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 = 0.95, 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) then 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 Wellsley 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-

ined 48 hours after the initial examination by a physical therapist that was blinded to group allocation. Baseline variables were compared between groups using independent *t* tests for continuous data and chi-square tests for categorical data. The primary aim was examined with 2-way repeated-measures analysis of variance (ANOVA), with treatment group (thrust versus nonthrust manipulation) as the between subjects variable and time (baseline and 48 hours) as the within subjects variable. Separate ANOVAs were performed for each dependent variable, pain (NPRS) and disability (NDI). For each ANOVA, the hypothesis of interest was the 2-way group-by-time interaction. Planned pairwise comparisons were performed at the 48-hour follow-up using the Bonferroni equality at an alpha level of .05.

RESULTS: Sixty patients, mean age 43.3 years (SD, 12.7 years) (57% female), satisfied the eligibility criteria and agreed to participate. Baseline characteristics between the groups were similar for all variables ($P>.05$). The overall 2-way group-by-time interaction for the repeated-measures ANOVA was statistically significant for disability ($P<.001$) and pain ($P<.001$). Post hoc comparisons demonstrated that patients receiving thrust manipulation experienced greater improvements in pain (NPRS, 2.6; 95% CI, 2.1-3.1) and disability (NDI, 15.5%; 95% CI, 12.5-18.9), compared to patients receiving nonthrust manipulation (NPRS, .54; 95% CI, .06-1.0 and NDI, 5.5%; 95% CI, 2.2-8.8).

CONCLUSIONS: The results of this study provide evidence that thoracic spine thrust manipulation results in significantly greater and clinically meaningful short-term reductions in pain and disability compared to thoracic nonthrust manipulation in patients with neck pain.

CLINICAL RELEVANCE: Physical therapists should consider performing thrust over nonthrust techniques directed at the thoracic spine in patients with neck pain.

OPL 3

PRELIMINARY STUDY OF 2 FACTORS THAT PREDICT IMPROVED OUTCOME IN PATIENTS WITH NECK PAIN USING THORACIC MANIPULATION

Brennan GP, Fritz 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 = 97; 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. Covariates included baseline scores on the NDI and pain, sex, and age.

RESULTS: Of the patients who had symptoms less than 30 days, 28 (20 women) received manipulation and 48 did not (38 women). 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, 0.99 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 the patient reports 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.

OPL4

COMPARISON OF SHORT-TERM RESPONSE TO 2 SPINAL MANIPULATION TECHNIQUES FOR PATIENTS WITH LOW BACK PAIN

Sutlive TG, Mabry LM, Easterling EJ, Durbin JD, Hanson SL, Wainner RS, Childs JD

US Army-Baylor University, Fort Sam Houston, TX; Texas State University, San Marcos, TX

PURPOSE/HYPOTHESIS: To compare short-term response to 2 different manipulation techniques in a subgroup of patients with LBP who are positive on a spinal manipulation clinical prediction rule (CPR) indicating a high likelihood of experiencing a successful outcome.

NUMBER OF SUBJECTS: 60.

MATERIALS/METHODS: 60 patients with LBP identified as being likely responders to spinal manipulation based on a previously validated manipulation CPR underwent a standardized clinical examination and were randomized to receive a lumbo-pelvic (LP) manipulation or lumbar neutral gap (NG) manipulation technique. Outcome measures included pain and disability based on the Numeric Pain Rating Scale (NPRS) and Oswestry Disability Questionnaire (ODQ), respectively. The data were analyzed with a 2 × 2 repeated-measures analysis of variance, with the independent variables being group with 2 levels (LP and NG) and time (baseline and 48-hour follow-up). The hypothesis of interest was the group-by-time interaction. The alpha-level was a priori set to .05 using a 2-tailed test.

RESULTS: Both patients in the LP and NG groups experienced significant reductions in pain and disability at the 48-hour follow-up ($P<.001$). However, the group-by-time interaction was nonsignificant ($P>.05$), indicating no differences between the groups.

CONCLUSIONS: This is the first study to directly compare manipulation techniques in a subgroup of patients likely to benefit from this form of treatment. Although patients in both groups achieved statistically significant reductions in pain and disability at 48 hours, no differences in pain or disability existed between the groups ($P>.05$). Power was sufficiently high to detect differences should they have existed (>80%).

CLINICAL RELEVANCE: These data provide evidence to suggest that choice of technique may be largely a matter of clinician preference during the first 48 hours. However, the short-term follow-up limited the opportunity for clinically meaningful change to occur in either group. Therefore, future studies should address longer periods of follow-up and multiple treatment sessions.

OPL5

EFFECT OF CLASSIFYING PATIENTS WITH SPINAL SYNDROMES BY PAIN PATTERN AND FEAR-AVOIDANCE BELIEFS OF PHYSICAL ACTIVITY

Werneke M, Hart DL, Stratford PW, Reyes A

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

PURPOSE/HYPOTHESIS: We conducted a prospective observational cohort effectiveness study of patients with nonspecific neck or low back pain syndromes (NSSS) referred to a rehabilitation outpatient hospital clinic. The overall purpose was to investigate applicability of using centralization and fear avoidance beliefs as important constructs that clinicians can apply in real-time to classify and manage patients with NSSS treated in a busy outpatient clinic regardless of age and symptom acuity. Specific purposes were to determine if classifying patients with NSSS at intake by pain pattern and fear avoidance methods could (1) differentiate patients by functional status (FS) and pain intensity (PI) at intake and (2) predict change in FS and PI, number of treatment visits, and duration of treatment episode at rehabilitation discharge.

NUMBER OF SUBJECTS: Of 517 consecutive patients solicited, 355 volunteered, started and finished treatment (mean, 59 years; SD, 17; range, 19-91; 36% male).

MATERIALS/METHODS: Patients completed pain, function, and psychosocial questionnaires at initial examination 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, which controlled for important risk-adjustment 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.

OPL6

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

Werneke 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: Purposes were (1) to determine if there was a difference in number of visits, duration, change in functional status (FS) or pain intensity (PI) assessed at discharge from rehabilitation for patients with nonspecific cervical or lumbar spinal syndromes (NSSS) who were classified using time-dependent, dual-level classification methods based on pain pattern (PPC) and fear-avoidance beliefs (FABQ), and (2) to determine relative differences in the percent variance of data explained by PPC and FABQ using time-dependent models compared to models using intake classification data for visits, duration, or change in FS or PI.

NUMBER OF SUBJECTS: Patients (n = 355; mean, 59 years; SD, 17; range, 19-91; 36% male) referred to physical therapy participated.

MATERIALS/METHODS: Patients completed pain and psychosocial surveys at intake and discharge and pain diagrams throughout treatment. Therapists classified patients using PPC and FABQ data at intake and again at rehabilitation discharge (latter: time-dependent classification). Once classified, therapists applied a priori dual-level treatment strategies based on intake classifications. Pain diagram templates were used to score pain diagrams and determine PPC and changes in PPC over time. Global rating of change data were used to estimate clinically important change and identify cut-points in discharge FABQ. For a patient to be classified over time as having better fear, discharge FABQ had to be above the cut point and change (discharge intake) in FABQ had to be clinically important. Risk-adjusted analyses of covariance (ANCOVAs) were used to test purpose 1. Multivariate regression models were used to test purpose 2.

RESULTS: ANCOVA results supported time-dependent PPC and FABQ classification methods predicted change in FS and PI; only PPC predicted visits or duration. Regression results suggested PPC controlled 125% more data variance compared to FABQ for change in FS using either intake or time-dependent classification methods. PPC controlled 78% data variance compared to FABQ for change in PI using intake classification methods; PPC controlled 6 times more PI data variance compared to FABQ using time-dependent classification methods.

CONCLUSIONS: Results supported predictive validity of time-dependent, dual-level classification methods. Tracking PPC and FABQ over time tended to increase the power of predictive validity models compared to using intake PPC and FABQ classification models. Within time (intake or time-dependent data), PPC classification controlled relatively more data variance compared to FABQ classification for all dependent variables, with intake PI being the only exception.

CLINICAL RELEVANCE: Classification processes should mimic clinical reality and capture changes in clinical status as patients progress through treatment. Data supported classifying patients over time. Time-dependent PPC and FABQ classifications are clinically useful for understanding differences in outcomes within samples of patients with NSSS.

OPL7

EFFECTIVENESS OF AN EXTENSION-ORIENTED TREATMENT APPROACH IN A SUBGROUP OF PATIENTS WITH LOW BACK PAIN: A RANDOMIZED CLINICAL TRIAL

Browder D, Childs 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). Presence of the centralization phenomenon with extension movements performed during the physical examination is the key criteria for inclusion in this subgroup of patients. Trunk strengthening exercises are an evidence-based alternate exercise that is not matched to this subgroup. 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 but-

tocks 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 patients receiving 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.

OPL8

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 proposed to improve treatment effectiveness by directing treatment 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 patients in the mobilization 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 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 subgroups 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.

OPL9

THE EFFECTIVENESS OF IONTOPHORESIS WITH 4 MG/ML DEXAMETHASONE VERSUS 5% ACETIC ACID IN PATIENTS DIAGNOSED WITH PLANTAR FASCIITIS

Fallano J, Ioli J, McLoughlin J, Watkins MP, Klein A

Rehabilitation Services, Brigham and Women's Hospital, Boston, MA; Orthopedic Department, Division of Podiatry, Brigham and Women's Hospital, Boston, MA; MGH Institute of Health Professions, Boston, MA

PURPOSE/HYPOTHESIS: Plantar fasciitis is one of the most common causes of inferior heel pain. It is an inflammatory condition that affects approximately 10% of the population. A majority of the research reports that 80% to 90% of patients diagnosed with plantar fasciitis will have a complete resolution of symptoms with conservative treatment in less than 18 months. Iontophoresis, the introduction of medication into an area via an electrical current, is one conservative modality used to treat plantar fasciitis. Acetic acid and dexamethasone are 2 medications that have been studied and have demonstrated favorable results in the treatment of plantar fasciitis. No studies have been performed that examine if a difference exists between the effectiveness of the 2 medications. The purpose of this pilot study was to examine which medication is more efficient and effective in the treatment of plantar fasciitis with iontophoresis: 4 mg/ml dexamethasone or 5% acetic acid.

