


Identifying episodes of back pain using medical expenditures panel survey data: patient experience, use of services, and chronicity. Smith M

Journal of manipulative and physiological therapeutics [Add to My Journals List](#) 
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OBJECTIVE: To explore the correspondence between "Episodes-of-Pain" and "episodes of care" for individuals with back pain. **METHODS:** This study was a secondary analysis of Medical Expenditures Panel Survey (MEPS) 2-year longitudinal data. Individual use and utilization of back pain services were examined across ambulatory settings and providers, and linked to MEPS medical condition data to identify individuals with back pain who do not use or who delay or discontinue utilization of health services for back pain. "Episodes-of-Care" and Episodes-of-Pain were approximated through round-by-round temporal mapping of MEPS back pain utilization events data and medical conditions data. **RESULTS:** Of 10 193 individuals with back pain, approximately one fifth did not actively seek care for their back pain. Utilization of services for back pain (Episodes-of-Care) does not always correspond with an individual's full experience of back pain (Episodes-of-Pain). Upwards of 20% of MEPS respondents who use services for some back pain episodes, reported additional episodes for which they do not use services. **CONCLUSIONS:** These findings suggest that other longitudinal studies based only on data that reflect service use, for example, claims data, may incorrectly infer the nature of back pain and back pain episodes. Many individuals report ongoing back pain that continues beyond their Episodes-of-Care, and many individuals with persistent back pain may use prescription drugs, medical services, and other health services only intermittently.

Performance and reliability of a variable rate, force/displacement application system. Vaillant M, Pickar JG, Kawchuk GN

Journal of manipulative and physiological therapeutics [Add to My Journals List](#) 
201010 33(8):585-93 Language: eng Country: United States Graduate Student,
University of Alberta, Edmonton, Alberta, Canada.

OBJECTIVE: Spinal manipulation therapy (SMT), an intervention used to treat low back pain, has been demonstrated to affect the stiffness of the spine. To adequately quantify the effects of SMT on stiffness, a device capable of applying specific parameters of manipulation in addition to measuring force-displacement values has been developed previously. Previously developed indentation techniques that quantify stiffness have been modified for novel use in evaluating SMT parameters. The reliability of stiffness measurements performed by the newly adapted device was assessed in this study. **METHODS:** Seven springs of varying stiffness were each indented 10 times by a variable rate force/displacement (VRFD) device. Indentations were performed at a rate of 0.5 mm/s to a maximal displacement of 4 mm. The stiffness coefficients for a middle portion of the resulting force-displacement graph and the terminal instantaneous stiffness (stiffness at end displacement) were calculated. The intraclass correlation and confidence interval were calculated for these stiffness measurements to assess device reliability. **RESULTS:** Repeated spring stiffness measures yielded an intraclass correlation coefficient value of 1.0. The mean stiffness values had narrow 95% confidence intervals ranging from 0.01 N/mm to 0.06 N/mm and small coefficients of variation. **CONCLUSION:** This VRFD device provides highly reliable stiffness measurements in controlled conditions. Although in vivo reliability remains to be established, the results of this study support the use of the VRFD device in future trials investigating the impact of various SMT parameters on spinal stiffness.

Efficacy of physiotherapy interventions late after stroke: a meta-analysis.
Ferrarello F, Baccini M, Rinaldi LA, Cavallini MC, Mossello E, Masotti G, Marchionni N, Di Bari M

Journal of neurology, neurosurgery, and psychiatry [Add to My Journals List](#) 
201102 82(2):136-43 Language: eng Country: England Unit of Functional Rehabilitation, Azienda USL 4 Prato. Piazza dell'Ospedale 5, 59100 Prato, Italy; francescoferrarello@tiscali.it.

Objective Physiotherapy is usually provided only in the first few months after stroke, while its effectiveness and appropriateness in the chronic phase are uncertain. The authors conducted a systematic review and meta-analysis of randomised clinical trials (RCT) to evaluate the efficacy of physiotherapy interventions on motor and functional outcomes late after stroke. Methods The authors searched published studies where participants were randomised to an active physiotherapy intervention, compared with placebo or no intervention, at least 6 months after stroke. The outcome was a change in mobility and activities of daily living (ADL) independence. The quality of the trials was evaluated using the PEDro scale. Findings were summarised across studies as effect size (ES) or, whenever possible, weighted mean difference (WMD) with 95% CI in random effects models. Results Fifteen RCT were included, enrolling 700 participants with follow-up data. The meta-analysis of primary outcomes from the original studies showed a significant effect of the intervention (ES 0.29, 95% CI 0.14 to 0.45). The efficacy of the intervention was particularly evident when short- and long-distance walking were considered as separate outcomes, with WMD of 0.05 m/s (95% CI 0.008 to 0.088) and 20 m (95% CI 3.6 to 36.0), respectively. Also, ADL improvement was greater, though non-significantly, in the intervention group. No significant heterogeneity was found. Interpretation A variety of physiotherapy interventions improve functional outcomes, even when applied late after stroke. These findings challenge the concept of a plateau in functional recovery of patients who had experienced stroke and should be valued in planning community rehabilitation services.

