid tests for injury prediction and prevention can be established.

OPL31

THE GYMNASTICS FUNCTIONAL MEASUREMENT TOOL: PILOT VALIDATION OF A PHYSICAL ABILITIES FIELD TEST FOR COMPETITIVE GYMNASTS

Sleeper MD, Wildeboer M, Strobel M, Schornak E, Passaglia J, Meyer J, Erwin M, Beers M

Physical Therapy and Human Movement Science, Northwestern University, Chicago, IL

PURPOSE/HYPOTHESIS: To compete successfully in the sport of gymnastics, high degree of physical abilities are needed. The analysis of competitive gymnasts’ physical fitness has largely been based on team tradition and observation. Individual field-tests that assess the generic physical abilities of flexibility, strength, speed, and power have been shown to be reliable and valid measurements in a sport-specific context. Until the Gymnastics Functional Measurement Tool (GFMT), no field test or measurement tool had been developed to reliably assess the collection of physical attributes needed for success in competitive gymnastics. The GFMT was designed to measure the gymnasts’ flexibility, speed, agility, strength, balance, and power, without measuring gymnastic skill. The 10 components to the GFMT include timed rope climb, hanging pikes, handstand hold, over grip pull-ups and standard push-ups; agility test and 20-meter sprint; vertical jump for height and measurements of hip/pelvis and shoulder flexibility. Individually, these tests can be used to assess and monitor specific physical abilities needed by gymnasts to resist injury and successfully compete. Combined, these tests are designed to score gymnasts’ overall physical fitness level on a 0 to 100 scale. The purpose of this study was to assess the construct validity of the GFMT as a measurement of applied gymnastic physical ability testing the hypothesis that there would be a positive linear relationship between an athlete’s GFMT score and her current competition level, which is currently the gold standard for performance ability.

NUMBER OF SUBJECTS: 51 level 4 to level 10 competitive gymnasts (ages 6-18)

MATERIALS/METHODS: After obtaining gymnast and parent IRB-approved informed consent, the gymnasts were tested using the GFMT. The data were analyzed using linear regression to calculate the coefficient of determination ($r^2$).

RESULTS: Total GFMT scores range from 20 to 78 out of a possible 100 points. There was a strong positive linear relationship between the GFMT total score and gymnastic competitive level ($r^2 = 0.9663$).

CONCLUSIONS: Initial testing of the GFMT appears to support its construct validity pertaining to the physical abilities possessed by competitive gymnasts.

CLINICAL RELEVANCE: The practicality of screening programs should be carefully considered until more specific, reliable and valid tests for injury prediction and prevention can be established.

OPL32

COMPREHENSIVE INJURY SURVEILLANCE OF DANCE INJURIES: A PROPOSAL FOR UNIFORM REPORTING GUIDELINES FOR PROFESSIONAL COMPANIES

Bronner S, Ojofeitimi S, Mayers L

ADAM Center, Long Island University, Brooklyn, NY; Sports Medicine, Pace University, Pleasantville, NY

PURPOSE: Varying methods of injury definition, data collection and interpretation of findings complicate analysis of results from epidemiological studies of sport and dance injuries. Comparison between studies is therefore difficult. There are currently no standards or guidelines for tracking injury incidence and patterns in the dance community. Researchers have suggested adoption of uniform methodology for injury definition and reporting. To this end we are presenting a comprehensive injury reporting system for professional dance companies.

DESCRIPTION: Components of a comprehensive injury surveillance system include: (1) preseason screening of intrinsic risk factors, (2) extrinsic risk factor tracking, and (3) injury occurrence reporting system. Dance screens provide healthy baseline data, uncover existing pathology, and help define population characteristics. Extrinsic risk factor tracking includes quantification of exposure to specific environment, equipment, and technique demands. Exposure may be delineated as activity (number of performance, class, and rehearsal events) or time (hours of participation in dance activities) based. These exposure measures are incorporated into incidence calculations, enabling injury rate comparison between populations. Standardized injury definitions are proposed to facilitate the comparison of injury rates. We propose defining injury as any physical complaint sustained by a dancer resulting from performance, rehearsal, or technique class. Injury is further delineated in the following ways: (1) physical complaint injury, (2) medical injury, (3) time-loss injury, and (4) financial injury. Coding by severity, injury type, location, tissue, activity, and style of dance and choreography is also included.

SUMMARY OF USE: These tools were derived from our comprehensive injury management and surveillance program developed over the last 8 years at a modern dance organization, which includes 2 companies and a large dance school. Following an extensive literature review, we attempted to incorporate the recommendations of sports medicine researchers, while making dance-specific modifications to reflect this population. This system has enabled us to ascertain the effectiveness of our program in reducing new workers compensation cases and to calculate the financial savings resulting from our program.

IMPORTANT TO MEMBERS: We anticipate this may ultimately result in uniform injury registration for dancers of all ages and ability levels. Adoption of a common system should result in improved understanding of injury incidence and risk factors with potential to increase the effectiveness of injury prevention interventions and rehabilitation. We hope this provides groundwork for further dialogue.

OPL33

DIRECT MEASUREMENT OF THE STERNOCLAVICULAR AND ACROMIOCLAVICULAR JOINTS DURING ELEVATION OF THE ARM

Ludwig PM, Phadke V, Hassett DR, Cieniinski CJ, Braman JP, LaPrade RF

Program in Physical Therapy, University of Minnesota, Minneapolis, MN; Orthopaedic Surgery, University of Minnesota, Minneapolis, MN

PURPOSE/HYPOTHESIS: Scapular motions on the thorax are directly associated with sternoclavicular (SC) and acromioclavicular (AC) joint motions. However, limited data are available on how these specific joints function during elevation of the arm. The purpose of this study was to precisely measure active SC and AC joint motions comparing across planes of elevation (frontal, sagittal, scapular) and between raising and lowering of the arm.

NUMBER OF SUBJECTS: Ten subjects (5 male, 5 female) with no history of shoulder pathology. Nondominant arms were tested for all but 2 subjects.

MATERIALS/METHODS: Electromagnetic motion sensors (Flock of Birds mini-birds) were rigidly attached to bony segments of the clavicle, scapula and humerus via intracortical pins placed under sterile procedures by an orthopaedic surgeon. A surface sensor monitored trunk motion.
Antomical landmarks were digitized to establish clinically meaningful reference frames for each segment. Subjects completed 2 repetitions of raising and lowering the arm in flexion, scapular, and abduction planes. Three-dimensional SC (clavele relative to the trunk) and AC (scapula relative to the clavicle) joint angles were extracted from the continuous motion data at 30°, 60°, 90°, and 120° of humeral elevation relative to the trunk. A 3-way repeated-measures ANOVA tested for effects of plane of elevation, phase of elevation (raising or lowering) and elevation angle (30-120) using a significance level of P<.05.

RESULTS: The general pattern of motion at the SC joint was retraction, elevation, and posterior rotation during elevation of the arm in all planes. The predominant rotation was posterior axial rotation, averaging 25° by 120° of arm elevation. Significant differences existed across planes of elevation. The clavicle was significantly more retracted (14° difference) and elevated (4° difference) in abduction versus flexion. At the AC joint, the general pattern of motion during arm elevation was upward rotation, internal rotation, and posterior tilting. The predominant rotation was posterior tilting averaging 12° by 120° of arm elevation. The scapula was significantly more internally rotated relative to the clavicle (4° difference) during flexion and more posteriorly tilted (3° difference) in scapular plane abduction as compared to other planes of elevation. The AC joint was significantly more internally rotated when lowering as compared to raising the arm.

CONCLUSIONS: Significant angular motion occurs at both the SC and AC joints during elevation of the arm. Differences between planes of elevation are greatest for the SC joint. Few differences were present between raising and lowering the arm in these healthy subjects.

CLINICAL RELEVANCE: Scapular motion abnormalities have been identified in clinical populations with shoulder pain. Understanding how normal and abnormal SC and AC joint motions contribute to scapular motion on the thorax is important foundational knowledge for planning scapular focused treatment programs for patients with shoulder pain.

OPL34

ULTRASONOGRAPHIC MEASUREMENT OF THE ACROMIOHUMERAL DISTANCE IN PATIENTS WITH ROTATOR CUFF DISEASE: A PILOT STUDY
Michener L, Kaira N, Pinkstaff S, Ericksen J, Boardman ND
Physical Therapy, VCU-ACV Campus, Richmond, VA; VCU/HSV Virginia Commonwealth University, Richmond, VA

PURPOSE/HYPOTHESIS: Changes in subacromial space dimensions have been demonstrated in patients with rotator cuff disease (RC), using radiographs and MRI. However, these techniques are expensive and have limitations. Radiographic beams superimpose bone images thus leading to projectional artifacts, while MRI techniques are lengthy and costly.