NUMBER OF SUBJECTS: Sixteen subjects, age 26 to 60 years (mean ± SD, 46.7 ± 10.6 years), with a diagnosis of plantar fasciitis, participated in this study.

MATERIALS/METHODS: A prospective randomized double blind study design with repeated measures was used. Two podiatric physicians at Brigham and Women's Hospital referred potential subjects to the Rehabilitation Services Department. The subjects were randomly assigned to receive either dexamethasone or acetic acid with the iontophoresis treatment and all the subjects were instructed in a standard home exercise program. Treatment, consisting of 80 mA-min of iontophoresis, was administered twice a week for a maximum of 4 weeks. The visual analog scale (VAS) and the Foot and Ankle Outcome Score (FAOS) were used to assess the subjects overall outcome.

RESULTS: Both iontophoresis treatments with dexamethasone and acetic acid demonstrated a significant difference in VAS from the initial evaluation and discharge (P<.05). Acetic acid was shown to have a significant difference in 2 of the 5 subcategories of the FAOS (P<.05) while dexamethasone demonstrated no significant differences in any of the subcategories. However no significant difference existed in the overall outcome as measured by the VAS and FAOS between the 2 medications.

CONCLUSIONS: No significant difference appears to exist between the 2 different medications used with iontophoresis in the treatment of plantar fasciitis. Further study is recommended to attempt to answer the original question due to the small sample size.

CLINICAL RELEVANCE: To determine if iontophoresis with either 4 mg/ml dexamethasone or 5% acetic acid is more efficient or effective in treating plantar fasciitis.

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, <.306) or pes cavus (n = 35; AHI, >.386) based on AHI values 1.5 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: nonshod (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. Modified 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). Independent variables were arch type (pes planus and cavus) and shod condition (NS, MC, and C). Correlation coefficients were derived to analyze the relationship between static AHI and dynamic MAI for all shod conditions.

RESULTS: A significant interaction effect was found for MAI between shod condition and arch type (P = .017). For subjects with pes planus there was a significant difference in MAI between NS and both shod conditions (P<.001) and between C and MC conditions (P<.001). For subjects with pes cavus, significant differences in MAI were found only between NS and both shod conditions (P<.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 (P<.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 = –0.68; MC, r = –0.70; C, r = –0.72).

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.

OPL11

EFFECT OF THE AIRLIFT PTTD BRACE ON FOOT KINEMATICS IN SUBJECTS WITH STAGE II POSTERIOR TIBIAL TENDON DYSFUNCTION

Neville CG, Flemister 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 Optotrak Motion Analysis System (Northern Digital, Inc, CAN) and Motion Monitor Software (Innsport 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 (z-x-y sequence) including HF inversion/eversion, FF dorsiflexion/plantar flexion, and FF abduction/adduction. The midstance phase of gait, immediately following footflat 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.

OPL12

EVIDENCE OF VALIDITY FOR THE FOOT AND ANKLE ABILITY MEASURE (FAAM) IN INDIVIDUALS WITH CHRONIC ANKLE INSTABILITY

Carcia 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.

NUMBER OF SUBJECTS: 15 individuals with CAI and 15 normal individuals.
MATERIALS/METHODS: All subjects were competitive college athletes with an average age of 20 (SD, 1.3). There were 14 females and 16 males. During a preseason evaluation subjects completed the FAAM Activities of Daily Living (ADL) and Sports subscales, global rating of function (0%-100%) for ADLs, global rating of function (0%-100%) for sports activities, and a categorical rating of function (normal or abnormal). One-way ANOVAs were used to assess if differences existed between mean FAAM scores. Pearson correlation coefficients were used to assess the relationship between FAAM scores and global rating of function values. Alpha was set at $P<.05$ for all comparisons.
RESULTS: ADL subscale scores were different ($F_{1,28} = 36.4$; $P<.0001$) between those with CAI (mean, 88) and normals (mean, 100). Sports subscale scores were also different ($F_{1,28} = 45$; $P<.0001$) between those with CAI (mean, 76) and normals (mean, 99). ADL scores were not different ($F_{1,28} = .34$; $P = .57$) between males (mean, 95) and females (mean, 93). Sports subscales scores were also not different ($F_{1,28} = .84$; $P = .37$) between males (mean, 85) and females (mean, 90). Within the CAI group, Sports subscale scores were different ($F_{1,13} = 6.3$; $P = .026$) 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 different ($F_{1,13} = 3.1$; $P = .59$) between those that reported normal level of function (mean, 90) from those that reported an abnormal level of function (mean, 87). Using all subjects, significant relationships were found between ADL subscale scores and the ADL global rating ($r = .55$; $P = .001$) and Sports subscale scores and the sports global rating ($r = .79$; $P<.0001$).
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.

OPL13

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; Physiotherapy, University of Queensland, Brisbane, QLD, Australia

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, or acute injury 6 months prior to the start of the study. The mean age of the AKP group was 29.4 years and 29 years for the NoAKP group.
MATERIALS/METHODS: Each subject had their dorsal arch height (AHwb) and midfoot width (MFWwb) 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 (AHnwb) and midfoot width (MFWnwb) 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 (DiffMFW) was calculated by subtracting MFWwb from MFWnwb. The difference in dorsal arch height (DiffAH) was calculated by subtracting AHnwb from AHwb. The mobility magnitude (MobMag) was calculated as the square root of the sum of DiffAH squared and DiffMW squared. The AHR was used to assess foot posture while the MobMag was used to assess foot mobility. To determine intrarater and interrater reliability, a random sample of 12 subjects was selected and analyzed by 3 physical therapists with varying levels of clinical experience. Intra and interrater reliability was assessed using an intraclass correlation coefficient (type 2,1). A series of *t* tests were used to determine if differences existed between the AKP and NoAKP groups for the variables measured.
RESULTS: The intrarater reliability for the 3 therapists ranged from .97 to .99. Interrater reliability ranged from .9 to .98. *t* test results showed that the AHR was not significantly different ($P>.05$) between groups, but significant differences were noted between the 2 groups for DiffAH ($P<.02$) and MobMag ($P<.003$).
CONCLUSIONS: The results indicate that while differences in foot posture did not exist between subjects with AKP in comparison to the control, measures of foot mobility were significantly different. The AHR, DiffMFW, DiffAH, and MobMag were shown to have high levels of intrarater and interrater reliability.
CLINICAL RELEVANCE: While previous studies have suggested that variations in foot posture and mobility are present in individuals with AKP, the measurement techniques utilized to assess foot posture and mobility have had poor levels of reliability. The results of this study demonstrate that while foot posture may not be different between individuals with AKP in comparison to controls, foot mobility as determined using a composite static measure such as the mobility magnitude is different between the 2 groups.

OPL14

RELIABILITY OF THE FOOT POSTURE INDEX

Cornwall MW, McPoil T, Lebec M, Wilson J
Program in Physical Therapy, Northern Arizona University, Flagstaff, AZ

PURPOSE/HYPOTHESIS: The Foot Posture Index (FPI) is designed to quantify standing foot posture as either supinated or pronated. When the FPI was first described, the therapist would visually rate a person's foot shape based on 8 characteristics and assign a value between negative 2 (supinated) and positive 2 (pronated). The resulting score would range from a negative 16 to a positive 16. Recently, the tool has been modified to include only 6 characteristics with the resulting score being from negative 12 to positive 12. Although intrarater and interrater reliability has been reported to be .809 and .580, respectively, for the 8 characteristic FPI, to date there has not been an analysis of the reliability of the new 6 characteristic FPI version. The purpose of this study was to determine the intrarater and interrater reliability of the new 6-factor FPI.
NUMBER OF SUBJECTS: Forty-six individuals (22 male and 24 female) with a mean age of 26 years were recruited to participate in this study. All subjects were asymptomatic at the time of the study.
MATERIALS/METHODS: The posture of each subject's feet was rated twice by 3 different raters, with at least 15 minutes between each rating. The first rater was a physical therapy student with no experience using the FPI. The second rater was a physical therapist with 9 years of experience, but had no prior experience using the FPI. The third rater was a physical therapist with over 25 years of experience and had prior experience using the FPI. Rater 1 and 2 received a 1-hour training session on how to score the FPI. In addition to descriptive statistics, intraclass correlation coefficients (ICC) were used to assess each rater's reliability as well as the amount of reliability between the 3 raters.
RESULTS: The mean FPI value for all of the subjects was found to be 2.2 (±2.9), 2.9 (±3.0), and 2.7 (±2.7) for the 3 raters respectively. No statistically significant difference ($P>.05$) was found between the FPI values of the 3 raters. The intrarater reliability $ICC_{2,1}$ values for the 3 raters ranged from 0.928 to 0.937. The $ICC_{3,1}$ for interrater reliability was found to be 0.590.
CONCLUSIONS: The revised 6-factor FPI appears to have higher intrarater reliability compared to the previous 8-factor version. The interrater reliability, however, remains only moderate. A comparison of the scoring of each rater revealed that differences of as much as 8 points existed between the raters and the amount of agreement between raters on the total score ranged from 11.9% to 18.5%.
CLINICAL RELEVANCE: The FPI provides the clinician with a quick tool to assess overall posture of the foot in standing. Although intrarater reliabil-

ity is very high, even with minimal experience or training, the amount of agreement between raters is only moderate. Clinicians therefore should use caution when comparing a FPI score obtained by one individual with that of another. Finally, level of training or length of clinical experience does not appear to be a factor in determining the level of agreement between therapists.