Gregg

Went to a parents weekend lecture by the head of the Stanford pain center Saturday, smackey@stanford.edu , or <http://paincenter.stanford.edu>

A lot like the Butler stuff that you have forwarded.

First, good to see that what we are doing in the subjective eval section is pretty right on course!
And second, that it is REALLY important in chronic pain, and we should certainly consider keeping it in the course.

A few "pearls".

1 in 5 Americans in chronic pain (60 million).

More \$ spent on chronic pain than on cardiac and cancer combined.

Chronic pain patients lose 5.4% gray matter, vs. non chronics lose 0.5% (i.e. 10 years premature atrophy). So if your patient is acting a bit "off" (i.e. diminished cognitive functioning) it may not just be the pain or the meds, they are literally losing their brains. Hence, advise to take on a new task like learn a new language, musical instrument, card game, etc. can reverse some of these loses, and also rewire the pain perception. That is, distraction works to alter perception of pain.

They are doing work with fMRI training , aimed at, amongst other areas, the anterior cingulate, to retrain the brain to increase activity here, which helps to modulate the pain response.

"Without the brain, there is no pain." Good quote.

Alterations of the pain experience. Genetics is 20-40%, with females having a higher perception of experimental pain, but they also cope better.

Attention/distraction plays a big part. Hence advise to get up and take a walk, listen to music, talk to a friend, etc.etc. will help to distract from the pain perception. Also why pain at night may not be, as we were taught cancer, but the fact that lying in bed we have no distractions. Thought of the Feldenkrais lessons, moving but staying short of the pain as a way to rewire the experience. Also, having them concentrate on the quality of the movement, be it an exercise, or resistance with PNF, vs the pain, is a good thing.

Increased fear and anxiety before surgery leads to higher post op pain perception, prefrontal cortex.

Here's a good one. Showed some vidoes like the photos from George of the gruesome breaks, etc. , and studies have shown that the same part of the brain for empathy lights up on the fMRI if experience the pain or see it.

And then asked who after seeing the rolled ankle actually "felt" it in that part of their body, most often have had that same thing happen to them. He showed a video of a tennis player rolling his ankle and I immediately felt my ankles, creepy.

All for now, have a good one.

Brian

Case Series: The immediate effect of lumbar rotational mobilization on straight leg raise - Adam Braxmeyer

Background:

The nervous system is a continuum requiring movement, space, and blood. Numerous research articles have been and continue to involve these concepts and how they affect nerve function, or what is commonly referred to as the study of neurodynamics. It is widely accepted that nerves move and that neural tissue requires blood. It has been stated that the nervous system accounts for 2-3% of our body weight but consumes 20-25% of our cardiac output. Regarding space, nerves require space so they can move and conduct impulses without interference. Often a goal of manual therapy is to afford the patient additional space.

Purpose/Hypothesis: The purpose of this study is to assess the effect of Grade III lumbar rotational mobilization on neurodynamics in patients with a physical therapy diagnosis of lumbar radiculopathy who demonstrated a positive straight leg raise (SLR). It is hypothesized that following lumbar rotational mobilization there will be improved neural mobility, demonstrated by increased SLR secondary to improved space at the intervertebral foramen.

Design: Case Series

Methods: The case series took place over 3 months in a single outpatient physical therapy clinic. Patients identified as having a physical therapy diagnosis of lumbar radiculopathy with a positive SLR were included in the case series. Lumbar radiculopathy was defined for this case series as having either pain, numbness, or tingling below the knee thought to be secondary to nerve root irritation. A SLR was considered positive if patient had reproduction of lower extremity symptoms that intensified with sensitizing maneuver. In this case series the sensitizing maneuver was ankle dorsiflexion. Age range was 28-74 years old. There were 4 males and 4 females. Patient was placed in supine. Bubble inclinometer was placed at the distal anterior tibia just proximal to the ankle to measure hip flexion angle. Lower extremity was passively moved by the physical therapist into hip flexion with knee maintained in neutral. Straight leg raise was performed to the first onset of symptoms. Sensitizing movement was ankle DF. Hip flexion angle was then recorded. Patient was then placed on non-affected (see description of position below) side and a Grade III rotational mobilization was performed on the affected side 30s x 3 repetitions. Grade III mobilization is described as a large amplitude movement into resistance from the beginning of the resistance. Patient was then placed in supine and SLR was measured again as previously described and numbers were recorded.