MATERIALS/METHODS: All subjects were seated, with their shoulder elevated. A 7.5-MHz US probe was placed on the superior posterior shoulder, adjusted to obtain the image of the acromion and humeral head without superimposition. Four images were captured and saved at 4 test positions of the shoulder: rest, 45° of shoulder abduction, 60° of shoulder abduction, and 90° of shoulder flexion. For all test positions except rest, the subject maintained the position of the shoulder actively while the image was captured. Images were captured in consecutive order, to control for the effects of pain with higher shoulder elevation angles. The sequence of testing was then repeated, for a total of 2 images at each of the 4 shoulder positions. Blinded measurements of the subacromial space were performed using the saved images, by measuring the acromio-humeral distance (AHD) with an on-screen ruler. The AHD was defined as the shortest distance between the most inferior aspect of the acromion and the most superior aspect of the humeral head.

RESULTS: Test-retest reliability and standard error of the measurement for the AHD measurements were calculated for each shoulder test position using all subjects. Reliability coefficients [ICC] across the 4 test positions ranged from 0.80 to 0.88. The standard error of measurement (90% CI) ranged from 1.0 to 1.6 mm. Discriminate validity will be examined by comparing the AHD measure at all 4 test positions between 3 groups: subjects without shoulder pain, subjects with partial thickness RC tears, and those with impingement syndrome. Discriminate validity analysis was not performed due to the low number of subjects with RC disease.

CONCLUSIONS: Measurement of the subacromial space via US measurement of the AHD in patients with and without shoulder pain is reliable. However, due to the low number of subjects with RC disease in this pilot study, results should be applied with caution to subjects with RC disease until further analysis of the reliability and validity of this measurement technique.

CLINICAL RELEVANCE: This US measurement technique of the subacromial space may be useful to examine the mechanisms of RC disease, and to enhance the understanding of treatment approaches for RC disease.

OPL35

THE EFFECTIVENESS OF TRANSLATIONAL MANIPULATION UNDER INTERSCALENE BLOCK FOR TREATMENT OF ADHESIVE CAPSULITIS OF THE SHOULDER: A PROSPECTIVE CLINICAL TRIAL
Rendeiro DG, Majkowski GR, Lee IE, Gill NW, Jensen DA, Doyle GD, Wainner RA, Overbaugh R
US Army-Baylor University Postprofessional Doctoral Program in Orthopaedic and Manual Physical Therapy, Brooke Army Medical Center, Fort Sam Houston, TX; Anaesthesiology/Pain Management, The Pennsylvania State University Medical Center, Hershey, PA

PURPOSE/HYPOTHESIS: Translational manipulation under anaesthesia has been shown in several case series to improve range of motion and function in patients with adhesive capsulitis (AC) of the shoulder. However, this form of intervention has not been directly compared to traditional manual physical therapy treatment in a prospective trial. The purpose of this clinical trial was to determine whether translational manipulation under anaesthesia combined with joint mobilization and exercise is more effective than joint mobilization and exercise alone in treating patients with AC.

NUMBER OF SUBJECTS: Seventeen consenting patients (10 female, 7 male) with a primary diagnosis of AC. Mean age was 53 years (range, 40-76 years). Mean duration of symptoms was 22 weeks (range, 6-74 weeks), and the mean baseline Shoulder Pain and Disability Index (SPADI) score was 56 (range, 11-89).

MATERIALS/METHODS: Prospective controlled trial. Patients in the treatment group received an initial session of translational manipulation under interscalene block, followed by 6 additional sessions of impairment-based mobilization and a standardized therapeutic exercise program for the involved upper quarter. Outcome measures taken at baseline and 3 weeks as well as 3, 6, and 12 months were assessed using the Shoulder Pain and Disability Index (SPADI), the OARS Pain Scale, and a visual analog scale.

RESULTS: Both groups showed improved SPADI and CROM outcomes across all follow-up times compared to baseline. The treatment group showed a greater improvement (57%) in SPADI scores than the comparison group (35%) at 3 weeks (P = .021), but no subsequent between-group differences were significant. Between-group differences in average

JOURNAL OF ORTHOPAEDIC & SPORTS PHYSICAL THERAPY | VOLUME 37 | NUMBER 1 | JANUARY 2007 | A23
CROM scores were not significant at any follow-up time point.

**CONCLUSIONS:** Patients with AC who undergo translational manipulation under anaesthesia may experience a more rapid reduction of pain and disability than those patients receiving manual therapy and exercise alone.

**CLINICAL RELEVANCE:** This is the first study to prospectively compare translational manipulation with a comparison treatment in patients with AC. Translational manipulation may be a useful adjunct to joint mobilization and exercise in treating patients with AC.

---

**OPL37**

**EFFECT OF 2-SPEED MANUAL WHEELCHAIR WHEEL ON SHOULDER PAIN IN WHEELCHAIR USERS**

Finley M, Rodgers MM

Physical Therapy and Rehabilitation Science, University of Maryland/BVAMC, Baltimore, MD

**PURPOSE/HYPOTHESIS:** Up to 80% of today’s manual wheelchair users (MWCU) suffer from shoulder pain. The purpose of this study was to investigate the impact of a new manual 2-gear drive wheelchair wheel (Magic Wheels, Seattle, WA) on shoulder pain in MWCU.

**NUMBER OF SUBJECTS:** Seventeen MWCU with shoulder pain (mean age = 46.8 ± 14.1 years; years WC use, 15 ± 10.8) enrolled in the study.

**MATERIALS/METHODS:** The protocol included a 4-week baseline phase (no intervention) using personal wheels (PW) and a 5-month 2-gear wheel phase. Subjects completed the Wheelchair Users Shoulder Pain Index (WUSPI), Wheelchair Users Functional Assessment (WUFUA) using PW, and a timed hill test (20 m, 20° incline) with relative perceived exertion (RPE) using PW and MW. To determine stability of shoulder pain prior to intervention, 4 weekly WUSPI surveys were completed during the PW phase. The percentage change in WUSPI compared with average baseline was determined at weeks 1 through 4 of 2-gear wheel use (n = 17), and weeks 8 (n = 15), 12 (n = 15), 16 (n = 13), and 20 (n = 11). Differences in repeated baseline measures and pre- and post-2-gear wheel phase were determined using ANOVA (P < .05).

**RESULTS:** Mean baseline WUFUA (Max score = 91) of participants was 77.5 ± 2.0 indicating a relatively high level of independent function and activity. Shoulder pain was found to be stable (P = .40) prior to intervention. The mean WUSPI score using PW was 50.5 ± 5.2. Significant reduction in shoulder pain with the 2-gear wheel intervention was found at week 2 (P = .004) and continued at every week through week 16 (P = .002). The difference was not found at week 20; however, 1 participant reported a significant increase in pain during week 20 due to factors unrelated to the study. This subject had experienced reduced pain throughout all weeks of 2-gear wheel use. Significant reduction in shoulder pain (P = .002) resulted when the percentage change from baseline was calculated using this subject’s data (−57.7 ± 13.3%). No difference was found in WUFUA after using the 2-gear wheel (pre-2-gear wheel = 79.7 ± 2.5, post-2-gear wheel = 81.0 ± 1.9, P = .11). Time to climb the hill was significantly longer using the 2-gear wheel (P = .04), but no difference in the RPE (P = .39) resulted. No difference was found between the pre and post testing hill climbing time or RPE using the PW or when using 2-gear wheel.

**CONCLUSIONS:** Pain reductions were noted as early as 2 weeks after using the 2-gear wheel indicating a relatively rapid response to the intervention. We attribute the lack of change in the WUFUA to a ceiling effect—participants were expected to be highly active and independent as an inclusion criterion since hill climbing was required.

**CLINICAL RELEVANCE:** These findings do indicate the potential for shoulder pain reduction with the use of 2-gear wheel during daily mobility, even in highly functional MWCU.

---

**OPL38**

**RELIABILITY OF A CLINICAL TEST TO DETECT SCAPULAR DYSKINESIA**

McCleure P, Kareha S, Tate AR, Irwin D, Stueckey E

Physical Therapy, Arcadia University, Glenside, PA

**PURPOSE/HYPOTHESIS:** The purpose of this study was to determine the inter-rater reliability of a new test designed to detect abnormal scapular motion.

**NUMBER OF SUBJECTS:** A random sample of 90 college athletes was drawn from a group of 142 athletes participating in a larger study. There were 71 males and 19 females. There were 29 division 3 athletes involved in either baseball, swimming or volleyball, and 61 athletes were division 1.
water polo players. Subjects had to be actively competing in an overhead sport, and could not be obese (BMI > 30), or have a recent history of rotator cuff tear, dislocation or direct contact shoulder injury.