OPL15

IMMOBILIZATION-INDUCED BONE LOSS IN DIABETIC FOOT DISEASES

Sinacore DR, Hastings MK, Bohnert KL

Physical Therapy/Internal Medicine, Washington University School of Medicine, Saint Louis, MO; Physical Therapy, Washington University School of Medicine, Saint Louis, MO; Physical Therapy/Orthopaedic Surgery, Washington University School of Medicine, Saint Louis, MO

PURPOSE/HYPOTHESIS: Diabetic foot disease (DFD) is an amalgam of impairments including peripheral neuropathy (PN), ulceration, fracture or arthropathy. Physical therapists often treat DFD with maximal off-loading using total contact cast (TCC) immobilization. Our purpose is to determine the impact of immobilization-induced bone loss in individuals with DFD.

NUMBER OF SUBJECTS: Twenty-nine subjects (15 men, 14 women; 24 Caucasian, 5 Black; mean ± SD age, 54 ± 11 years) with chronic diabetes mellitus (DM), PN were studied. Twelve subjects had a unilateral acute neuropathic (Charcot) arthropathy (NCA) of the ankle or foot without ulceration, while 17 subjects had a unilateral plantar ulceration without NCA.

MATERIALS/METHODS: Bone mineral density (BMD) was estimated in each calcaneus using quantitative ultrasonometry (QUS-Sahara Clinical Bone Sonometer, Hologic, Bedford MA). All subjects were immobilized in a TCC for an average of 6-12 weeks to achieve successful healing and were assessed for BMD before and after an average of 35 weeks. Estimates of mean BMD of the immobilized foot with plantar ulceration (or NCA) was compared to the nonimmobilized foot without ulceration or NCA using *t* tests for paired observations. The percent of immobilized and nonimmobilized feet in each group that demonstrated a loss or gain in BMD over the average of 35 weeks were calculated.

RESULTS: Prior to TCC treatment, the mean ± SD estimated BMD in the immobilized foot with plantar ulceration was 0.403 ± 0.12 g/cm; while the contralateral nonimmobilized foot without plantar ulceration was 0.483 ± 0.12 g/cm ($P<.001$). The immobilized foot with acute NCA had a before treatment BMD of 0.448 ± 0.11 g/cm while the contralateral nonimmobilized foot averaged 0.453 ± 0.10 g/cm (NS, $P>.05$). After 35 ± 22 weeks, the immobilized foot with plantar ulceration lost only 3 mg/cm of bone, while the contralateral nonimmobilized foot lost only 6 mg/cm of bone. By contrast, the immobilized foot with NCA lost 48 mg/cm and the nonimmobilized foot lost 46 mg/cm. Fifty-three percent of immobilized feet with plantar ulceration lost bone, while 47% of feet gained BMD. By contrast, 92% of feet immobilized with NCA lost bone while only 8% gained bone after 35 weeks.

CONCLUSIONS: There is a significant greater loss of pedal bone in the immobilized and nonimmobilized feet of individuals with DM, PN and recent-onset NCA compared to individuals with DM, PN and plantar ulceration. It is likely that several synergistic factors account for these differences including the response to immobilization and perhaps a more prolonged inflammatory osteolysis attributable to the impairment-specific response of NCA to immobilization.

CLINICAL RELEVANCE: We speculate that the more pronounced osteolysis in individuals with DM, PN and NCA impairment may contribute to the insidious and progressive onset of deformities that are the hallmarks of the chronic Charcot rocker-bottom foot. Physical therapists treating DFD with TCC immobilization should recognize the variable extent of pedal bone loss among impairments of DFD. Supported by NIDDK R01 DK59224.

OPL16

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 talocrural arthroscopy placement of 2 cartilage growth stimulation picks 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), medial 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 uninvolved side post immobilization. Post reloading, total foot 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 involved side remained 9% 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, 2RO1 HD036895-04A1, and 1R21 HD048972-01.

OPL17

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-

ficial therapy for OA; the mechanism of action of both processes is unknown. The purpose of this study was to conduct a related series of investigations concerning specific biological aspects of the role of endogenous and exogenous HA in the development and progression of OA in the human knee.

NUMBER OF SUBJECTS: 10.

MATERIALS/METHODS: Gel electrophoresis and light-scattering were used to measure the concentration and molecular-mass distribution of HA in SF of subjects with and without OA. Western blots were used to quantify HA receptor expression in synovial tissues. Enzymatic and immunosorbent assays were used to measure the activity and presence of inflammatory mediators in media conditioned by synovial cells exposed to various HA concentrations and sizes.

RESULTS: The concentration and molecular mass of HA in SF did not differ between subjects with and without OA. Subjects with OA had significantly increased expression of the HA receptors CD44, RHAMM, and TSG-6 ($P<.05$). HA of 35-790 kDa and 7-500 μg/mL did not elicit a proinflammatory response in OA synovial tissue or HIG-82 synovial cells. HA of 12.81 MDa reduced IL-1β-induced MMP activity in a concentration-dependent manner at 4 and 8 mg/mL and at 8 mg/mL reduced the concentration of IL-1β in media conditioned by synovial cells.

CONCLUSIONS: The assumption that the concentration and molecular mass of HA in synovial fluid are reduced in persons with OA is likely incorrect. The beneficial effects of high-molecular-mass HA in the treatment of OA may result from a reduction in the concentration of IL-1β.

CLINICAL RELEVANCE: Upregulation of HA receptors may be responsible for the perpetuation of the inflammatory process of OA and may represent a potential target in the design of therapeutic strategies to manage inflammation associated with OA.

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

Physical Therapy, University of Utah, Salt Lake, UT; Exercise Science, University of Utah, Salt Lake, UT; Orthopedics, University of Utah, Salt Lake, UT

PURPOSE/HYPOTHESIS: Thigh muscle atrophy is a major impairment that occurs early after anterior cruciate ligament reconstruction and persists for several years. Eccentric resistance training has the potential to induce considerable muscle size and strength gains that could prove beneficial during postoperative rehabilitation. The purpose of this study was to evaluate the effects of progressive eccentric exercise on thigh muscle structure in individuals having anterior cruciate ligament reconstruction.

NUMBER OF SUBJECTS: 40.

MATERIALS/METHODS: Beginning 3 weeks after surgery, subjects were randomly assigned into either a 12-week eccentric or standard rehabilitation program. To evaluate changes in muscle structure, magnetic resonance images of the involved and uninvolved thighs were taken before and after training. Volume and peak cross-sectional area of the quadriceps, hamstrings, gracilis and distal portion of the gluteus maximus were calculated from these images.

RESULTS: Improvement in quadriceps and gluteus maximus volume and peak cross-sectional area was significantly greater in the eccentric group for both the involved and uninvolved lower extremities, and for those with either the semitendinosis-gracilis or bone-patellar-tendon-bone grafts ($P<.01$). The magnitude of volume change was over 2-fold greater in the eccentric group (ie, improvement in involved quadriceps volume: eccentric, 23.91% ± 12.9%; standard, 8.8% ± 9.3%). No significant differences were observed between rehabilitation groups for any hamstring or gracilis structural measurements (P value range, 0.23-0.92). However, marked reductions in volume and peak cross-sectional area of the gracilis were observed in those who had reconstruction with the semitendinosis-gracilis graft, regardless of treatment group.

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.

OPL19

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

Hayes D, Loghmani MT, Lubitz R, Moore E

Department of Physical Therapy, Indiana University, Indianapolis, IN; Rehabilitation Services, St. Vincent Hospital, Indianapolis, IN; Medical Education, St. Vincent Hospital, Indianapolis, IN

PURPOSE/HYPOTHESIS: Soft tissue mobilization (STM) is a common therapeutic intervention used to facilitate the healing process of injured soft tissues, thereby improving patient function and reducing pain. Work-related musculoskeletal disorders have been reported in therapists who provide manual therapy, such as instrument-assisted soft tissue mobilization (ISTM). The purpose of this study was to compare the effects of specially designed ISTM instruments, the Graston Technique (GISTM), with a traditional instrument, the metal end of a 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.

NUMBER OF SUBJECTS: 13 therapists at a metropolitan hospital.

MATERIALS/METHODS: Therapists (13) treated outpatients (23) diagnosed with plantar fasciitis (17) or lateral epicondylitis (6) for 10 therapy sessions. Patients were randomized into the GISTM or TISTM group. Therapist discomfort/fatigue was assessed at the end of each treatment session using a visual analog scale (0 to 10; 0 = no discomfort/fatigue). Therapists also listed upper extremity (UE) body areas in which they experienced discomfort/fatigue and documented time spent on ISTM per treatment session. Analysis of variance (ANOVA) was performed to examine the difference between groups for discomfort/fatigue and Txtime.

RESULTS: Therapists completed a total of 212 visits with the total number of visits/therapist ranging from 8 to 45. The GISTM instruments were used on 12 patients (52%) for 57% of all visits. Mean and standard deviations (SD) for discomfort/fatigue were 1.27 ± 1.57 in the GISTM group; 2.71 ± 2.27 in TISTM group. Mean and SD Txtime in the GISTM group were 14.18 ± 3.65 minutes; 14.99 ± 3.65 in the TISTM group. ANOVAs indicated therapists had significantly less discomfort/fatigue with the GISTM instruments ($F = 27.07$; $P = .0001$). Txtime between groups was not significantly different ($F = .29$; $P = .59$). UE body areas that therapists reported significantly less discomfort/fatigue with the GISTM instruments were hand ($P = .0005$) and thumb ($P = .016$).

CONCLUSIONS: Preliminary data suggest that specially designed instruments benefit therapists by decreasing their discomfort/fatigue during ISTM treatment sessions. The type of instrument used for ISTM does not appear to affect the length of treatment sessions. A potential study limitation is exclusion of a control group.

CLINICAL RELEVANCE: Therapists should consider using specially designed instruments, as compared to traditional instruments, during ISTM treatment sessions to reduce and possibly prevent work related musculoskeletal disorders/conditions. Additional research comparing ISTM to manual STM, and different instrument designs and materials needs to be completed.