Results: Seven out of eight patients demonstrated improved SLR after grade III lumbar rotational mobilizations. Of the seven that demonstrated improved SLR, the greatest improvement was 20 degrees with the least being 5 degrees. Mean difference for those demonstrating positive results was 10 degrees. There was one patient who demonstrated a 5-degree decrease.

Conclusion: It could be concluded that an individual with a physical therapy diagnosis of lumbar radiculopathy with positive SLR may have improved neurodynamics following grade III lumbar rotational mobilization on the affected side. It is proposed that the lumbar mobilization improved the space around the nerve root leading to improved mobility. However, we cannot discount that the mobilization may have also created improved blood flow around the nerve root also contributing to decreased mechanosensitivity (of the nerve root) and subsequent (improved) movement.

Clinical Relevance: This case series suggest (s) that lumbar rotational mobilization may be an effective physical therapy intervention for improving neural mobility for patients experiencing lumbar radiculopathy.

Surgical Versus Nonoperative Treatment for Lumbar Spinal Stenosis Four-Year Results of the Spine Patient Outcomes Research Trial Spine; 15 June 2010 - Volume 35 - Issue 14 - pp 1329-1338

Surgery for spinal stenosis has been shown to be more effective compared to nonoperative treatment over 2 years, but longer-term data have not been analyzed.

Methods: Surgical candidates from 13 centers in 11

US states with at least 12 weeks of symptoms and confirmatory imaging were enrolled in a randomized cohort (RC) or observational cohort (OC). Treatment was standard decompressive laminectomy or standard non-operative care. Primary outcomes were SF-36 bodily pain (BP) and physical function scales and the modified Oswestry Disability index assessed at 6 weeks, 3 months, 6 months, and yearly up to 4 years.

Results: A total of 289 patients enrolled in the RC and 365 patients enrolled in the OC. An as-treated analysis combining the RC and OC and adjusting for potential confounders found that the

clinically significant advantages for surgery previously reported were maintained through 4 years, with treatment effects (defined as mean change in surgery group minus mean change in non-operative group) for bodily pain 12.6; and Oswestry Disability index. Early advantages for surgical treatment for secondary measures such as bothersomeness, satisfaction with symptoms, and self-rated progress were also maintained.

Conclusion: Patients with symptomatic spinal stenosis treated surgically compared to those treated non-operatively maintain substantially greater improvement in pain and function through 4 years.

Age-Related Changes of Thoracic and Cervical Intervertebral Discs in Asymptomatic Subjects

Spine; 15 June 2010 - Volume 35 - Issue 14 - pp 1359-1364

Studies on age-related degenerative changes of the thoracic spine are scarce.

Methods: Ninety-four asymptomatic Japanese volunteers (48 men and 46 women, mean age of 48.0 ± 13.4 years) underwent MRI of the thoracic and cervical spine and filled the questionnaire regarding life styles. The items evaluated on MRI using a numerical grading system were (1) decrease in the signal intensity of the intervertebral discs (DSI), (2) posterior disc protrusion (PDP), (3) anterior compression of the dural sac (ACD), and (4) disc space narrowing.

Association between each degenerative MRI finding and several factors, including age, sex, smoking, sports, body mass index, and degeneration of cervical spine was investigated.

Results: Forty-four (46.8%) patients demonstrated positive degenerative MRI findings at 1 or more thoracic intervertebral levels. The percentage of the subjects with positive MRI findings was 37.2% in DSI, 30.9% in PDP, 29.8% in ACD, and 4.3% in disc space narrowing. The percentages of all MRI findings increased with aging. In 85 (90.4%) patients, degenerative MRI findings were positive in the cervical spine. DSI was significantly associated with age, PDP with age, smoking and presence of PDP in the cervical spine, and ACD was associated with smoking.

Conclusion: Degenerative changes in the thoracic spine on MRI were observed in approximately half of the asymptomatic subjects, whereas their incidences were less frequent than those in the cervical spine. Factors significantly associated with degenerative changes in the thoracic spine included age, smoking, and degeneration in the cervical spine.