**MATERIALS/METHODS:** Subjects were videotaped from a posterior view using high quality digital video format while performing 5 repetitions of bilateral, weighted (3 or 5 lb) shoulder flexion and frontal plane abduction. Videos were subsequently viewed and rated for the presence of scapular dyskinesia. Raters were trained to detect scapular dyskinesia using a self-instructional format with standardized operational definitions and video examples of normal and abnormal motion. Scapular dyskinesia was defined as the presence of either “winging” or “dysrhythmia.” Winging was defined as the medial or inferior border of the scapula protruding greater than equal to 1 inch, with a sulcus/gap present between thorax and scapula. Dysrhythmia was defined as premature or excessive elevation or protraction or a nonsmooth, stuttering motion during arm elevation or lowering. Right and left sides were rated independently as either “normal,” “subtle,” or “obvious” dyskinesia. A total of 6 raters (3 pairs) independently rated scapular motion; each pair rated 30 different subjects. One pair were athletic trainers with 2 years experience each and the other 2 pairs were physical therapists with experience ranging from 6 to 19 years. Reliability was assessed using percent agreement and weighted kappa with 95% confidence intervals. Kappa values were calculated for left and right sides separately and then averaged.

**RESULTS:** Percent agreement was 79% and Kw (95% CI) was 0.55 (0.36-0.73). The maximum kappa possible, given the variability among subjects was 0.76. Among the 3 rater pairs, percent agreement ranged from 75% to 82% and Kw ranged from 0.48 to 0.57.

**CONCLUSIONS:** The test for scapular dyskinesia showed satisfactory reliability for clinical use in a random sample of overhead athletes known to be at increased risk for shoulder symptoms. Rater training using a self-instructional format with standardized operational definitions and video examples was an effective method and clinical experience of raters did not affect results.

**CLINICAL RELEVANCE:** Scapular dyskinesia is thought to be related to shoulder symptoms and dysfunction yet clinically practical methods for screening and documenting its presence are lacking. This method could assist clinicians and researchers in identifying those patients or subjects most likely to benefit from scapular exercises.

---

**OPL40**

**EFFECT OF THE SCAPULA REPOSITION TEST ON IMPELLMENT SYMPTOMS AND ELEVATION STRENGTH IN OVERHEAD ATHLETES**

**Tate AR, McClure PW, Kareha S, Irwin D**

Arcadia University, Glenside, PA

**PURPOSE/HYPOTHESIS:** To determine the effect of a clinical test involving manual repositioning of the scapula into greater retraction and posterior tilt on impingement symptoms and elevation strength in overhead athletes.

**NUMBER OF SUBJECTS:** A total of 142 college athletes were tested, 111 males and 31 females. The mean age was 20.8 ± 2.8 years. There were 49 athletes involved in either baseball, swimming or volleyball and 93 athletes who played water polo. Subjects had to be actively competing in an overhead sport, and could not be obese (BMI > 30), or have a recent history of rotator cuff tear, dislocation or direct contact shoulder injury.

**MATERIALS/METHODS:** Subjects were tested for impingement using the Neer, Hawkins’ and Jobe impingement tests. Tests found to provoke symptoms were then repeated with the scapula manually repositioned into greater retraction and posterior tilt, and a numeric rating scale was used to measure symptom intensity during both of these conditions. A mounted handheld dynamometer was used to measure isometric elevation force with the arm elevated to 90° in the scapular plane and internally rotated with the scapula in its natural position and when manually repositioned as previously described. A paired t test was used to compare the strength in both positions for those with and without impingement signs. The frequency of a clinically significant increase in strength with scapular repositioning, defined as a ≥ 2 standard error of measurement (SEM) increase, was also assessed. SEM was determined from a prior reliability study.

**RESULTS:** At least 1 positive impingement test was present in 98 of 142 athletes, while 44 athletes had negative impingement tests. Of those with positive impingement tests, 46/98 had reduced pain with scapular repositioning. Scapular repositioning produced an increase in strength in both the impingement (P < .001) and nonimpingement groups (P = .012). A clinically significant increase in strength was found with repositioning in 34.7% of athletes with, and 34.1% of athletes without impingement signs. For the impingement group, 53.1% showed no change in strength and 12.2% were weaker (2 SEM decrease) with the scapula

---

**OPL39**

**VALIDITY OF A NEW TEST FOR SCAPULAR DYSKINESIA**

**Tate AR, McClure PW, Irwin D, Kareha S, Stucely E**

Arcadia University, Glenside, PA

**PURPOSE/HYPOTHESIS:** The purpose of this study was to determine the validity of a newly developed clinical test designed to detect abnormal scapular motion (dyskinesia). We compared 3-D measures of scapular motion between subjects clinically judged as either normal or having scapular dyskinesia. A secondary purpose was to explore the relationship between scapular dyskinesia and the presence of shoulder symptoms in overhead athletes.

**NUMBER OF SUBJECTS:** Subjects were viewed posteriorly by 2 raters while performing bilateral, weighted (3 or 5 lb) shoulder flexion and frontal plane abduction. Raters were trained to detect scapular dyskinesia using written operational definitions and video examples of normal and abnormal motion. Scapular dyskinesia was defined as the presence of either “winging” (medial or inferior border of the scapula protrudes greater than equal to 1 inch, with a sulcus/gap present between thorax and scapula) or “dysrhythmia” (premature or excessive elevation or protraction; or nonsmooth or stuttering motion during arm elevation or lowering). Right and left sides were rated independently for each test motion as either “normal,” “subtle dyskinesia,” or “obvious dyskinesia.” Symptoms were assessed using the U Penn Shoulder Score, which is a composite

---

**COMBINED SECTIONS MEETING**
A high percentage of athletes participating in overhead sports exhibited clinical signs of shoulder impingement. Manually repositioning the scapula resulted in a reduction in pain during impingement testing in nearly half of the athletes. Manual repositioning of the scapula increased strength in a subgroup of athletes, regardless of the absence or presence of impingement symptoms.

**Clinical Relevance:** The scapula reposition test is a simple clinical test that may be useful in a treatment-based classification approach to identify a subset of those with shoulder impingement syndrome that would benefit from interventions aimed at improving scapular position.

---

### OPL41

**The Use of Magnetic Resonance Imaging to Quantify Diffusion of Water in Normal and Abnormal Lumbar Intervertebral Discs**

**Beattie PF**

Program in Physical Therapy, University of South Carolina, Columbia, SC

**Purpose/Hypothesis:** The purpose of this study was to determine the reliability of measures reflecting water diffusion in the lumbar intervertebral discs (IVDs) and to establish the variation in these measures obtained from subjects undergoing serial magnetic resonance imaging (MRI) scans.

**Number of Subjects:** Nine adults who had activity-limiting low back pain and six adults who did not have activity-limiting low back pain participated in this study.

**Materials/Methods:** Subjects underwent T2-weighted lumbar MRI scans followed by diffusion-weighted imaging using echo-planar techniques. IVDs were classified as normal, mild to moderately degenerative and severely degenerative based upon the T2-signal intensity of the nucleus pulposus. At each segmental level (L1 to L5-S1) an apparent diffusion coefficient (ADC) was calculated for the center of the nucleus pulposus. Linear measures were obtained for the anterior and posterior intervertebral disc height. Subjects were asked to maintain their normal daily activities and underwent a second MRI scan 4 to 7 weeks after the initial scan.

**RESULTS:** The intrarater and interrater reliability of measures of the ADC was excellent (ICC, .95 to 1.00; 95% CI, .85 to 1.00; SEM, .03 to .46; 95% CI of SEM, .00 to .50). The intra- and interrater reliability of measures of disc height was good to excellent (ICC, .83 to .99; 95% CI, .76 to .99; SEM, .07 to .48; 95% CI of SEM, .13 to .94). The mean ADC for normal IVDs was 192.2 (range, 187.8-200.0; n = 45 discs). For mild to moderately degenerative IVDs the mean ADC was 176.3 (range, 168.0 to 198.4; n = 19 discs), and for the severely degenerative IVDs the mean ADC was 106.4 (range, 77.9 to 162.0; n = 11). The test retest difference in the overall mean ADC was 2.9 (SD, 13.3) and the 95% CI of this difference was -6.8 to 12.5. The average variation in the ADC that occurred over 4 to 7 weeks was 11%.

**Conclusions:** Measures of water diffusion and disc height of the IVDs may be reliably obtained. Consistent with previously reported data, the typical variation in diffusion over time in our sample was ~11%.