OPL20

LONG-TERM EFFECTS OF INSTRUMENT-ASSISTED CROSS-FIBER MASSAGE ON HEALING MEDIAL COLLATERAL LIGAMENTS

Loghmani MT, Kiesel J, Lassiter J, Taylor L, Beaman M, Grogg J, Streeter H, Warden SJ

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 isofluorane 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: The mean 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 a biomechanical property 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.

CLINICAL 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.

OPL21

USE OF REHABILITATIVE ULTRASOUND IMAGING TO CHARACTERIZE ABDOMINAL MUSCLE STRUCTURE AND FUNCTION IN LOWER EXTREMITY AMPUTEES

Gill NW, Springer BA

Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, Washington, DC

PURPOSE/HYPOTHESIS: Lumbar stabilization and core strengthening exercises are key components of rehabilitation following limb amputation to address movement, balance and gait impairments arising from an altered center of gravity. As part of routine clinical practice, amputees at our facility receive rehabilitative ultrasound imaging (RUSI) of the lateral abdominals as both a biofeedback/training and assessment tool. It is unknown whether there is a side-to-side difference in abdominal muscle thickness or in the ability to preferentially activate the transversus abdominis based on level of amputation. There exists the possibility that specific rehabilitation strategies are needed for different populations within the amputee community.

NUMBER OF SUBJECTS: Over a period of 20 months, 70 patients with unilateral lower extremity amputations received an RUSI examination. There were 39 subjects with transtibial amputations (TTA) and 31 with transfemoral amputations (TFA).

MATERIALS/METHODS: A retrospective review of clinical records was conducted. The subjects were imaged at various stages during their therapy program when deemed appropriate by the therapist. The lateral abdominals at the level directly above the iliac crest were imaged on both sides using a standardized technique. The average of 2 measurements was taken of the resting and contracted thickness of the transversus abdominis (TrA), and the external obliques and internal obliques combined (EO + IO). Contraction ratios for the TrA and EO + IO, along with the preferential activation ratio for the TrA were calculated. 2 × 2 mixed-model ANOVAs were used to compare side-to-side (amputated versus nonamputated) and between group (TTA versus TFA) differences for thickness and contraction ratios, using an alpha of .05.

RESULTS: There was a significant increase in thickness of the superficial abdominals (EO + IO) on the side of amputation, but no difference between groups. No side-to-side or group differences were found in the TrA thickness. However, there was a significant difference in the ability to preferentially activate the TrA, with the TTA group demonstrating an improved ability over the TFA group. No side-to-side differences in the muscle activation ratios were found.

CONCLUSIONS: The results suggest that the superficial abdominals hypertrophy on the side of amputation regardless of whether the amputation occurs above or below the knee. This may be a result of an altered movement or gait strategy. Further, those with TFAs appear to have a more difficult time preferentially activating the TrA.

CLINICAL RELEVANCE: Rehabilitative ultrasound imaging can be a useful adjunct in the assessment and management of amputees undergoing a lumbar stabilization or core stability exercise program. Exercises are generally geared towards both sides, but may need to be modified in those with asymmetric muscle thicknesses. Additionally, an increased emphasis during the early phase exercises on preferential activation of the transversus abdominis may be appropriate in the transfemoral amputee population.

OPL22

USE OF DIAGNOSTIC IMAGING TO IDENTIFY A LIPOSARCOMA

Garber MB, Middag TR

US Army-Baylor University DSc Program in OMPT, Ft. Sam Houston, TX; McWethy Troop Medical Clinic, Brooke Army Medical Center, Ft. Sam Houston, TX

BACKGROUND AND PURPOSE: It is important for physical therapists to recognize when diagnostic imaging is necessary to assist in the clinical decision-making process. A case is presented illustrating how a physical therapist, credentialed to request and review diagnostic imaging, effectively and efficiently utilized multiple forms of diagnostic imaging to assist in the differential diagnosis and clinical decision-making process.

CASE DESCRIPTION: The case report describes the differential diagnostic process for a 58-year-old school teacher with a 5-year history of swelling in his left thigh. He initially presented to his primary care provider (PCP) after twisting his knee in June 2000. He noted swelling in his thigh 3 months later. After multiple visits to his PCP he was referred to an orthopedic surgeon who diagnosed a meniscal tear. The patient subsequently underwent arthroscopic partial meniscectomy, but his thigh swelling persisted. His symptoms continued for several years with progressive stiffness and pain in his knee and thigh. The orthopedic surgeon prescribed a TENS unit which improved the patient's symptoms, but his

insurance company would not continue payment for the TENS. He was referred to physical therapy for evaluation of a home TENS unit. The patient denied feeling sick, any fevers, chills, night sweats, or unexplained weight changes. Examination revealed considerable edema in the thigh with decreased knee range of motion. No palpable mass was detected.

OUTCOMES: The patient had knee radiographs in October 2000, but had not had any diagnostic imaging of his thigh or femur. The physical therapist requested radiographs of the thigh which revealed a large mass consistent with a possible liposarcoma. Subsequent magnetic resonance imaging confirmed the presence of a large lipomatous mass, but a definitive diagnosis could not be made. The patient was referred to an orthopedic oncologist who biopsied the area and eventually removed an 8-lb mass from the patient's thigh. Pathology reports indicated a low level liposarcoma.

DISCUSSION: In this case the physical therapist requested imaging needed for appropriate management despite the patient having previously seen 2 other providers. In this example, the physical therapist effectively communicated with radiologists to assist in the clinical decision-making process. Additional communication with an orthopedic oncologist indicated a high suspicion for a liposarcoma. The patient subsequently underwent surgery for removal of a large liposarcoma which relieved his symptoms. It is important that physical therapists understand when diagnostic imaging is necessary to assist in the differential diagnosis of patients. Likewise, it is important for physical therapists to be competent in interpreting the results of these tests. This case provides a strong example of how good communication between providers on the medical team results in appropriate and efficient delivery of healthcare.

OPL23

EVIDENCE OF RELIABILITY AND RESPONSIVENESS FOR THE HIP OUTCOME SCORE (HOS)

Martin RL, Philippon MJ, Briggs K

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

PURPOSE/HYPOTHESIS: Previous work has demonstrated evidence of validity to support the use of the Hip Outcome Score (HOS). The purpose of this project was to assess the reliability and responsiveness of both the HOS Activities of Daily Living (ADL) and Sports subscales.

NUMBER OF SUBJECTS: 108 subjects in a group that changed and 18 subjects in a 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, 85-399 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 ($ICC_{2,1}$) 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 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.

OPL24

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, 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 y) The following procedures were performed: labral debridement (89%), labral repair (10%), microfracture (23%), chondroplasty (32%), capsular modification (70%), psoas release (62%), iliotibial band release (13%), and ligamentum teres debridement (53%). The HOS ADL and Sport subscales were related to the SF-36 physical function subscale ($r = .81,.82$) and physical component summary score ($r = .76,.79$) while being less related to the SF-36 mental function subscale ($r = .38,.41$) and mental component summary score ($r = .16,.18$). Correlations between the HOS subscales and measures of physical function were significantly different than their correlation to measures of mental functioning ($P<.005$). One-way ANOVA and post hoc comparison found that both HOS ADL and Sports subscale scores were significantly different ($P<.005$) at each of the 4 reported activity levels (severely abnormal, abnormal, nearly normal, and normal). Individuals that reported an excellent to good outcome scored significantly higher than individuals that reported a fair to poor outcome on the HOS ADL and Sports subscales ($P<.0005$). Individuals with no arthritis/minimal arthritis scored significantly higher than individuals with mild/moderate/advanced arthritis on the HOS ADL and Sports subscales ($P = .005$, $P = .001$).

CONCLUSIONS: The results of this study offer evidence of usefulness for the HOS as scores related to other measures of function and were different between individuals at different activity levels, outcomes and degree of arthritis.

CLINICAL RELEVANCE: 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.

OPL25

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 exercise) incorporated into a more standard regimen consisting of scapular strengthening, rhythmic stabilizations, PNF, strengthening of isolated shoulder motions, allowed the patient to regain enough strength in his involved shoulder to feed himself, open doors and care for himself without pain or difficulty.

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 and driving. He was discharged with a DASH score of 44%.

DISCUSSION: Latissimus dorsi transfer surgery has been shown to improve pain and function in those with irreparable rotator cuff repair. This salvage procedure along with physical therapy intervention helped return a highly active individual with a poor prognosis to a more functional and active life style.

OPL26

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 gymnast 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 ¼ × BW to 4 × BW. 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.

OPL27

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 instituted in-house medical and therapy services to reduce the financial impact of such injuries (Bronner, Ojofeitimi, and Rose, 2003; Garrick and Requa, 1993; Solomon, Solomon, Micheli, and McGray, 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, new workers' compensation claims, experience modification ratio (EMR), and healthcare costs, comparing the preintervention (2 years) and an extended postintervention period (6 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 physcal therapists from the same sources. Preintervention (2 years) and postintervention (6 years) number of injuries, new 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 $P<.05$ 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 subtantiated 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.

OPL29

FLEXOR HALLUCIS LONGUS TENDINITIS IN A DANCER

Berglund CL, Philipps LE, Ojofeitimi S

Physical Therapy, University of St. Augustine for Health Sciences, St. Augustine, FL; Division of Physical Therapy, West Virginia University, Morgantown, WV; Analysis of Dance and Movement (ADAM) Center, Long Island University, Brooklyn, NY

BACKGROUND AND PURPOSE: Although rare in the general population, flexor hallucis longus (FHL) tendinitis is common in dancers. Dancers place increased stress and high demands on the FHL, predisposing them to tendinitis from overuse. Repetitive movements involving excessive plantar flexion of the toes, foot, and ankle, such as going from demi-plié to pointe or jumping, can lead to irritation and inflammation of the FHL tendon. 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.