Whiplash-associated disorders: who gets depressed? Who stays depressed? European Spine Journal; Volume 19 (6); June 2010. Pages 945-956

Depression is common in whiplash-associated disorders (WAD). Our objectives were to identify factors associated with depressive symptomatology occurring in the initial stages of WAD, and to identify factors predicting the course of depressive symptoms. A population-based cohort of adults sustaining traffic-related WAD was followed at 6 weeks, 3, 6, 9, and 12 months. Baseline measures (assessed a median of 11 days post-crash) included demographic and collision-related factors, prior health, and initial post-crash pain and symptoms. Depressive symptomatology was assessed at baseline and at each follow-up using the Centre for Epidemiological Studies Depression Scale (CES-D). We included only those who participated at all follow-ups ($n = 3,452$; 59% of eligible participants). Using logistic regression, we identified factors associated with initial (post-crash) depression. Using multinomial regression, we identified baseline factors predicting course of depression. Courses of depression were no depression; initial depression that resolves, recurs or persists, and later onset depression. Factors associated with initial depression included greater neck and low back pain severity, greater percentage of body in pain, numbness/tingling in arms/hand, dizziness, vision problems, post-crash anxiety, fracture, prior mental health problems, and poorer general health. Predictors of persistent depression included older age, greater initial neck and low back pain, post-crash dizziness, vision and hearing problems, numbness/tingling in arms/hands, anxiety, prior mental health problems, and poorer general health. Recognition of these underlying risk factors may assist health care providers to predict the course of psychological reactions and to provide effective interventions.

Soft and Rigid Collars Provide Similar Restriction in Cervical Range of Motion During Fifteen Activities of Daily Living Spine; 1 June 2010 - Volume 35 - Issue 13 - pp 1271-1278

Cervical collars are frequently used for the purpose of limiting cervical motion after surgical procedures or as a treatment for certain injuries. Rigid collars are generally believed to reduce cervical motion to a greater extent than soft collars but the latter are often preferred by patients because of their greater comfort. Although there are some data to suggest that soft collars restrict full, active ROM (i.e., the extremes of motion) to a lesser degree than rigid braces, there are currently no comparative studies that have assessed the effects of these 2 types of cervical collars on the functional ROM that is required to perform multiple ADLs.

Methods: In this investigation, a previously validated electrogoniometer device was used to quantify both the full, active ROM of 10 subjects as well as the functional ROM they exhibited during a series of 15 ADLs. For each individual, these ROM measurements were repeated after the application of both a soft collar and a rigid orthosis.

Results: The soft collar limited flexion/extension, lateral bending, and rotation by $27.1\% \pm 9.9\%$ (mean \pm standard deviation), $26.1\% \pm 4.8\%$, and $29.3\% \pm 10.3\%$, respectively. The corresponding reductions in ROM with a rigid collar were $53.7\% \pm 7.2\%$, $34.9\% \pm 6\%$, and $59.2\% \pm 5.3\%$, respectively. The rigid collar resulted in significantly lower full, active ROM in both the sagittal and axial planes but not in the lateral bending plane. Compared with the soft collar, the rigid collar afforded no difference in motion during 13 of the 15 simulated ADLs. Greater motion was only noted with backing up a car and sitting from a standing position.

Conclusion: Although subjects exhibited less full, active ROM of the cervical spine when immobilized in a rigid collar than when they were placed in a soft collar, the motion recorded during various functional tasks was not significantly different for nearly all of the ADLs in this study, regardless of which cervical device was applied. One potential explanation for this finding is that both collars may serve as proprioceptive guides, which allow patients to regulate their own cervical motion based on their level of comfort. Given the paucity of data supporting the use of postoperative bracing, especially after procedures which incorporate internal fixation, this study indicates that a rigid orthosis may be unnecessary in many cases because even a soft collar seems to be sufficient for restricting motion during routine activities until the normal, physiologic ROM of the cervical spine has been restored.

Sitting Postures and Trunk Muscle Activity in Adolescents With and Without Nonspecific Chronic Low Back Pain: An Analysis Based on Subclassification Spine; 15 June 2010 - Volume 35 - Issue 14 - pp 1387-1395

Evidence suggests that low back pain commonly develops in adolescence and increases the risk for low back pain in adulthood. Sitting is an important consideration in adolescents with nonspecific chronic low back pain (NSCLBP): currently there are no reports investigating their motor control strategies in sitting.

Methods: Twenty-eight adolescents (14 female) with NSCLBP and 28 matched pain-free controls were recruited from a large cohort study. Pain subjects were subclassified based on O'Sullivan's classification system. Three-dimensional lumbo-pelvic kinematic data and the activation of 3 back and 2 abdominal muscles were recorded during usual and slump sitting. The flexion-relaxation phenomenon in sitting was also investigated.

Results: Spinal posture in usual and slump sitting were similar for adolescents with and without NSCLBP. However, differences were identified in both sitting conditions when those with NSCLBP were subclassified and compared with controls. Muscle activation differences were not consistently identified, with only lower levels of internal oblique activation in usual sitting in NSCLBP compared with pain-free controls showing significance. Flexion relaxation was observed in both iliocostalis and thoracic erector spinae in the NSCLBP group but not controls.

Conclusion: This study provides preliminary results. Differences with sitting posture are only seen when adolescents with NSCLBP are classified. Trunk muscle activation is not a sensitive marker for discriminating subgroups of NSCLBP during adolescence.