**Clinical Relevance:** Reduced water diffusion in the intervertebral disc is believed to be a central component of pain-related syndromes associated with degenerative disc disease. This phenomenon has, however, been very difficult to measure in vivo. New applications of lumbar MRI allow high resolution diffusion-weighted images to be obtained and quantified to accurately reflect water diffusion. This technology will allow clinicians and researchers to investigate the mechanisms by which physical therapy interventions such as manual therapies; traction and exercise influence the lumbar intervertebral disc. This will lead to advancements in the treatment of people with back pain related to degenerative disc disease.

---

### OPL42

**Radiographic Factors Associated with Long-Term Physical Therapy Outcomes of Patients with Lumbar Spinal Stenosis**

**Hunter SJ, Fritz JM, Brennan GP**

Rehabilitation Agency, Intermountain Health Care, Salt Lake City, UT

**Purpose/Hypothesis:** Radiographic findings are important factors physical therapists use to evaluate and treat orthopedic patients. This is especially true with lumbar spinal stenosis (LSS) where radiographic findings have been used to determine disease severity. However, little information is currently available associating radiographic findings with physical therapy outcomes. The purpose of this study was to determine if the radiographic variables found on MRI were associated with long-term (2-year follow-up) outcomes of patients undergoing a standardized treatment program for LSS.

**Number of Subjects:** Twenty-eight subjects (59% female; mean ± SD age, 67.8 ± 8.0 years) completing a questionnaire an average of 23 (range, 6-40) months after treatment for LSS were evaluated.

**Materials/Methods:** All patients with LSS confirmed by MRI treated in a standardized program with a 2-year follow-up were studied. Demographic and impairment data were collected at the beginning of treatment. The Oswestry Disability Index (OSW) and numeric pain rating (NPR) were recorded at the beginning and completion of therapy. The standardized program included recumbent cycling, total gym, stabilization exercise, education, and flexion-biased ROM. The OSW, NPR, and a follow-up questionnaire were mailed to all patients at least 6 months after completing therapy. MRI findings were classified by degree of severity by an evaluating radiologist. Findings in the areas of central, foraminal, and recess stenosis were classified as mild, moderate or severe. Disc herniations were graded as I, II, or III based on the size of the protrusion. Disc and facet degeneration was graded as mild, moderate, or severe.

**Results:** Symptoms with this group of patients were chronic and severe. The mean duration of current symptoms was 1.9 (SD, 2.4) years, 82% were experiencing leg pain, and the mean pre-treatment OSW was 39.9 (SD, 14.1). The only imaging factor associated with the long-term outcome of self-reported disability was “any presence of foraminal stenosis.” The long-term OSW of the 21 patients with foraminal stenosis was 34.6 (SD, 16.1) compared to 20.6 (SD, 10.6) of those without foraminal stenosis (P < .05). Severity of central or foraminal stenosis, as well as severity of facet or disc degeneration was not associated with worse long-term outcomes.

**Conclusions:** The presence of pretreatment foraminal stenosis was associated with significantly worse outcomes in patients with LSS. Radiographic factors generally associated with severity (degenerative disc or facet disease or size of disc herniation) were not associated with worse pain or disability outcomes.

**Clinical Relevance:** When evaluating radiographic evidence in patients with LSS, the presence of foraminal stenosis should be considered as a factor influencing long-term outcomes.
tion between the flexors/extensors tended to occur after 30 ms. The multifidus was soon followed by an erector spinae response in 69% of the trials. Typically, the flexors then responded at 31 to 80 ms (M2 response) concurrent with quiescence in the extensors. Finally, a response began after 80 ms (votional response) in the extensors and/or flexors. In the subjects with LBP, M1 responses in the multifidus muscles were not detected. Instead, protracted periods of cocontraction between the flexors/extensors tended to occur after 30 ms.

CONCLUSIONS: In asymptomatic controls, the M1, M2, and votional responses were distinct and displayed a segmented pattern usually separated by periods of neural silence typical of reciprocal inhibition. In subjects with subacute LBP, the differences in the multifidus responses may reflect low reflex gain, making responses undetectable, or prolonged laten-cies. Either case could be detrimental to trunk stability. Cocontraction may represent a compensatory strategy for stiffening the spine that requires more energy and produces higher compression loads on the spine.

CLINICAL RELEVANCE: Subjective improvements in pain and disability are achieved in both men and women with nonspecific LBP following a structured protocol of progressive trunk strengthening exercises for 6 weeks.

OPL44

SEX DIFFERENCES IN RESPONSE TO TRUNK STRENGTHENING EXERCISES IN THE MANAGEMENT OF NONSPECIFIC LOW BACK PAIN

Rielly LC

Physical Medicine and Rehabilitation, Willis Knighton Spine Institute, Shreveport, LA; College of Allied Health and Nursing, Nova Southeastern University, Fort Lauderdale, FL

PURPOSE/HYPOTHESIS: Strengthening of the trunk musculature is promoted as an evidence-based rehabilitation option for the management of nonspecific low back pain (LBP). Few investigations have focused on the presence of sex differences in response to trunk strengthening exercises in this population. The purpose of this prospective observational study is to compare the results of a structured rehabilitation program utilizing progressive resistance exercises for the trunk musculature in a sample of males and females with nonspecific LBP.

NUMBER OF SUBJECTS: 298 patients (female, n = 186; male, n = 112) referred to a multidisciplinary spine center for the nonoperative management of nonspecific LBP participated in the study.

MATERIALS/METHODS: Consecutive patients were enrolled in the study if they (1) had no medical condition preventing exercise, (2) had nonspecific LBP of at least 6 weeks in duration, (3) had measurable strength deficits in the trunk musculature, and (4) were willing to participate in an outpatient rehabilitation program. A standardized physical therapy evaluation included isometric strength testing performed on specific equipment that isolates the trunk musculature. Outcome measurements obtained at baseline and following completion of the program included self-reported pain intensity, perceived disability, isometric trunk strength, and spinal range of motion. Treatment consisted of supervised, progressive-resistance exercises for the lumbar extensors and abdominal musculature on specialized equipment using a standardized protocol. Exercise intensity was progressed weekly using a linear periodization model and patients were encouraged to work through their pain using a cognitive-behavioral model of rehabilitation.

RESULTS: Groups were comparable at baseline on all variables except of age and isometric trunk strength. Male subjects were younger and significantly stronger than their female counterparts. The average duration of treatment was 6 weeks for each group. The structured protocol of progressive trunk strengthening exercises resulted in clinically meaningful and statistically significant improvements in all outcome measures. There were no clinically meaningful differences observed between groups in response to the training program.

CONCLUSIONS: A standardized physical therapy evaluation including objective measures of trunk strength can identify patients who benefit from a structured protocol of progressive resistance exercises. This investigation revealed no evidence of sex differences in response to the trunk strengthening exercises with both men and women reporting clinically meaningful reductions in subjective complaints of pain and perceived disability.

CLINICAL RELEVANCE: Subjective improvements in pain and disability are achieved in both men and women with nonspecific LBP following a structured protocol of progressive trunk strengthening exercises for 6 weeks.
initial physical therapy visit. The mean ODQ score was 9 (SD, 6.8) at the time of discharge from physical therapy. The mean ODQ score was 5.5 (SD, 4.4) at a mean of 35.5 (SD, 12.4) weeks following their initial physical therapy visit.

DISCUSSION: While the use of NMES to the lumbar musculature may serve as a useful adjunct to traditional lumbar stabilization programs for patients with LBP related to lumbar segmental instability, caution should be used in inferring a cause-and-effect relationship based upon the results of this case series. Randomized clinical trials are necessary to further investigate the effectiveness of the application of NMES to the lumbar spine musculature as an adjunct to traditional lumbar stabilization programs for patients with LBP related to lumbar segmental instability.

**OPL46**

**IMPROVED CONTRACTION OF THE LUMBAR MULTIFIDUS FOLLOWING SPINAL MANIPULATION: A CASE STUDY USING REHABILITATIVE ULTRASOUND IMAGING**

Brenner AK, Buscema CJ, Gill NW, Kiesel K

Physical Therapy and Rehabilitation Program, US Army, Fort Knox, KY; Physical Therapy, US Army Health Clinic-Vicenza, US Army, Vicenza, Italy; Spine Research Center, Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, Washington, DC; Doctoral Candidate; Rehabilitation Sciences-Doctoral Program, University of Kentucky Department of Rehabilitation Sciences, Lexington, KY

**BACKGROUND AND PURPOSE:** The use of spinal manipulation as an adjunctive treatment to facilitate neuromuscular control of the paraspinal musculature is not well described in the literature. Using rehabilitative ultrasound imaging (RUSI), this case study documents clinically relevant changes observed in the lumbar multifidus muscle immediately and 1 day post manipulation in a subject exhibiting difficulty in performing a low back lift with耸吊 muscle activation of this muscle.