OUTCOMES: Two weeks after her presentation she discontinued her class modifications and returned to full activity. Six weeks later she remained symptom free.

DISCUSSION: Due to the repetitive nature of dancing, the FHL is continually stressed and subject to tendinitis from overuse. Additionally, improper technique may place an increased strain upon the FHL. These factors predispose the dancer to injury. The treatment approach varies in the literature and ranges from conservative physical therapy management to surgical treatment followed by rehabilitation. Additionally, the outcomes vary. Despite the method of treatment, the dancer can often return to full activity with the complete resolution of symptoms. As physical therapists, we have a responsibility to ensure our patients receive the best quality of care. Dancers are a very unique population. Creative strategies are necessary to meet the demands required by them in order to return to full activity as soon as possible.

OPL30

INJURY PATTERNS IN ELITE ADOLESCENT PREPROFESSIONAL BALLET DANCERS AND THE USE OF SCREENING DATA TO DESCRIBE AND PREDICT INJURY CHARACTERISTICS

Gamboa JM, Roberts LA, Mahring 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%, 42.9%) remained similar. The order of most to least common area of injury was: foot/ankle (45.8-55.6%), hip (11.1%-45.8%), knee (4.2%-25%), and back (4.2%-9.3%). Few significant differences were identified among screening variables between injured and noninjured dancers

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 by 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 ranges 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 GFMT is a stable measure of gymnastics abilities that is designed to better foster coaches and trainers capability to monitor athletic physical progression. The measurement tool is designed to help identify weaknesses in physical abilities that can be corrected to create a more physically rounded gymnast. In addition, the GFMT can be used as a measure of physical fitness when returning from an injury or from seasonal time off. Following longitudinal testing, the GFMT could conceivably be used as a predictor of gymnastics related injury.

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 proposing 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.
IMPORTANCE 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

Ludewig PM, Phadke V, Hassett DR, Cieminski 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 (clavicle 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 signicantly 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 internaly 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, Kalra N, Pinkstaff S, Ericksen J, Boardman ND

Physical Therapy, VCU-MCV Campus, Richmond, VA; VCUHS 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 without the projectional artifacts. The purpose of this study is to examine the ability of ultrasonography (US) to measure the subacromial space in patients with rotator cuff disease.

NUMBER OF SUBJECTS: Subjects (n = 20): with partial thickness RC tears (n = 4), with subacromial impingement syndrome (n = 4), and free from shoulder pain (n = 12). For subjects with RC disease, the diagnosis was rendered with an MRI.

MATERIALS/METHODS: All subjects were seated, with their shoulder exposed. 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 [$ICC_{3,1}$] 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, Deyle 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. Patients in the comparison group received 7 sessions of impairment-based mobilization, and the same 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 by a blinded evaluator included SPADI scores and shoulder combined passive range of motion (CROM). The Friedman ANOVA was used to assess the change in outcome measures over time for each group. The Mann-Whitney *U* test was used to compare outcome measures between groups.

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

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.

OPL36

PLASTICITY OF MUSCLE ARCHITECTURE AFTER ACUTE SUPRASPINATUS TEAR

Ward SR, Sarver JJ, Eng CM, Wuergler-Hauri CC, Perry SM, Williams GR, Soslowsky LJ, Lieber RL
Radiology, University of California San Diego, La Jolla, CA; Orthopaedic Surgery, University of California San Diego, La Jolla, CA; Orthopaedic Surgery, University of Pennsylvania, Philadelphia, PA

PURPOSE/HYPOTHESIS: Although it is accepted that muscle performance changes after rotator cuff tears, there are no quantitative data in the literature to support this assertion. Therefore, our purpose was to measure the architectural properties of the supraspinatus muscle after a complete tear of its distal tendon.
NUMBER OF SUBJECTS: Twenty Sprague-Dawley rats.
MATERIALS/METHODS: Supraspinatus muscles were released from the left humerus of 20 rats (mass, ~450 g) and animals were returned to cage activity for 14 days (n = 12) or 28 days (n = 8) before sacrifice. Shoulders were skinned and placed in formalin for 48 hours, then rinsed in 0.2M PBS. Measurements of muscle mass, pennation angle, fiber bundle length, and sarcomere length permitted normalized fiber length, serial sarcomere number, and physiological cross-sectional area (PCSA) to be calculated. Sarcomere lengths were determined by laser diffraction and were used to normalize fiber lengths. In some animals, shoulders were harvested and sectioned for histological evaluation. To control for growth, right shoulders from the same animal were also analyzed. Paired *t* tests were used to compare the experimental and control muscles and values are reported as percent difference (mean ± SE) from the contralateral muscle.
RESULTS: Coronal oblique sections of the supraspinatus confirmed surgical transection of the supraspinatus muscle at 2 weeks, but revealed reattachment by 4 weeks. Not surprisingly, muscle mass was significantly lower in released muscles at 2 weeks (–16.5% ± 1.8%, $P<.001$), but were returning to control values by 4 weeks (–10.0% ± 1.8%, $P = .003$). Sarcomere lengths were significantly shorter at 2 weeks (–10.0% ± 1.6%, $P<.001$) but not different from the control muscle by 4 weeks. However, normalized fiber lengths were significantly shorter in released muscles compared to control muscles at 2 weeks (–8.7% ± 2.4%, $P = .006$) and 4 weeks (–12.5% ± 2.6%, $P = .005$), indicating reduction in serial sarcomere number. Interestingly, the opposing effects of smaller mass and shorter fibers produced a trend towards reduced PCSA at 2 weeks (–8.0% ± 3.9%, $P = .06$), but PCSA returned to control levels by 4 weeks.
CONCLUSIONS: Muscle fiber length decreased in surgically released supraspinatus muscles due to reductions in serial sarcomere number. Despite the rat's ability to reattach the supraspinatus muscle by 4 weeks, fiber lengths were still short, perhaps due to muscle retraction at the time of injury.
CLINICAL RELEVANCE: The functional implications of this adaptation would be most profound at the time of repair, when the muscle would be forced to operate over a larger portion of the length-tension curve, or perhaps even more detrimental, beyond the physiological sarcomere length limits. Based on the PCSA results, impairments in force generating capacity would be expected when the muscle is completely detached but should return to normal levels with reattachment. This suggests that post-reattachment weakness may be due to changes in the operating range of the muscle and not reductions to the radial dimension of this muscle.

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 (WUFA) 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 ($P\leq.05$).
RESULTS: Mean baseline WUFA (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 ± 3.2. 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 without this subject's data (–57.7 ± 13.3%). No difference was found in WUFA 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 ($P = .99$) 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 WUFA 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

McClure P, Kareha S, Tate AR, Irwin D, Stuckey 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 or 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.

OPL39

VALIDITY OF A NEW TEST FOR SCAPULAR DYSKINESIA

Tate AR, McClure PW, Irwin D, Kareha S, Stuckey 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 63 collegiate athletes competing in an overhead sport such as baseball, swimming, or water polo.
MATERIALS/METHODS: 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 or 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 based on pain at rest, moderate activity, and strenuous activity. Athletes judged by both raters as having either "normal" motion or "obvious dyskinesia" underwent kinematic testing with a previously validated electromagnetic tracking system while performing the same movements. The kinematic data from those with "normal" motion and "obvious dyskinesia" were compared using a multifactor ANOVA and post hoc testing was performed using the LSD procedure. The relationship between symptoms and scapular dyskinesia was evaluated by odds ratios.
RESULTS: Significant differences during humeral elevation were found between the "normal" and "obvious dyskinesia" groups. Subjects with "obvious dyskinesia" showed less scapular upward rotation ($P<.001$), less clavicular elevation ($P<.0001$), and greater clavicular protraction ($P<.044$). The presence of shoulder symptoms was not significantly different between the "normal" and "obvious dyskinesia" subjects (OR, 0.79; 95% CI, 0.33-1.89).
CONCLUSIONS: Shoulders visually judged as having dyskinesia show distinct alterations in 3-dimensional scapular motion. These alterations have previously been associated with subacromial impingement. However, the presence of scapular dyskinesia was not related to shoulder symptoms in athletes engaged in overhead sports in this study.
CLINICAL RELEVANCE: Scapular dyskinesia in overhead athletes can be visually recognized and distinguished from normal patterns by trained raters using the scapular dyskinesia test. Validity of this test has been demonstrated by differences in scapular kinematics found between subjects with and without dyskinesia.

OPL40

EFFECT OF THE SCAPULA REPOSITION TEST ON IMPINGEMENT 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 athletes competing in an overhead sport.
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, Hawkin's 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

reposition test. For those without impingement, 50% had no strength change and 15.9% were weaker.
CONCLUSIONS: 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 6 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 pulposis. At each segmental level (L1-2 to L5-S1) an apparent diffusion coefficient (ADC) was calculated for the center of the nucleus pulposis. 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, 0 to .90). 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, 13.5) 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 invivo. 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. Follow-up scores on the OSW and NPR were compared between patients with various imaging findings using independent *t* tests or analysis of variance (ANOVA) as appropriate. Post hoc testing was performed as needed using the Tukey procedures.
RESULTS: Symptoms with this group of patients were chronic and severe. The mean duration of current symptoms was 1.9 (SD, 4.2) 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 factor influencing long-term outcomes.