Efficacy and Safety of Duloxetine (Cymbalta) in Patients With Chronic Low Back Pain
Spine; 1 June 2010 - Volume 35 - Issue 13 - pp E578-E585

Imbalance of serotonin and norepinephrine within modulatory pain pathways has been implicated in the development and maintenance of chronic pain. Duloxetine, a selective reuptake inhibitor of serotonin and norepinephrine, has demonstrated clinical efficacy in 3 distinct chronic pain conditions: diabetic peripheral neuropathic pain, fibromyalgia, and chronic pain because of osteoarthritis.

Methods: In this randomized double-blind trial, adult nondepressed patients with a non-neuropathic CLBP and a weekly mean of the 24-hour average pain score ≥ 4 at baseline (0–10 scale) were treated with either duloxetine or placebo for 13 weeks. The dose of duloxetine during first 7 weeks was 60 mg once daily. At week 7, patients reporting $<30\%$ pain reduction had their dose increased to 120 mg. The primary outcome measure was the Brief Pain Inventory (BPI) 24-hour average pain rating. Secondary measures included Roland-Morris Disability Questionnaire-24; Patient's Global Impressions of Improvement; Clinical Global Impressions-Severity (CGI-S); BPI-Severity and -Interference (BPI-I); and weekly means of the 24-hour average pain, night pain, and worst pain scores from patient diaries. Quality-of-life, safety, and tolerability outcomes were also assessed.

Results: Compared with placebo-treated patients (least-squares mean change of -1.50), patients on duloxetine had a significantly greater reduction in the BPI 24-hour average pain from baseline to endpoint. Additionally, the duloxetine group significantly improved on Patient's Global Impressions of Improvement; Roland-Morris Disability Questionnaire-24; BPI-Severity and average BPI-Interference; weekly mean of the 24-hour average pain, night pain, and worst pain. Significantly more patients in the duloxetine group (13.9%) compared with placebo (5.8%) discontinued because of adverse events. The most common treatment-emergent adverse events in the duloxetine group included nausea, dry mouth, fatigue, diarrhea, hyperhidrosis, dizziness, and constipation.

Conclusion: Duloxetine significantly reduced pain and improved functioning in patients with CLBP. The safety and tolerability were similar to those reported in earlier studies.

Obesity increases the risk of recurrent herniated nucleus pulposus after lumbar microdiscectomy The Spine Journal; Volume 10 (7); pages 575-580. July 2010

Recurrent herniation of the nucleus pulposus (HNP) frequently causes poor outcomes after lumbar discectomy. The relationship between obesity and recurrent HNP has not previously been reported.

Purpose: The purpose of this study was to investigate the association of obesity with recurrent HNP after lumbar microdiscectomy.

Patient sample: We reviewed all cases of one- or two-level lumbar microdiscectomy from L2–S1 performed by a single surgeon with a minimum follow-up of 6 months.

Outcome measures: The primary clinical outcomes were evidence of recurrent HNP on magnetic resonance imaging (MRI) and need for repeat surgery.

Methods: All patients with recurrent radicular pain or new neurological deficits underwent a postoperative MRI scan. Recurrent HNP was defined as a HNP at the same side and same level as the index procedure.

Results: Seventy-five patients were included in the study. The average body mass index (BMI) was 27.6 ± 4.6 . Thirty-two patients received an MRI scan. The time from operation to repeat MRI scan varied widely (3 days to 15 months). Eight patients (10.7%) had recurrent HNP. Four patients had persistent symptoms requiring reoperation (5.3%). The mean BMI of patients with recurrent HNP was significantly higher than that of those without recurrence (33.6 ± 5.1 vs. 26.9 ± 3.9). In univariate analysis, obese patients (BMI ≥ 30) were 12 times more likely to have recurrent HNP than non-obese patients. Obese patients were 30 times more likely to require reoperation. Age, sex, smoking, and being a manual laborer were not significantly associated with recurrent HNP. A logistic regression analysis supported the findings of the univariate analysis. In a survival analysis using a Cox proportional hazards model, the hazard ratio of recurrent HNP for obese patients was 17.

Conclusions: Obesity was a strong and independent predictor of recurrent HNP after lumbar microdiscectomy. Surgeons should incorporate weight loss counseling into their preoperative discussions with patients.

Lumbar Spine Stability for Subjects With and Without Low Back Pain During One-Leg Standing Test Spine; 15 July 2010 - Volume 35 - Issue 16 - pp E753-E760

The purpose of this study was to evaluate the lumbar stability index, which includes relative holding time (RHT) and relative standstill time (RST), in subjects with and without LBP. Even though a number of studies have evaluated postural adjustments based on kinematic changes in subjects with LBP, lumbar spine stability has not been examined for abnormal postural responses with visual feedback.