**CASE DESCRIPTION:** The patient was a 33-year-old male with a 21-year history of low back pain (LBP) and left leg pain. He reported as a 12-year-old an insidious onset of debilitating LBP and left leg pain which radiated to his ankle. Since that time he reports recurrent, nondebulitating LBP and occasional left thigh numbness on average twice per year. During examination the patient was asked to perform a prone upper extremity lifting task. The examiner noted through palpation the left paraspinal musculature did not activate as strongly when compared to the right in the L4 region. To explore this further a decision was made to assess the multifidus with RUSI and perform a lumbar regional manipulation with the intention of improving multifidus activation. Ultrasound images of the multifidus muscles at the L4-5 and L5-S1 levels were obtained both pre-manipulation and postmanipulation (immediately and 1 day post).

**OUTCOMES:** A change in thickness of the multifidus was noted immediately and 1 day post manipulation. Average percent change in thickness from rest increased from 3.6% premanipulation to 17.2% immediately after manipulation and 20.6% approximately 24 hours later. The measured changes corresponded with improved ability to perform the lifting task. These changes in muscular function were also accompanied by modest clinical improvements.

**DISCUSSION:** In this single case of a patient with a long history of recurrent low back pain, improvement in the contraction of the lumbar multifidus at the L4-5 and L5-S1 levels was found immediately after and 1 day following spinal manipulation. Spinal manipulation, via a neurophysiologic mechanism, may improve contraction of the lumbar multifidus in patients with LBP who demonstrate reduced contraction. RUSI offers a noninvasive way to investigate and document these changes.

**OPL47**

**ELEVATED FEAR-AVOIDANCE BELIEFS FOR SUBJECTS PARTICIPATING IN PHYSICAL THERAPY CLINICAL TRIALS**

George SZ, Frits JM, Childs JD

Physical Therapy Department, University of Florida, Gainesville, FL; Division of Physical Therapy, University of Utah and Intermountain Health Care, Salt Lake City, UT; Doctoral Program in Physical Therapy, US Army-Baylor University, San Antonio, TX

**PURPOSE/HYPOTHESIS:** Consistent evidence suggests that fear-avoidance beliefs are predictive of short-term outcomes for patients with low back pain (LBP). However, cut-off scores have not been widely reported for patients receiving physical therapy. This secondary analysis investigated the Fear-Avoidance Beliefs Questionnaire (FABQ) as a predictor of 6-month outcomes for subjects receiving standard physical therapy while participating in clinical trials.

**NUMBER OF SUBJECTS:** Subjects (n = 160) were participants in 2 separate randomized trials that used standard methodology and investigated the efficacy of physical therapy interventions for LBP. This sample was randomly split into development (n = 80) and validation (n = 80) samples for purposes of investigating the accuracy of the FABQ for predicting 6-month outcomes.

**MATERIALS/METHODS:** Subjects completed baseline measures of pain, disability, fear-avoidance beliefs, and physical impairment. Subjects completed 4-weeks of randomly assigned physical therapy and were reassessed at 4-weeks and 6-months with standard examination techniques. In the development sample, a hierarchical regression model determined which FABQ scale better predicted 4-week disability scores, and ROC curves analysis generated a cut-off score that maximally predicted less than or equal to 1 minimally clinical important difference (MCID) change in disability. In the validation sample, a regression model entered the appropriate FABQ scale to predict 6-month disability scores. The accuracy of predicting patients that experienced 6-month less than or equal to 1 MCID changes in disability was assessed by chi-square analysis.

**RESULTS:** Only the baseline work scale of the FABQ (FABQW) uniquely contributed to 4-week disability scores after controlling for baseline pain, disability, and physical impairment. In the development sample, the best generated cut-off score was FABQW greater than 23 (+ LR, 2.93; 95% CI, 1.0–4.7). In the validation sample, the FABQW remained a unique predictor of 6-month disability. Five out of 16 (31.3%) patients scoring above the proposed FABQW cut-off improved less than or equal to 1 MCID over 6 months. In contrast, only 5 out of 43 (11.6%) patients scoring below the cut-off score improved less than or equal to 1 MCID. This difference did not achieve statistical significance (P = .074) in the validation sample.

**CONCLUSIONS:** The FABQW was the better predictor of 6-month disability scores in this sample of subjects participating in physical therapy trials.

**CLINICAL RELEVANCE:** The FABQW may be more appropriate than the physical activity scale for predicting 6-month outcomes for subjects receiving standard physical therapy treatment. However, outcome prediction using the FABQW was not definitive and has not been validated in an independent sample. Therefore, future studies are necessary to further test and refine the FABQ as a screening tool alone, and in combination with other examination findings.

**OPL48**

**OUTCOMES FOR EMPLOYEES PARTICIPATING IN LOW BACK EDUCATION AND TRAINING**

Passey EJ, Loveday L, Hunter SD, Fritz JM

Onsite Physical Therapy, Intermountain Healthcare, Salt Lake City, UT; BD Medical, Salt Lake City, UT; Intermountain Healthcare, Salt Lake City, UT

**PURPOSE/HYPOTHESIS:** The purpose of this study was to examine the effectiveness of an education and exercise program on beliefs related to the low back for employees at a manufacturing facility. Background: Low back related pain and disability are leading areas of concern and interest in an attempt to provide effective intervention to this group of individuals. Media campaigns focused on educating general practitioners as well as the public have been effective in altering beliefs related to the low back. Providing education and exercise to a specific population may have an equivalent effect.
NUMBER OF SUBJECTS: 32 employees.

MATERIALS/METHODS: Employees at a local manufacturing company volunteered to participate in the “Healthy Back” program, to satisfy a goal in their annual Health Balance program. The employee was required to participate in pre and post program testing, attend three 1-hour education classes, and 16 core strengthening classes over a 1-year period during 2005. The onsite physical therapist provided the education sessions, and the fitness center exercise physiologist taught the core strengthening classes. Pre and post testing included aerobic fitness level, sit and reach test, back extensor endurance, and completing 2 questionnaires, the Back Relief Questionnaire (BBQ) and the Fear-Avoidance Beliefs Questionnaire (FABQ) physical activity (FABQPA) and work (FABQW) subscales. Age, sex, height, and weight were also recorded. The change in scores was computed by subtracting the final score from the initial score.

RESULTS: 32 employees enrolled in the program, 3 were lost due to termination of employment. Mean age was 46.6 years (±9.8), and 22 (69%) were female. Mean baseline questionnaire scores were FABQPA 32 (±10.7), FABQW 32 (±9.9), and BBQ 32 (±27.6). The average change in questionnaires was FABQPA 2.7 (7.6), FABQW 0.68 (6.9), and BBQ 3.2 (8.0). Older individuals had higher FABQPA scores (r = 0.37, P = .046). Baseline FABQPA and FABQW scores were highly correlated (P = .002). There was no significant correlation between the BBQ scores and the FABQ scores. Changes in BBQ scores were correlated with baseline aerobic capacity (r = 0.38, P = .047). Changes in FABQPA were significantly correlated to age (r = 0.41, P = .025). Changes in FABQW scores were correlated with age (r = 0.37, P = .058).

CONCLUSIONS: Aerobic fitness level was predictive of improvement in the BBQ scores and age was predictive of improvement with FABQPA scores.

CLINICAL RELEVANCE: Providing back education in conjunction with exercise training including aerobic and spinal stabilization exercises demonstrates improvement with basic back beliefs. Identifying and targeting at risk populations may improve outcomes from back school and exercise training programs.
were seen on a direct access basis by a PT. In soldiers with acute MS injuries (LBP, ankle and knee injuries) who needed help walking, were bleeding or had an open wound, suspected a limb loss and complex trauma. A managerial database was developed to record clinical information on patient care, facilitate patient administration, and to ensure timely accurate reporting of clinic operations to the command. This report will discuss the prosthetic and rehabilitation management of Iraqi local nationals over the course of a 4-month time frame providing information on number and type of patient visits, analysis of patient injury severity and level of amputation, mechanisms of injury, patient comorbidities, patient participation in and compliance with therapy, as well as anecdotal clinical observations about amputee conditions and barriers to progress in a developing country.

**SUMMARY OF USE:** Ongoing conflicts in Iraq, Afghanistan and other regions of the world have necessitated a highly specialized and multidisciplinary approach to amputee rehabilitation and prosthetic management. Clinical lessons learned by physical therapists and prosthetists working with traumatic amputees in the United States Armed Forces Amputee Patient Care Program have important implications for improving the quality of care to patients with limb loss internationally. Army doctrine is moving toward the deployment of rehabilitation teams to train foreign national providers on best practices to care for polytrauma casualties and this report documents the findings of the first such mission.