OPL43

A PILOT STUDY OF TRUNK MUSCLE REFLEXES IN FEMALES WITH AND WITHOUT SUBACUTE LOW BACK PAIN

Wadsworth TS, Navalgund A, Buford JA, Heiss DG

Physical Therapy Division, Ohio State University, Columbus, OH; Sports Medicine, Ohio State University, Columbus, OH; Mechanical Engineering, Ohio State University, Columbus, OH

PURPOSE/HYPOTHESIS: Stability of the lumbar spine is maintained by neuromuscular control via active corrective responses and intrinsic joint torques to maintain dynamic equilibrium in the presence of kinematic and control disturbances. Recent work by Moorehouse and Granata (*J*

Biomech, June 2006) indicates that reflex responses are a necessary component in the stabilizing control of spinal stability. The purpose was to investigate the reflex responses of the trunk muscles in females with and without subacute low back pain (LBP).
NUMBER OF SUBJECTS: 6 subjects (4 asymptomatic and 2 with LBP) were studied.
MATERIALS/METHODS: Subjects were secured in a standing frame and subjected to 10 repetitions of 100-N impulse forces which induced trunk flexion. Surface electromyography over the lumbar multifidus, internal oblique, external oblique, and erector spinae recorded the bilateral responses. The response latency was defined as time from perturbation to the start of an event magnitude greater than 2 standard deviations above baseline.
RESULTS: For asymptomatic subjects, the multifidus was consistently (97% of trials) the first responder with a latency less than 30 ms, defined as an M1 response. 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 (volitional 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 volitional 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 latencies. 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: Trunk muscle responses to a perturbation elicited different patterns of EMG responses in symptomatic and asymptomatic females. Further research that can assess the lumbar reflex pattern in this manner may establish a more precise method to assess the changes in motor control associated with LBP and determine the consequences of those changes on spinal stability.

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.

OPL45

NEUROMUSCULAR ELECTRICAL STIMULATION AS AN ADJUNCT TO TRADITIONAL LUMBAR STABILIZATION EXERCISES FOR PATIENTS WITH LUMBAR SEGMENTAL INSTABILITY: A CASE SERIES

Lyons CL, Ross MD
6th Medical Group, USAF, MacDill AFB, FL; 60th Medical Group, USAF, Travis AFB, CA

BACKGROUND AND PURPOSE: Lumbar stabilization training programs are commonly employed for patients with low back pain (LBP) related to lumbar segmental instability. Theoretically, the application of neuromuscular electrical stimulation (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. The purpose of this case series is to describe the use of NMES as an adjunct to a traditional lumbar stabilization program for 4 patients with LBP related to lumbar segmental instability.
CASE DESCRIPTION: Four men (mean age, 30 years; SD, 9.4 years) that had LBP related to lumbar segmental instability participated. The mean duration of the current episode of LBP was 14 (SD, 9.9) weeks and each patient had history and physical examination findings that were consistent with a diagnosis of lumbar segmental instability. Each patient also demonstrated a grade 1 spondylolisthesis and bilateral pars interarticularis defects at the L5-S1 level on conventional radiographs. All patients were treated with a standardized approach, which included treatments of NMES to their lumbar spine musculature and instruction in a lumbar stabilization program. A portable NMES unit was used to stimulate the lumbar musculature. While in a supine hooklying position, patients received 10 seconds of stimulation followed by 30 seconds of rest for a 10 minute treatment session. The patients were asked to contract their abdominal musculature during the NMES stimulation by drawing their abdomen "up and in." The Oswestry Low Back Pain Disability Questionnaire (ODQ) served as our primary outcome measure. All patients completed the ODQ at the time of their initial physical therapy visit, at the time of discharge from physical therapy, and after a mean of 35.5 (SD, 12.4) weeks following their initial physical therapy visit.
OUTCOMES: Each patient demonstrated clinically meaningful reductions in pain and disability following a mean of 6.3 (SD, 2.4) physical therapy visits over a range of 3 to 4 weeks and at a mean follow-up of 35.5 (SD, 12.4) weeks. The mean ODQ score was 37.5 (SD, 12) at the time of the

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, 4.8) 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-load volition 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, nondebilitating 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 premanipulation 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, Fritz 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 Healthy Balance program. The employee was required to participate in pre and post program testing, attend three 1-hour educational 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 Belief 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 = 0.43, 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 spine stabilization exercises demonstrates improvement with basic back beliefs. Identifying and targeting at risk populations may improve outcomes from back school and exercise training programs.

OPL49

MEASUREMENT OF CHANGES IN HAND TEMPERATURE DURING THE UPPER LIMB TENSION TEST USING THERMAL IMAGING

Quick NE
Physical Therapy, University of New England, Portland, ME

PURPOSE/HYPOTHESIS: Previous work has demonstrated increases in blood flow velocity (BFV) during the Upper Limb Tension Test (ULTT) in healthy adults, which is likely related to a reduction in blood vessel diameter as the vessel is stretched during the ULTT. The immediate effect of this may result in ischemia, thus reducing skin temperature within the region affected. Therefore, the intent of this pilot study is to determine if changes in skin temperature occur immediately following the application of the ULTT.
NUMBER OF SUBJECTS: 11 healthy adults (7 female and 4 male) between the ages of 22 and 36 years participated in this study.
MATERIALS/METHODS: Room temperature was maintained between 68°F and 72°F. Each subject rested quietly for a period of 15 minutes prior to testing to acclimate to room temperature. Using Computerized Infrared Thermography (CTI, Inc) the average skin temperature in the right palmar hand was measured before the ULTT with their arm placed into 90° of shoulder abduction and their palm facing upwards (C1) and then immediately after application of the ULTT (C2) with their arm placed in the initial resting position. Ten subjects were right hand dominant while 1 subject was left hand dominant.
RESULTS: The average skin temperature during C1 was 30.6°C (±1.4) and 30.3°C (±1.4) during C2. The mean change in skin temperature was –.3°C (±.2). A 1-tailed paired t test was used to identify statistical differences between conditions (α = .05). Results showed that skin temperature decreased after application of the ULTT (P = .0003).
CONCLUSIONS: Application of the ULTT decreases skin temperature in the hand. This finding is consistent with previous studies that have shown decreases in temperature in the lower extremities following the slump test.
CLINICAL RELEVANCE: The drop in skin temperature noted in this study may be related to decreased blood flow to the palm as a result of reducing blood vessel diameter. This diameter change may lead to temporary ischemia. These findings may account for the subjective symptoms, such as numbness and tingling, reported in healthy adults. Further work is needed in this area to determine if patients with pathology react in a similar manner and whether repeated application of the ULTT, similar to what occurs when this maneuver is used as a treatment, results in vasodilation via a vasomotor reflex.

OPL50

CHANGES IN BLOOD FLOW VELOCITY IN THE RADIAL ARTERY DURING THE UPPER LIMB TENSION TEST

Quick NE, Kelly PJ
Physical Therapy, University of New England, Portland, ME; GE Ultrasound, GE Healthcare, Wauwatosa, WI

PURPOSE/HYPOTHESIS: The Upper Limb Tension Test (ULTT) has continued to become increasingly popular over the past decade. Although there is some research to support its validity, there is still much that is unknown about the physiological response to this technique. Therefore, the intent of this pilot study was to measure the impact of this maneuver on peripheral blood flow in the extremity. This is especially important since it has been shown that peripheral nerves are highly dependent upon blood flow and fail quickly without it.
NUMBER OF SUBJECTS: Eleven healthy adults between the ages of 22 and 51 years of age (5 female and 6 male) participated in this pilot study.
MATERIALS/METHODS: Using a GE Logiq7 ultrasound with a M12L probe, the blood flow velocity (BFV) within the right radial artery at the wrist was measured using pulsed wave Doppler Ultrasound during 2 conditions. Condition 1 (C1) consisted of obtaining a BFV value with their arm positioned in resting at their side. Once a measurement was obtained, the skin was marked to identify the site of measurement. Condition 2 (C2) consisted of obtaining a BFV measurement in the same location as C1 but with their arm placed in the end range ULTT position. During C2 the shoulder was manually blocked from elevation and maintained at 90° of shoulder abduction while the arm was placed into terminal external rotation, elbow extension and wrist extension. In 4 subjects maximal wrist extension caused complete occlusion of the artery. In those instances, the wrist was relaxed until a BFV measurement could be obtained. Consequently, the wrist was passively extended to 75° for 1 subject, 80° for 1 subject, 85° for 1 subject, and 90° for the remaining 6 subjects. All subjects were positioned in full elbow extension.
RESULTS: The mean BFV during C1 was 61.72 cm/s (±9.9 cm/s) and 82.23 cm/s (±14.54 cm/s) during C2. The mean difference between conditions was 20.52 cm/s (±14.13 cm/s). The range in BFV values for C1 was 42.5 cm/s to 74.9 cm/s while the range for C2 was 56.9 cm/s to 108.8 cm/s. A 1-tailed paired t test (α = .05) demonstrated that differences did exist between conditions (P = .0002).
CONCLUSIONS: The results of this study indicate that BFV within the radial artery is increased significantly during the ULTT.
CLINICAL RELEVANCE: Since BFV increases as the blood vessel diameter decreases, this likely indicates that the ULTT imposes a stretch to the blood vessel severe enough to reduce its diameter, in some cases severe enough to completely occlude the vessel. Since changes in diameter likely lead to increased intravessel pressures significant enough to activate sympathetic mechanoreceptors within the vessel wall, these findings may provide an alternate theory for what occurs during treatment using the ULTT. Further investigation is needed to explore this potential vasomotor reflex and to determine if other vessels within the extremity are also affected.

OPL51

DIRECT-ACCESS PHYSICAL THERAPY FOR SOLDIERS WITH ACUTE MUSCULOSKELETAL (MS) INJURIES

Brenner AK

Physical Therapy, US Army, Fort Knox, KY

PURPOSE/HYPOTHESIS: A problem was identified in an Army hospital concerning access times to PT for soldiers with acute injuries. A plan was developed to allow PTs to work along side the primary care physicians during sick call hours to treat the acute MS injuries on a direct access basis. The purpose of this study was to utilize 2 different functional outcomes measures to evaluate the effectiveness of direct access PT interventions in soldiers with acute MS injuries (LBP,ankle and knee injuries) who were seen on a direct access basis by a PT.