Methods: All participants were asked to maintain the stork test position (standing on one leg with the contra lateral hip flexed 90°) for 25 seconds. The outcome measures included RHT and RST for the axes of the core spine and lumbar spine. Independent *t* tests were used to compare the differences between groups. Two-way repeated measure analysis of variance was used

to compare the differences for both axes. The age variable was used as a covariate to control confounding effects for the data analyses.

Results: The RHT was longer for the lumbar spine axis in subjects without LBP than those with LBP, especially without visual feedback. There was also significant interaction in RST between subjects with and without LBP. For the core axis of the trunk, significant differences existed based on the main effect of side, trunk rotation, and both of these interactions. However, there was a lack of significant interaction with age for the lumbar and core spine axes.

Conclusion: Although the control group included slightly younger volunteers compared with the

LBP group, the stability index of the core spine significantly decreased in RHT and RST, especially when visual feedback was blocked for subjects with LBP. The interaction between visual feedback and trunk rotation indicated that core spine stability is critical in coordinating balance control. A trunk muscle imbalance may contribute to unbalanced postural activity, which could prompt a decreased, uncoordinated bracing effect in subjects with LBP. As a result, core spine training could be used in the prevention of postural instability in such subjects.

Manual therapy and exercise for neck pain: A systematic review *Manual Therapy*; 15 (4); August 2010; Pages 334-354

Manual therapy is often used with exercise to treat neck pain. This cervical over-view group systematic review update assesses if manual therapy, including manipulation or mobilization, combined with exercise improves pain, function/disability, quality of life, global perceived effect, and patient satisfaction for adults with neck pain with or without cervicogenic headache or radiculopathy. Computerized searches were performed to July 2009. Two or more authors independently selected studies, abstracted data, and assessed methodological quality. Pooled relative risk (pRR) and standardized mean differences (pSMD) were calculated.

Of 17 randomized controlled trials included, 29% had a low risk of bias. Low quality evidence suggests clinically important long-term improvements in pain (pSMD-0.87(95% CI:-1.69,-0.06)), function/disability, and global perceived effect when manual therapy and exercise are compared to no treatment. High quality evidence suggests greater short-term pain relief [pSMD-0.50(95% CI:-0.76,-0.24)] than exercise alone, but no long-term differences across multiple outcomes for (sub)acute/chronic neck pain with or with-out cervicogenic headache.

Moderate quality evidence supports this treatment combination for pain reduction and improved quality of life over manual therapy alone for chronic neck pain; and suggests greater short-term pain reduction when compared to traditional care for acute whiplash. Evidence regarding radiculopathy was sparse. Specific re-search recommendations are made.

Manipulation or mobilization for neck pain: A Cochrane Review Manual Therapy; 15 (4); August 2010; Pages 315 – 333

Manipulation and mobilization are often used, either alone or combined with other treatment approaches, to treat neck pain. This review assesses if manipulation or mobilization improves pain, function/disability, patient satisfaction, quality of life (QoL), and global perceived effect (GPE) in adults experiencing neck pain with or without cervicogenic headache or radicular findings. A computerized search was performed in July 2009. Randomized trials investigating manipulation or mobilization for neck pain were included. Two or more authors independently selected studies, abstracted data, and assessed methodological quality. Pooled relative risk (pRR) and standardized mean differences (pSMD) were calculated. 33% of 27 trials had a low risk of bias.

Moderate quality evidence showed cervical manipulation and mobilization produced similar effects on pain, function and patient satisfaction at intermediate-term follow-up. Low quality evidence suggested cervical manipulation may provide greater short-term pain relief than a control (pSMD -0.90 (95%CI: -1.78 to -0.02)). Low quality evidence also supported thoracic manipulation for pain reduction (NNT 7; 46.6% treatment advantage) and increased function (NNT 5; 40.6% treatment advantage) in acute pain and immediate pain reduction in chronic neck pain (NNT 5; 29% treatment advantage). Optimal technique and dose need to be determined.