**IMPORTANCE TO MEMBERS:** Innovations in amputee rehabilitation and prosthetic management traditionally come to the foreground during prolonged military engagements. Clinical lessons learned from the management of over 450 amputees at Walter Reed have importance not only to US clinicians caring for those with limb loss but also for the international community of providers. Our findings highlight the role of military physical therapists, occupational therapists, and prosthetists in caring for wounded amputees internationally at a time when this skill set is in great demand. This presentation will showcase our efforts to enhance the capabilities of Iraqi providers to care for their nation’s significant amputee population and discuss the similarities and differences between patients with limb loss treated in a nation under reconstruction with those seen in US facilities. Our findings have important implications for others interested in amputee care at home and abroad.

**DESCRIPTION:** From January 2006 to June 2006 our team of 5 physical therapy, occupational therapy and rehabilitation providers from Walter Reed AMC worked with Iraqi prosthetic and rehabilitation providers in Baghdad, Iraq to educate them on best practices in caring for patients with limb loss and complex trauma. A managerial database was developed to record clinical information on patient care, facilitate patient administration, and to ensure timely accurate reporting of the interventions to the command. This report will discuss the prosthetic and rehabilitation management of Iraqi local nationals over the course of a 4-month time frame providing information on number and type of patient visits, analysis of patient injury severity and level of amputation, mechanisms of injury, patient comorbidities, patient participation in and compliance with therapy, as well as anecdotal clinical observations about amputee conditions and barriers to progress in a developing country.

**SUMMARY OF USE:** Ongoing conflicts in Iraq, Afghanistan and other regions of the world have necessitated a highly specialized and multidisciplinary approach to amputee rehabilitation and prosthetic management. Clinical lessons learned by physical therapists and prosthetists working with traumatic amputees in the United States Armed Forces Amputee Patient Care Program have important implications for improving the quality of care to patients with limb loss internationally. Army doctrine is moving toward the deployment of rehabilitation teams to train foreign national providers on best practices to care for polytrauma casualties and this report documents the findings of the first such mission.

**IMPORTANCE TO MEMBERS:** Innovations in amputee rehabilitation and prosthetic management traditionally come to the foreground during prolonged military engagements. Clinical lessons learned from the management of over 450 amputees at Walter Reed have importance not only to US clinicians caring for those with limb loss but also for the international community of providers. Our findings highlight the role of military physical therapists, occupational therapists, and prosthetists in caring for wounded amputees internationally at a time when this skill set is in great demand. This presentation will showcase our efforts to enhance the capabilities of Iraqi providers to care for their nation’s significant amputee population and discuss the similarities and differences between patients with limb loss treated in a nation under reconstruction with those seen in US facilities. Our findings have important implications for others interested in amputee care at home and abroad.

**DESCRIPTION:** From January 2006 to June 2006 our team of 5 physical therapy, occupational therapy and rehabilitation providers from Walter Reed AMC worked with Iraqi prosthetic and rehabilitation providers in Baghdad, Iraq to educate them on best practices in caring for patients with limb loss and complex trauma. A managerial database was developed to record clinical information on patient care, facilitate patient administration, and to ensure timely accurate reporting of the interventions to the command. This report will discuss the prosthetic and rehabilitation management of Iraqi local nationals over the course of a 4-month time frame providing information on number and type of patient visits, analysis of patient injury severity and level of amputation, mechanisms of injury, patient comorbidities, patient participation in and compliance with therapy, as well as anecdotal clinical observations about amputee conditions and barriers to progress in a developing country.

**SUMMARY OF USE:** Ongoing conflicts in Iraq, Afghanistan and other regions of the world have necessitated a highly specialized and multidisciplinary approach to amputee rehabilitation and prosthetic management. Clinical lessons learned by physical therapists and prosthetists working with traumatic amputees in the United States Armed Forces Amputee Patient Care Program have important implications for improving the quality of care to patients with limb loss internationally. Army doctrine is moving toward the deployment of rehabilitation teams to train foreign national providers on best practices to care for polytrauma casualties and this report documents the findings of the first such mission.

**IMPORTANCE TO MEMBERS:** Innovations in amputee rehabilitation and prosthetic management traditionally come to the foreground during prolonged military engagements. Clinical lessons learned from the management of over 450 amputees at Walter Reed have importance not only to US clinicians caring for those with limb loss but also for the international community of providers. Our findings highlight the role of military physical therapists, occupational therapists, and prosthetists in caring for wounded amputees internationally at a time when this skill set is in great demand. This presentation will showcase our efforts to enhance the capabilities of Iraqi providers to care for their nation’s significant amputee population and discuss the similarities and differences between patients with limb loss treated in a nation under reconstruction with those seen in US facilities. Our findings have important implications for others interested in amputee care at home and abroad.

**DESCRIPTION:** From January 2006 to June 2006 our team of 5 physical therapy, occupational therapy and rehabilitation providers from Walter Reed AMC worked with Iraqi prosthetic and rehabilitation providers in Baghdad, Iraq to educate them on best practices in caring for patients with limb loss and complex trauma. A managerial database was developed to record clinical information on patient care, facilitate patient administration, and to ensure timely accurate reporting of the interventions to the command. This report will discuss the prosthetic and rehabilitation management of Iraqi local nationals over the course of a 4-month time frame providing information on number and type of patient visits, analysis of patient injury severity and level of amputation, mechanisms of injury, patient comorbidities, patient participation in and compliance with therapy, as well as anecdotal clinical observations about amputee conditions and barriers to progress in a developing country.

**SUMMARY OF USE:** Ongoing conflicts in Iraq, Afghanistan and other regions of the world have necessitated a highly specialized and multidisciplinary approach to amputee rehabilitation and prosthetic management. Clinical lessons learned by physical therapists and prosthetists working with traumatic amputees in the United States Armed Forces Amputee Patient Care Program have important implications for improving the quality of care to patients with limb loss internationally. Army doctrine is moving toward the deployment of rehabilitation teams to train foreign national providers on best practices to care for polytrauma casualties and this report documents the findings of the first such mission.
and rib problems were excluded as the examinations were designed to be completed in 15 minutes or less. Following the examination, the PT could (1) send the patient home with a home program, (2) refer to a primary care physician or an orthopaedist, (3) refer for PT. The program was funded by student fees.

RESULTS: Between September 2000 and June 2003, 3617 patients were seen in the MSK injury clinic. Of these patients, 12.5% (451) were referred to PT, 10.7% (386) were referred to a primary care physician, and 5% (192) were referred to an orthopaedist for further evaluation. Less than 16% (568) required care from a provider other than a PT. Fifty percent of the time the patient’s condition was managed with a 1-time consultation. Ninety-six percent received some patient education and self-management strategies from the PT. WHC receives a percentage of the students’ insurance premium to pay for services; hence it is financially desirable to manage this pool of money. For fiscal year 2000-2001, the MSK injury clinic resulted in a $934 000 savings to the insurance pool. A satisfaction survey was issued to the patients who accessed the clinic. With a 72% return rate, 99% of the people who accessed the clinic were satisfied and felt that their needs were met. During the 4 months there were no reported adverse events resulting from the PTs’ diagnoses or management.

CONCLUSIONS: Providing direct access PT services to a university population resulted in a significant savings of health care dollars and resources. Referrals by PTs to both physical therapy and orthopaedics were lower than the average referral rate for primary care physicians seeing patients with MSK complaints.

CLINICAL RELEVANCE: Direct access PT presents an avenue for patients to get the care they need in a timely manner while managing the numbers of services provided and decreasing expenditure of health care dollars.

OPL54

DEVELOPMENT OF AN OUTCOMES-BASED PAY-FOR-PERFORMANCE PROCESS FOR OUTPATIENT PHYSICAL AND OCCUPATIONAL THERAPY

Hart DL

Consulting and Research, Focus On Therapeutic Outcomes, Inc, White Stone, VA; Connolly Strategies and Initiatives, Annapolis, MD; Presbyterian Health Plan, Albuquerque, NM; CentraState Medical Center, Freehold, NJ

PURPOSE/HYPOTHESIS: Purposes were to develop an outcomes-based risk-adjusted pay-for-performance (P4P) model for patients receiving outpatient therapy; assess model predictive validity; develop a value-based purchasing payment algorithm (VPPA); and compare simulated differences in payment using VPPA compared to fee-for-service (FFS).

NUMBER OF SUBJECTS: Data from 189 088 patients (50 years; SD, 16; min, 18; max, 102; 39% male) in Focus on Therapeutic Outcomes, Inc data set from 552 outpatient clinics in 40 states treated by 3447 therapists (2000-2003) were analyzed: 94% orthopedic, 4% medical, 2% neurological conditions.