NUMBER OF SUBJECTS: In this study 2 groups, direct access (DA) and delayed access (DDA) were compared. Each group (DA and DDA) consisted of 3 subgroups; (1) LBP, (2) knee pain, (3) ankle pain. The DA group contained a total of 78 patients (26 ankles, 25 knees, 27 LBP). The DDA group consisted of 61 patients (20 ankles, 19 knees, 22 LBP).

MATERIALS/METHODS: All soldiers with acute MS injuries were first screened by a medic. Those determined to be MS complaints were sent directly over to see the PT instead of seeing a physician. Soldiers who had ankle, knee or low back injuries 7 days old or less were placed into the DA group. Those soldiers who had similar ankle, knee or low back injuries that were 7 days or more were placed into the DDA group. Each patient was evaluated and treated in PT for a 3 week period. The Lower Extremity Functional Scale (LEFS) was utilized to evaluate function for the patients with knee and ankle injuries and the Modified Oswestry (ODI) was administered to those patients with LBP. The LEFS and the ODIs were administered at the initial visit and then each following week for a total of 3 weeks. In addition to functional outcomes measures; return to duty rates and access time were also observed and recorded.

RESULTS: Both groups appeared to have clinically meaningful functional improvements;however,the DA group appeared to show greater and faster improvements as compared to the DDA group. The DA Ankle subgroup went from an initial LEFS score of 37 to a week 3 score of 66 where the DDA Ankle subgroup went from 34 to 45. The DA Knee subgroup moved from an initial score of 26 to 67 after 3 weeks as compared to the DDA Knee subgroup which scored 33 to 44. The most dramatic improvements between groups appeared to be in the LBP subgroups. The DA low back pain group had an initial ODI score of 37 which was lowered to a score of 8 after 3 weeks. The DDA LBP group had an initial score of 35 and a 3 week score of 25. Access time for patients with acute MS injuries from 7 days to 1 day. The DA group demonstrated faster return to duty rates. Four days faster for the ankles,knees and 8 days faster for the low back subgroups.

CONCLUSIONS: It appears that direct access PT is beneficial in: (1) lowering access times for acute injuries to PT, (2) improving functional outcomes and return to duty rates, and (3) improved overall satisfaction among clinical staff and patients.

CLINICAL RELEVANCE: This study demonstrates improved functional outcomes for patients seen in a direct access PT setting and provides some evidence to support the efficacy of PTs practicing in this capacity.

OPL52

PHYSICAL THERAPY AND PROSTHETIC MANAGEMENT OF IRAQI AMPUTEES IN SUPPORT OF OIF RECONSTRUCTION OPERATIONS

Scherer M, Miller JA, John OB

Walter Reed, Washington, DC; Orthopedics and Rehabilitation, Walter Reed Army Medical Center, Washington, DC; Defense Sciences Office, DARPA-DSO, Arlington, VA

PURPOSE: To describe clinical operations, patient demographics, and patient interventions in a jointly run US Army-Iraqi Ministry of Defense/ Iraqi Veterans Affairs Amputee Clinic from January 06 to June 06. We will also describe anecdotal observations on the current state of amputee care in Iraq and the challenges associated with delivery of rehabilitation and prosthetic services in Iraq.

DESCRIPTION: From January 2006 to June 2006 our team of 5 physical therapy, occupational therapy and prosthetic 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 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 rehab 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 war 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.

OPL53

IMPLEMENTATION OF A DIRECT ACCESS MUSCULOSKELETAL INJURY CLINIC IN A UNIVERSITY SETTING

Mintken P

University of Colorado at Denver and Health Sciences Center, Denver, CO

PURPOSE/HYPOTHESIS: Musculoskeletal (MSK) symptoms account for 20% to 33% of primary care physician visits. It has been reported that 16% to 32% of patients seen by family physicians and general internists for MSK complaints receive referrals to physical therapy (PT), and 7% to 11% receive referrals to orthopaedic surgeons. PTs are MSK experts who are well trained to be the first contact for patients with MSK injuries. Mitchell and Lissovy found that patients who accessed PT directly used fewer visits, had shorter episodes and spent fewer health care dollars. The University of Colorado at Boulder instituted a direct access MSK injury clinic in 2000 to improve the quality and cost effectiveness of medical care and ease case load of the physicians and nurse practitioners who were seeing patients with musculoskeletal complaints.

NUMBER OF SUBJECTS: 3617.

MATERIALS/METHODS: The MSK injury clinic at Wardenburg Health Center (WHC) allowed students, faculty and staff access to a 15 minute examination by a PT for extremity injuries. Patients were excluded if they needed help walking, were bleeding or had an open wound, suspected a fracture, or were seeking care for a neck, back or chest/rib injury. Spine

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% (182) 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 $234 000 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 45 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. Patients were randomly separated into 2 samples: developmental, testing. Discharge FS was analyzed using multivariate models controlling for 12 independent variables. Beta coefficients of developmental sample were used to predict discharge FS in the testing sample. Predictive ratios were estimated by dividing predicted discharge FS by actual discharge FS. A VPPA was developed using the 3 most powerful independent variables from regression analyses. Patients were partitioned into risk-adjusted cells by these 3 variables. In each cell, patients were placed into 1 of 9 payment groups using above, predicted, and below predicted FS change (discharge-intake) and visits allowing comparisons of FS change (effectiveness) and visits (efficiency). We developed payment levels for each group that collectively were designed to encourage clinicians to produce good outcomes efficiently.

RESULTS: Model controlled 35% of data variance. Beta coefficients were similar ($P>.05$) between samples supporting model cross-validation. Predictive ratio averages for all patients (1.05), by impairment (range, 0.96-1.05) and by type of clinic (1.03-1.06) supported model predictive validity. The 3 most powerful independent variables were condition severity, age and symptom acuity, which were combined with impairment category (diagnosis) to develop 396 homogeneous risk-adjusted cells of patients. Simulating VPPA for all patients, a 12% reduction in payment was estimated had providers been reimbursed using VPPA compared to FFS. VPPA payment favored patients who improved and were treated efficiently.

CONCLUSIONS: Results support a valid, risk-adjusted P4P model based on measures of effectiveness and efficiency could be developed for patients receiving outpatient therapy. Simulation using the VPPA suggested reduced reimbursement and realignment of resources.

CLINICAL RELEVANCE: A P4P process based on clinical outcomes and visits and independent of treatment or provider may encourage providers to use evidence-based rehabilitation effectively and efficiently and may allow payers to realign resources to patients benefiting from effective and efficient treatment. P4P could be an alternative to the annual per beneficiary therapy caps for outpatient rehabilitation under Medicare Part B.

OPL55

FEASIBILITY OF IMPLEMENTING AN OUTCOMES-BASED PAY-FOR-PERFORMANCE PROCESS FOR PATIENTS RECEIVING OUTPATIENT PHYSICAL OR OCCUPATIONAL THERAPY: MEDICARE PART B

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: To test feasibility of implementing an outcomes-based risk-adjusted pay-for-performance (P4P) process in outpatient therapy for Medicare Part B; test responsiveness, sensitivity to change and construct validity of the functional status (FS) measure; compare simulated differences in payment using fee-for-service (FFS) and a value-based purchasing payment algorithm (VPPA) based on the P4P model.

NUMBER OF SUBJECTS: Patients (n = 956; mean, 73 years; SD, 9; min, 25; max, 93; 31% male) were treated in 3 hospital outpatient clinics participating with Focus On Therapeutic Outcomes, Inc in 2005: 90% orthopedic, 10% neurological conditions.

MATERIALS/METHODS: Patients entered FS data at therapy 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 .73; 95% CI, .66-.80; sensitivity, .64; 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

compared to FFS. Staff comments supported feasibility of using the data collection method, but offered some recommendations.

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.

OPL56

DELAYED EPISODIC PAIN FLARES SECONDARY TO STRESS-INDUCED RELEASE OF THYROXINE IN PATIENTS WITH NEUROPATHIC PAIN SYNDROMES

Allen RJ

Physical Therapy, University of Puget Sound, Tacoma, WA

Patients with chronic pain of neuropathic origin routinely experience fluctuations in the intensity and quality of pain. Episodic pain flares may be distressing and disabling. Some flare-ups are understandable based on physical stress to distal tissue, overexertion, or poorly paced activity/exercise. Many significant pain flares remain inexplicable to patients and therapists. For patients, this may lead to the development of an ever-expanding list of suspected activities, leading to avoidance and progressive behavioral disability. While feeling helpless to aid patients in explaining reasons for some pain flares, therapists may misinterpret them as responses to therapeutic exercise or activity pacing.

Recent studies have established a temporal link between perceived psychogenic stress and subsequent pain flares in patients with chronic pain due to syndromes now thought to have, at least in part, neuropathic components. Counterintuitively, increases in stress do not appear to produce same-day pain flares. However, in cases of patients with complex regional pain syndrome, marked increases in pain intensity have been measured 10 days following reported stressful periods. Patients with fibromyalgia syndrome report the same consistently delayed tenth-day flare after major stressors.

A pathophysiologically plausible hypothesis for delayed flares is based on timing and activity of a stress-related hormone. Psychogenic stress is known to trigger thyearsoxine (T4) release via hypothalamic stimulation of thyearsotrophic hormone (TTH) secretion by the pituitary. Once the thyearsoid releases T4 in response to TTH, it is immediately bound by blood proteins to circulate in an inactive state until the protein bonds begin to denature. Peak liberation of T4 to its active state occurs 10 days after initial stress-related release. While the principal effect of T4 is to elevate metabolism, its systemic effects may increase the severity of perceived pain by increasing excitability of peripheral nerve fibers (including nociceptive fibers) and increasing rate of cerebration with resultant anxiety and episodic insomnia.

Understanding the relationship between stress endocrinology and pain flares may assist therapists to differentially recognize the origins of increased pain and distinguish between stress-related flares and those induced by overly aggressive therapy. For patients, this knowledge may help reduce fear and uncertainty as to causes of some pain flares, thereby reducing fear-related avoidance of unrelated activity and providing predictability and explanation for some increased pain episodes.