Compensation claim lodgement and health outcome developmental trajectories following whiplash injury: A prospective study Pain; 150 (1); July 2010; Pages 22-28

This study aimed to identify distinctive trajectories for pain/disability and posttraumatic stress disorder (PTSD) symptoms following whiplash injury and to examine the effect of injury compensation claim lodgement on the trajectories. In a prospective study, 155 individuals with whiplash were assessed at <1 month, 3, 6 and 12 months post injury. Outcomes at each time point were Neck Disability Index (NDI) and the Posttraumatic Stress Diagnostic Scale (PDS). Group-based trajectory analytical techniques were used to identify outcome profiles. The analyses were then repeated after including third party compensation claim lodgment as a binary time-changing covariate. Three distinct NDI trajectories were determined: (1) *Mild*: mild or negligible pain/disability for the entire 12 months (45%), (2) *Moderate*: initial moderate pain/disability that decreased to mild levels by 3 months (39%) and (3) *Chronic-severe*: severe pain/disability persisting at moderate/severe levels for 12 months (16%). Three distinct PTSD trajectories were also identified: (1) *Resilient*: mild symptoms throughout (40%), (2) *Recovering*: initial moderate symptoms declining to mild levels by 3 months (43%) and (3) *Chronic moderate-severe*: persistent moderate/severe symptoms throughout 12 months (17%). Claim submission had a detrimental effect on all trajectories ($p < 0.001$) except for the *Chronic-severe* NDI trajectory ($p = 0.098$). Following whiplash injury, there are distinct pathways of recovery for pain/ disability and PTSD symptoms. Management of whiplash should consider the detrimental association of compensation claim with psychological recovery and recovery of those with mild to moderate pain/disability levels. However, claim lodgement has no significant association with a more severe pain and disability trajectory.

Do depression and pain intensity interfere with physical activity in daily life in patients with Chronic Low Back Pain? Pain; 150 (1); July 2010, Pages 161-166

Patients with chronic pain may have difficulties estimating their own physical activity level in daily life. Pain-related factors such as depression and pain intensity may affect a patients' ability to estimate their own daily life activity level. This study evaluates whether patients with Chronic Low Back Pain (CLBP) who are more depressed and/or report more pain indeed have a lower objectively assessed daily life activity level or whether they only perceive their activity level as lower. Patients with CLBP were included in a cross-sectional study. During 14 days physical activity in daily life was measured, with both an electronic diary and an accelerometer. Multilevel analyses were performed to evaluate whether a higher level of depression and/or pain intensity was associated with a lower objectively assessed activity level or the discrepancy between the self-reported and objectively assessed daily life activity levels. Results, based on 66 patients with CLBP (mean RDQ score 11.8), showed that the objectively assessed daily life activity level is not associated with depression or pain intensity. There was a moderate association between the self-reported and objectively assessed activity levels ($\beta = 0.39, p < 0.01$). The discrepancy between the two was significantly and negatively related to depression ($\beta = -0.19, p = 0.01$), indicating that patients who had higher levels of depression judged their own activity level to be relatively low compared to their objectively assessed activity level. Pain intensity was not associated with the perception of a patient's activity level ($\beta = 0.12, ns$).

Preliminary study of neck muscle size and strength measurements in females with chronic non-specific neck pain and healthy control subjects *Manual Therapy*; 15 (4); August 2010; Pages 400-403

Neck muscle weakness and atrophy are two common causes of pain and disability among office workers. The aim of this study was to compare the strength of the neck extensor and flexor muscles and the size of the semispinalis capitis muscle (SECM) in patients with chronic non-specific neck pain (CNNP) and healthy subjects. Twenty female office workers (10 patients with CNNP and 10 healthy subjects) participated in this study.

The strength of the neck extensor and flexor muscles was measured by an isometric device and the SECM size was measured by ultrasonography. Neck muscle strength, size of the SECM and the ratios of neck strength to body weight, neck extensor strength to SECM size, SECM size to body weight and neck flexor to extensor strength were all significantly lower in patients compared to controls ($P < 0.05$).

In conclusion, neck strength, the size of the SECM and the ratio of neck muscle strength to SECM size appear to be useful parameters in appraising patients with CNNP.

Abnormal thalamocortical activity in patients with Complex Regional Pain Syndrome (CRPS) Type I Pain; 150 (1); July 2010, Pages 41-51

Complex Regional Pain Syndrome (CRPS) is a neuropathic disease that presents a continuing challenge in terms of pathophysiology, diagnosis, and treatment. Recent studies of neuropathic pain, in both animals and patients, have established a direct relationship between abnormal thalamic rhythmicity related to Thalamocortical Dysrhythmia (TCD) and the occurrence of central pain. Here, this relationship has been examined using magneto-encephalographic (MEG) imaging in CRPS Type I, characterized by the absence of nerve lesions. The study addresses spontaneous MEG activity from 13 awake, adult patients (2 men, 11 women; age 15–62), with CRPS Type I of one extremity (duration range: 3 months to 10 years) and from 13 control subjects. All CRPS I patients demonstrated peaks in power spectrum in the delta (<4 Hz) and/or theta (4–9 Hz) frequency ranges resulting in a characteristically increased spectral power in those ranges when compared to control subjects. The localization of such abnormal activity, implemented using independent component analysis (ICA) of the sensor data, showed delta and/or theta range activity localized to the somatosensory cortex corresponding to the pain localization, and to orbitofrontal–temporal cortices related to the affective pain perception. Indeed, CRPS Type I patients presented abnormal brain activity typical of TCD, which has both diagnostic value indicating a central origin for this ailment and a potential treatment interest involving pharmacological and electrical stimulation therapies.