MATERIALS/METHODS: Patients entered functional status (FS) data at intake and discharge using self-report surveys. Therapists entered administrative data at discharge. Feasibility of P4P implementation was assessed with qualitative comments solicited from staff. We used: effect sizes to assess FS responsiveness; receiver operating characteristic (ROC) analyses to assess sensitivity to change of FS; 1-way ANCOVAs to assess construct validity of FS change for symptom acuity (acute, subacute, chronic), age (18 to 65, 65 to 75 years, >75 years), condition (orthopedic, neurologic), and surgical history (none, 1 or more). Patients were grouped into homogeneous, risk-adjusted cells using a previous regression model. In each cell, patients were placed into 1 of 9 payment groups using above, predicted, and below predicted FS change and visits. Differences in payment between FFS and P4P were simulated using a previously developed VPPA that assigns level of payment for patients within a group.

RESULTS: On average, FS improved during treatment (FS change 11; SD, 14) using 9 (SD, 6) visits over 37 (SD, 24) calendar days. Effect size was .91 overall, .98 for patients with orthopedic, .45 for patients with neurological conditions. ROC results supported FS change of 10 or more out of 100 was associated with clinically important improvement (area under ROC 79; 95% CI, .66-.80; sensitivity, .94; specificity, .75). FS measures discriminated patients in clinically logical ways for acuity, age, condition and surgical history (P<.05). Simulation estimated 7% reduction in payment and a shift of reimbursement to patients who improved functionally and treated efficiently had providers been reimbursed using P4P.
improvements. Its process studied here could serve as a good foundation for future improvements.

**CONCLUSIONS:** Results support the feasibility of using a risk-adjusted P4P process and a VPPA based on FS change and visits for payment of outpatient therapy. Realignment of resources to patients who are improving functionally and treated efficiently may be the catalyst for therapists to use evidence-based practice designed to get better outcomes efficiently.

**CLINICAL RELEVANCE:** If payers progress to reimbursing outpatient therapy using a P4P process based on clinical outcomes and treatment visits, the process studied here could serve as a good foundation for future improvements.
...subjects, from the 3-D fat-suppressed images using previously published methods (BOS and PTA were negatively correlated with contact area at 0° (BOS, \( r = -0.39; \) \( P < .002 \)). TKA subjects perform the return-to-sit with increased ankle dorsiflexion angle on the nonoperated side and increased ankle dorsiflexor moment (\( P = .05 \)). However, BOS and PTA were not correlated with contact area at any knee angle. There were no significant correlations at 40° regardless of subject grouping.

CONCLUSIONS: Correlational analysis revealed a more consistent relationship between TFROT and contact area than between patellar alignment and contact area at initial knee flexion angles. These data suggest that tibiofemoral rotation alignment may influence contact area throughout the progression of osteoarthritic changes in the nonoperated limb.

CLINICAL RELEVANCE: Physical therapy interventions directly addressing the promotion of symmetrical weight bearing during functional tasks will also reduce the compensation pattern of reliance on the nonoperated limb. Functionally decreasing the load on the nonoperated limb may reduce the risk of the progression of osteoarthritic changes in that limb.

**OPL60**

**STRENGTH TRAINING IMPROVES MUSCLE STRENGTH, POWER, VOLUME, AND OVERALL MOBILITY 1 YEAR FOLLOWING TOTAL KNEE REPLACEMENT**

Meier WA, Marcus RL, Dibble LE, Peters CL, LaStayo PC

Division of Physical Therapy, University of Utah, Salt Lake City, UT; Department of Orthopedics, University of Utah, Salt Lake City, UT

**PURPOSE/HYPOTHESIS:** Total knee replacement (TKR) is commonly performed to alleviate knee pain and improve function in individuals with knee osteoarthritis. TKR patients, however, demonstrate prolonged quadriceps weakness (12%-35%) compared to age-matched healthy controls. The increased forces at the hip and knee may be a quadriceps avoidance strategy. The increased moments on the hip and knee on the nonoperated side indicate that different muscle patterns are used by the TKA subjects compared to controls. The increased demand on the nonoperated limb has the potential to contribute to increased forces at the hip and knee. These forces may be a factor in the progression of osteoarthritic changes in the nonoperated limb.

**MATERIALS/METHODS:** Participants were tested prior to and following a 12 week intervention. Knee extensor isometric strength was tested using a superimposed burst electrical stimulation protocol. Knee and hip extension power was measured on a Nottingham power rig. Quadriceps muscle volume was measured with magnetic resonance imaging. Mobility was determined using the 6-minute walk test (6MW), timed stair ascent/descent test (TUG), and timed stair ascent/descent test (TUG).

**RESULTS:** Knee extensor strength increased by a mean of 12% (RENEW, 11.4%; TRAD, 13.6%). Power increased by a mean of 22% in both the RENEW and TRAD groups. Quadriceps muscle volume mean increase was 15% (RENEW, 17%; TRAD, 10%). Mean improvements in mobility occurred in the 6MW (RENEW, 19%; TRAD, 14%), TUG (RENEW, 35%; TRAD, 27%) and 31% during the SCT in both RENEW and TRAD.

**CONCLUSIONS:** Muscle impairment and related mobility deficits 1 year after TKR improved following strength training in these 6 individuals. Further research is needed to determine the optimal mode of strengthening, the sustainability of these improvements and their overall impact on long-term function and quality of life in persons following TKR.
CLINICAL RELEVANCE: Strength training 1 year following a TKR can be beneficial in improving leg extension power, quadriceps strength, quadriceps muscle volume and mobility.

**OPL61**

MUSCLE STABILIZATION STRATEGIES IN PERSONS WITH MEDIAL KNEE OSTEOARTHRITIS: THE EFFECT OF INSTABILITY

Schmitt LC, Rudolph K
Physical Therapy, University of Delaware, Newark, DE; Biomechanics and Movement Science Program, University of Delaware, Newark, DE

PURPOSE/HYPOTHESIS: Osteoarthritis (OA) is the most prevalent type of arthritis in the United States (Buckwalter, 2000) and commonly develops in the medial knee (MKOA) (Dearborn et al, 1996). Self-reported knee instability, the sensation of shifting, buckling, or giving way of the knee, is common in people with knee OA (Fitzgerald et al, 2004). Studies in people with anterior cruciate ligament deficiency show that those with knee instability use different neuromuscular control strategies compared to those without instability (Rudolph et al, 1998; Rudolph et al, 2001). The purpose of this study was to investigate the influence of knee instability on muscle activation strategies in persons with MKOA and evaluate the influence of knee instability, strength, laxity, and alignment on muscle activation strategies.

NUMBER OF SUBJECTS: Thirty-two participants were recruited.

MATERIALS/METHODS: Motion analysis and surface electromyography were used to evaluate muscle activation strategies during a disturbed walking task (lateral translation of the support surface). Knee instability (IKOS score) was measured using the Knee Outcome Survey-Activities of Daily Living Scale. Muscle activation patterns were compared between 3 groups: OA Unstable (OAU, n = 11), OA Stable (OAS, n = 10), and controls (C, n = 11). Contracon traction values were calculated between muscle groups and are evaluated prior to (preparation), during (weight acceptance), and following (midstance) the lateral translation. Stance alignment, passive medial knee laxity, and quadriceps force output (MVIC) were measured. The influence of these factors on cocontraction strategies were evaluated with hierarchical regression analysis.

RESULTS: There were no differences among the groups in terms of age (P = .561) or quadriceps MVIC (P = .553). The OA groups had greater medial knee laxity (P = .017) and were in greater varus alignment (P = .031) compared to the C group. The OA group used greater medial muscle cocontraction compared to the OAS and C groups prior to (P = .021), during (P = .012), and following (P = .020) lateral translation of the support surface. Across both OA groups, hierarchical regression analysis revealed that IKOS score was the only variable that predicted medial cocontraction during preparation (change in R² = 0.248, P = .023) and weight acceptance (change in R² = 0.325, P = .016). During midstance, quadriceps MVIC was a significant predictor of medial muscle cocontraction (change in R² = 0.459, P = .004), and IKOS score showed a trend (change in R² = 0.330, P = .060).

CONCLUSIONS: Using higher cocontraction can be a strategy to increase knee stability, but this strategy was ineffective for the OAU group. Using higher cocontraction can be particularly detrimental to the joint integrity of persons with MKOA due to the increased forces in the joint from high cocontraction and episodes of instability.

CLINICAL RELEVANCE: Knee instability needs to be addressed during rehabilitation with further investigation regarding the impact of instability on long-term joint integrity.