This theory presentation offers a psychophysiological overview of stress-related release and effects of thyearsoxine, the relationship between those effects and increased perceived intensity of neuropathic pain, a proposed research agenda for investigation of this hypothesis, and clinical implications for both therapists and patients.

OPL57

RESOLVING KNEE FLEXION DEFICITS IN AN ATHROFIBROTIC KNEE FOLLOWING A PATELLAR FRACTURE

Kilburn K, Hunter-Giordano A, Snyder-Mackler L, Baughman M, Schmitt L, Merritt M, Manal T

Physical Therapy Clinic, University of Delaware, Newark, DE

BACKGROUND AND PURPOSE: Loss of ROM can be significant following prolonged immobilization. To avoid stress over a healing patella fracture site, active range of motion is often slowed in the early phases of rehabilitation, coupled with immobilization; this precaution can increase the risk of a stiff knee. The purpose of this case is to present modifications of a stretching program to overcome substantial knee flexion range of motion loss following patellar open reduction internal fixation.

CASE DESCRIPTION: A 19-year-old college student was referred to our University-based PT clinic 6 weeks following ORIF for a right patella. She wore a long leg cast for the first 4 weeks after surgery and was progressed to a hinged brace locked in extension for use during all waking hours. On initial evaluation at our clinic, she had a large effusion, PROM of 3° hyperextension to 19° of flexion limited by 6/10 pain, and a hypomobile patella. She was unable to perform a straight leg raise and her self-assessment on the Knee Outcome Survey was 37% (higher the better). The initial prescription allowed for gentle PROM to 30° and 15° per week. Due to extreme guarding and patient intolerance with passive range of motion, initial stretching was primarily done with an isokinetic dynamometer in CPM mode as well as patellofemoral and tibiofemoral joint mobilizations. Nine weeks after surgery, she was unable to achieve greater than 45° of flexion. Because radiographs showed that her patella fracture was not healed, manipulation by the physician was not considered, and aggressive stretching remained the only option. For a more aggressive stretch: wall slides with manual overpressure, squatting on a leg press with manual overpressure and weights exceeding body weight, seated manual stretching with the thigh belted down, and a supine manual stretch where the thigh was supported by a sheet with 1 person and the primary PT was manually overpressing the knee into flexion. After 1 month, her flexion plateaued at 111° and contract-relax techniques were incorporated into supine manual stretching. Within 6 visits she was able to achieve and maintain greater than 130° of flexion. Her strength improved more slowly. She was able to perform a straight leg raise without a quad lag at 4 weeks after initial evaluation.

OUTCOMES: Following thirty-six treatments (3.5 months), she achieved 145° of flexion, trace effusion, normalized gait mechanics without a brace, improved strength demonstrated by the ability to perform a straight leg raise with resistance and her self-assessment on the KOS improved from 37% to 81%.

DISCUSSION: Significant knee flexion ROM loss can occur following prolonged immobilization and compounded by a patellar fracture with ORIF. Conventional stretching in these situations may be ineffective to overcome a profound loss of ROM. This case presents manual overpressure stretching techniques to improve knee flexion ROM when less aggressive methods are insufficient to restore functional motion.

OPL58

RELATIONSHIPS BETWEEN TIBIOFEMORAL ROTATION, PATELLAR ALIGNMENT, AND PATELLOFEMORAL JOINT CONTACT AREA IN SUBJECTS WITH AND WITHOUT PATELLOFEMORAL PAIN

Salsich GB, Long FJ, Perman WH

Physical Therapy, Saint Louis University, St. Louis, MO; Radiology, Saint Louis University, St. Louis, MO

PURPOSE/HYPOTHESIS: To determine if negative relationships exist between tibiofemoral rotation and patellofemoral joint contact area, and between patellar alignment and patellofemoral joint contact area over a range of knee flexion angles.

NUMBER OF SUBJECTS: Seventeen subjects with patellofemoral pain (PFP) (5 male, 12 female; mean ± SD age, 27 ± 8 years) and 18 pain-free sub-

jects (6 male, 12 female; mean ± SD age, 24 ± 4 years) participated. Groups were matched on age and body mass.

MATERIALS/METHODS: Subjects underwent MRI assessment of the knee at 0°, 20°, and 40° flexion. At each angle, sagittal (T1-weighted) and axial (3-D fat-suppressed) images were obtained with subjects in a simulated weight-bearing position. Each sagittal image series was reconstructed in 2 planes: axial to the distal femur and axial to the proximal tibia. In the axial femoral series the image exhibiting the largest portion of the distal femur was selected for measurement. In the axial tibial series the image selected displayed the largest portion of the proximal tibia. On the selected images, femoral and tibial rotation angles were measured with respect to the horizontal fields of view and summed to achieve the tibiofemoral rotation angle (TFROT). TFROT was expressed as the amount of medial femoral rotation with respect to the tibia. Patellofemoral alignment (bisect offset index, patellar tilt angle) and contact area were quantified from the 3-D fat-suppressed images using previously published methods. Relationships between variables were determined for all subjects, and for PFP subjects only, at each knee angle using Pearson correlation coefficients ($\alpha = .05$, 1-tailed).

RESULTS: When all subjects were analyzed, TFROT was negatively correlated with contact area at 0° ($r = -0.53$) and 20° ($r = -0.41$), $P<.01$. BOS and PTA were negatively correlated with contact area at 0° (BOS, $r = -0.39$; PTA, $r = -0.49$; $P<.01$). When only PFP subjects were considered, TFROT remained negatively correlated with contact area at 0° ($r = -0.47$, $P<.05$) and 20° ($r = -0.41$, $P = .05$); 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 a greater range of knee flexion than patellar alignment in some individuals with PFP.

CLINICAL RELEVANCE: Widely accepted theories suggest that patellar malalignment is a major factor contributing to reduced patellofemoral joint contact area. These data suggest that tibiofemoral rotation might have a greater influence on contact area than patellar alignment. Strategies targeting the maintenance of proper tibiofemoral alignment might be indicated in the rehabilitation of individuals with PFP.

OPL59

ASYMMETRICAL KINETICS AND KINEMATICS PERSIST 1 YEAR AFTER TOTAL KNEE ARTHROPLASTY DURING A RETURN-TO-SIT TASK

Farquhar S, Snyder-Mackler L

Physical Therapy, University of Delaware, Newark, DE

PURPOSE/HYPOTHESIS: Persons with unilateral total knee arthroplasty (TKA) stand from a chair using a different strategy than uninjured older adults. There is little information about sitting down into a chair. During sit-to-stand, the use of asymmetrical loading patterns may place additional demands on the nonoperated limb, and may be a contributing factor in the progression of osteoarthritic changes in the nonoperated limb. We sought to investigate the differences between subjects 1 year post-TKA and healthy controls during a return-to-sit task.

NUMBER OF SUBJECTS: 12 subjects 1 year following TKA 12 uninjured control subjects

MATERIALS/METHODS: Kinematics and kinetics were evaluated in the sagittal plane; muscle moments are expressed as internal moments. Quadriceps strength of both limbs was evaluated isometrically. Two-by-two ANOVA (group by limb) were used to compare limbs side-to-side and between groups.

RESULTS: In subjects with TKA, the operated quadriceps is weaker than the nonoperated quadriceps ($P = .014$), and also is weaker than controls ($P = .002$). TKA subjects perform the return-to-sit with increased hip flexion compared to the nonoperated side and compared to controls ($P<.01$). The hip extensor moment is greater on both the operated ($P = .014$) and the nonoperated limb ($P = .004$) compared to controls. At the knee, there are higher knee extensor moments on the nonoperated limb than in controls ($P = .04$). Subjects with TKA also have increased dorsiflexion angle on the nonoperated side ($P = .01$) with a concurrent increased ankle dorsiflexor moment ($P = .034$).

CONCLUSIONS: During a return-to-sit task, persons 1 year following TKA demonstrate altered movement patterns compared to controls. The increased hip moments reduce the demand on the knee extensors, or 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.

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 up to 13 years after surgery. This strength deficit can further accelerate mobility limitations and perpetuate quadriceps impairment. Postoperative rehabilitation focuses primarily on restoring knee range of motion and safe ambulation, though very few attempts have been made to overcome the persistent quadriceps weakness and functional limitations 1 or more years following a TKR. The purpose of this case series is to describe, in persons 1 year post TKR surgery, the changes in knee extensor strength, knee and hip extensor power, quadriceps muscle volume and mobility as a result of participating in 12 weeks of strength training via either a traditional program (TRAD) or a Resistance Exercise via Negative, Eccentrically-induced, Work (RENEW) strength training protocol.

NUMBER OF SUBJECTS: 6 individuals (males, 1; females, 5; mean age, 64.5 years; number of TKR, 9; average postoperative months, 23) participated in either a RENEW or a TRAD strength training program.

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 up and go (TUG), and timed stair ascent/descent test (SCT).

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). Cocontraction values were calculated between muscles around the knee and were evaluated prior to (preparation), during (weight acceptance), and following (midstance) the lateral translation. Standing 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 = .351). The OA groups had greater medial knee laxity (P = .017) and were in greater varus alignment (P = .031) compared to the C group. The OAU 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 R^2 = 0.248, P = .023) and weight acceptance (change in R^2 = 0.325, P = .016). During midstance, quadriceps MVIC was a significant predictor of medial muscle cocontraction (change in R^2 = 0.452, P = .004), and IKOS score showed a trend (change in R^2 = 0.130, P = .066).

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

Willson JD, Davis I

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 adduction (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 condlyes, 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 jumping.

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 = 0.51) and KER (r = 0.60) during running. Greater FPPAs were also significantly associated with greater HIR (r = 0.44) and KER (r = 0.55) 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. FPPAs 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 LUNGE

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 LTF 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°; $P = .036$). 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.

OPL64

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.