**OPL62**

FRONTAL PLANE PROJECTION ANGLES OF THE KNEE DURING SINGLE-LEG SQUATS AMONG FEMALES WITH AND WITHOUT PATELLOFEMORAL PAIN

William JD, Davis T
Physical Therapy, University of Delaware, Newark, DE

PURPOSE/HYPOTHESIS: Patellofemoral pain (PFPS) remains a common clinical entity, particularly among active females. Abnormal lower extremity (LE) mechanics are believed to contribute to the etiology of PFPS. However, a valid and reliable method to detect and document these abnormal mechanics is not commonly employed in the clinic. In a study of healthy individuals, it was recently reported that the frontal plane projection angle (FPPA) of the knee during a single leg (SL) squat can be easily determined using a digital camera. Further, the FPPA was found to be associated with 3D LE rotations known to increase retropatellar pressure. However, to date, the FPPA has not been analyzed in the context of females with PFPS. Thus, the purpose of this study was to analyze the knee FPPA during SL squats for females with and without PFPS.

We also aimed to analyze the association of the FPPA during SL squats and 3D rotations of the LE during running and SL jumping. We hypothesized that females with PFPS would demonstrate greater FPPAs during SL squats. We also hypothesized that the FPPA during SL squats would be associated with hip abduction (HADD) and internal rotation (HIR) and knee external rotation (KER) during running and SL jumping.

NUMBER OF SUBJECTS: As part of an ongoing study, 12 active females diagnosed with PFPS (mean age, 24.0 years) and 10 active healthy female controls (mean age, 25.6 years) participated.

MATERIALS/METHODS: 3D LE kinematics were recorded for the injured leg (PFPS group) and a randomly chosen leg (control group) during running and repetitive SL jumps (Vicon, 120 Hz). The knee FPPA was measured during 5 SL squats. For each squat trial, digital images were recorded by a camera placed 2m anterior to the subject, perpendicular to the frontal plane, and at the height of the knee joint. Markers placed on the LE bisecting the frontal plane of the proximal thigh, femoral condyles, and malleoli were used to determine the FPPA for each digital image (CorelDraw). The FPPA between groups was compared using independent t tests. Pearson correlation coefficients were determined for the FPPA during SL squats and selected discrete 3D kinematics during running and SL jumps.

RESULTS: Females with PFPS demonstrated FPPAs nearly twice as large as healthy female controls (PFPS mean, −7.5°, SD, 6.2; control mean, −3.8°, SD, 6.4; P = .09). Additionally, greater FPPAs during SL squats were significantly associated with greater HADD (r = .51) and KER (r = .60) during running. Greater FPPAs were also significantly associated with greater HIR (r = .44) and KER (r = .55) during SL jumps.

CONCLUSIONS: These preliminary results suggest that active females with PFPS perform SL squats with greater FPPAs than healthy, active female control subjects. PFPS during SL squats appear to be associated with LE rotations known to increase retropatellar contact pressure during dynamic activities.

CLINICAL RELEVANCE: A simple clinical test of LE alignment during weight bearing may lend insight into movement patterns thought to contribute to the etiology and exacerbation of PFPS.

**OPL63**

INFLUENCE OF TRUNK POSITION ON LOWER EXTREMITY BIOMECHANICS DURING A FORWARD LUNG

Farrokhi SS, Souza R, Chen Y, Pollard C, Powers C
Biokinesiology and Physical Therapy, University of Southern California, Los Angeles, CA

PURPOSE/HYPOTHESIS: The forward lunge is a common rehabilitation exercise utilized for lower extremity strengthening. However, little is known about the biomechanical demands associated with variations of this exercise. The purpose of this study was to examine how trunk position during a forward lunge influences the kinematics, kinetics and electromyographic (EMG) activity of the hip and knee. It was hypothesized that when compared to a normal lunge with the trunk erect (NL), a lunge with trunk flexion (LTF) will increase the demand of the hip extensors and decrease the demand on the knee extensors, while a lunge with a trunk extension (LTE) will increase the demand on the knee extensors and decrease the demand on the hip extensors.

NUMBER OF SUBJECTS: Five healthy young adults participated.
MATERIALS/METHODS: Subjects performed 5 repetitions of 3 different forward lunges that differed in trunk position. The NL condition consisted of a forward lunge with the subject’s trunk in an upright position and arms next to the body. During the LTE condition, the lunge was performed with a forward arm reach that induced trunk flexion. For the LTE condition, subjects performed the lunge by reaching overhead and back which induced trunk extension. Hip and knee kinematics (eight cameras, 60 Hz), ground reaction forces (1540 Hz) as well as the EMG activity (surface electrodes, 1540 Hz) of the gluteus maximus (GM), vastus medialis (VM), vastus lateralis (VL), biceps femoris (BF), and semimembranosus (SM) were collected. EMG data were reported as a percentage of the maximum voluntary isometric contraction (MVIC) of the muscle. Differences in sagittal plane peak joint angles, joint impulse (area under the moment curve), and EMG between the 3 lunge conditions were assessed using repeated measures ANOVAs.

RESULTS: Peak hip flexion during the LTF was significantly greater than the NL (103.8° versus 83.0°; \(P = .006\)). Conversely, peak hip flexion during the LTE was significantly less than the NL (76.9° versus 83.0°; \(P = .002\)). Hip extensor impulse during the LTF was 48% higher than the NL, while the hip extensor impulse during the LTE was 9% lower when compared to the NL (\(P = .042\)). Knee kinematics and knee extensor impulse were similar between all 3 lunge conditions. The integrated EMG activity of GM and SM were 31% and 32% higher respectively for the LTF compared to the NL (\(P<.05\)). No other differences in EMG activity were observed across lunge conditions.

CONCLUSIONS: Hip extensor demand is significantly affected by trunk position during lunging while the knee extensor demand remains unaffected. The marked increase in hip extensor demand during LTF condition may be due to greater hip excursion and movement of the body’s center of mass when compared to LTE condition.

CLINICAL RELEVANCE: Although the forward lunge is commonly used as a knee extensor exercise, the addition of trunk flexion can increase the demand on the hip extensors. This variation of the lunge may be beneficial for those patients who demonstrate a combination of hip and knee extensor weakness.

THE RELATIONSHIP BETWEEN HAMSTRING FLEXIBILITY AND KNEE FLEXION TORQUE PRODUCTION

Alonso J, Mullaney M, McHugh M, Tyler T

Nicholas Institute of Sports Medicine & Athletic Trauma, New York, NY; PRO Sports Therapy of Westchester, Scarsdale, NY; Sports Physical Therapy Institute, Somerset, NJ

PURPOSE/HYPOTHESIS: The relationship between muscular strength and flexibility is not well-understood. The purpose of this study was to examine the relationship between static hamstring flexibility and knee flexion torque production. It was hypothesized that the angle of peak knee flexion torque would occur at a shorter muscle length (greater knee flexion) in tighter hamstrings.

NUMBER OF SUBJECTS: Twenty healthy volunteers (10 men, 10 women) age 29 ± 7 years.

MATERIALS/METHODS: Hamstring flexibility was assessed using the passive straight leg raise (SLR) and active knee extension (AKE) tests. The AKE test is performed in supine with the test hip and knee flexed to 90° and the contralateral hip and knee at 0°. The subject then actively extends the test knee without compromising the test position. This knee angle was recorded. Isometric knee flexion strength was measured at 5 knee flexion angles (89°, 76°, 63°, 50°, 37°) while subjects were seated with the test thigh flexed 25° and the trunk flexed 20°. Lower extremities were classified as tight or normal for the SLR test (tight, SLR <60°; \(n = 16\) of 40 lower extremities) and AKE test (tight, AKE >10°; \(n = 19\) of 40 lower extremities). Peak knee flexion torque, angle of peak torque and the angle-torque relationship were compared between flexibility groups using independent \(t\) tests and analysis of variance.

RESULTS: Peak knee flexion torque was not different between tight and normal groups (SLR, \(P = .82\); AKE, \(P = .68\)). Peak knee flexion torque occurred in greater knee flexion (shorter muscle length) in the tight group compared to the normal group (SLR, \(P<.01\); AKE, \(P<.05\)). The angle-torque relationship was significantly affected by hamstring flexibility such that the tight group had higher torque than the normal group at 89° (shortest muscle length tested) but lower torque than the normal group at longer muscle lengths (63°, 50°, 37°; flexibility × angle SLR, \(P<.001\); AKE, \(P<.001\)).

CONCLUSIONS: Hamstring flexibility did not affect peak knee flexion torque. However, peak torque occurred at a shorter muscle length in the tight group. Additionally, the tight group produced greater torque at short muscle lengths and less torque at long muscle lengths compared to the normal group.

CLINICAL RELEVANCE: Hamstring tightness was associated with a decreased ability to generate knee flexion torque with the hamstring muscle group in a lengthened position. Decreased hamstring flexibility may prevent the hamstrings from effectively resisting potentially injurious lengthening during dynamic movements.