Changes in paraspinal muscles and their association with low back pain and spinal degeneration: CT study European Spine Journal; 19 (7); July 2010. Pages 1136-1144

The objectives of the study were to evaluate the association between lumbar paraspinal muscle density, evaluated on computed tomography (CT) and age, sex and BMI; and to evaluate the association of those changes with low back pain (LBP) and spinal degeneration features in a community-based sample. This study was an ancillary project to the Framingham Study. A sample of 3,529 participants aged 40–80 years had a CT scan performed to assess aortic calcification. 187 individuals were randomly enrolled in this study. LBP in the last 12 months was evaluated using self-report questionnaire. Density (in Hounsfield units) of multifidus and erector spinae was evaluated on CT. The prevalence of intervertebral disc narrowing, facet joint osteoarthritis (FJOA), spondylolysis, spondylolisthesis and spinal stenosis were also evaluated. We used linear regression models to examine the association of paraspinal muscles density with age, sex, BMI, LBP, and spinal degeneration features. The results show that in our study, men have higher density of paraspinal muscles than women, younger individuals have higher density than older ones and individuals with lower weight have higher muscle density than overweight. No differences between individuals with and without LBP were found. Significant association was found between L4 multifidus/erector spinae density and FJOA at L4–L5; between multifidus at L4 and spondylolisthesis at L4–5; and between erector spinae at L4 and L5 with disc narrowing at L4–5 and L5–S1, respectively.

We conclude that the paraspinal muscle density decreases with age, and increases BMI. It is associated with at some levels FJOA, spondylolisthesis and disc narrowing at the same level, but not associated with occurrence of LBP.

The study aimed to investigate intra-articular meniscoids (folds) and cartilage quality in the thoracic zygapophysial joints (ZAJs), and to discuss them in the context of possible causes of thoracic back pain. The clinical relevance of the intra-articular meniscoid structures described in the cervical and lumbar spine is unclear, particularly in relation to ZAJ blockades.

Corresponding data for the thoracic joints are not available.

Methods: A total of 297 ZAJs between C7 and L1, obtained from 12 human cadavers (7 female, 5 male; mean age 81 years), were studied. The intra-articular folds were described and classified morphologically. The characteristics of the folds and their association with zygapophysial cartilage quality were investigated. Thirteen example folds were studied histologically.

Results: In all, 268 intra-articular meniscoid folds were found in 183 joints. Three types were identified: type 1 (90%; mean length 3.1 mm) were thin, solid folds originating from a connective-tissue base, with multiple vessels at the joint capsule, extending between the joint surfaces. Type 2 folds (6%) were soft structures of fat and loose connective tissue including multiple vessels, located in the joint recess and not extending between the joint surfaces. The remaining folds (type 3, 4%) were circumscribed thickenings of the joint capsule. Three folds showed chronic hemorrhage, with dilated vessels at the base, and this was associated with severe cartilage lesions. In 16 folds, the base had direct tissue connection to the fat tissue of the epidural space.

Conclusion: This study for the first time systematically classifies intra-articular meniscoid folds in human thoracic ZAJs. These folds may represent an anatomic correlate for thoracic back pain. The chronic hemorrhage observed may be an important factor leading to arthritis.

In lumbar disc herniation surgery, dural lesions seem to be the most common complication today. Studies on incidence of and outcome after a dural lesion are mainly based on retrospective studies. In a prospective study within the frame-work of the Swedish Spine Register, 4,173 patients operated on for lumbar disc herniation were evaluated using pre- and 1-year postoperative protocols and complication registration.

Mean patient age was 41 (18–81) years and 53% of the patients were male. 93% of the operations were performed on the two lowermost lumbar levels. The incidence of dural lesions in the material was 2.7%. In patients with previous disc surgery, the incidence was doubled, 5%, a significant increase ($P = 0.02$). Patients with dural lesions preoperatively had more back pain and inferior scores in general health and role emotional do-mains of the SF-36. These factors, however, were because they had been operated on previously, not related to the dural lesion as such. The relative improvement after surgery was similar whether a dural lesion had occurred or not. It is concluded that a dural lesion is a technical complication which must be solved at the time of surgery but which does not bear any negative implications on the long-term outcome for the patient.

Low back pain (LBP) is a chronic disorder which exerts a profound impact on various spheres of psychosocial functioning, including emotional distress, functional limitations and decrements in social contacts. The objective of this study was to investigate the associations between the indices of psychosocial functioning in patients with chronic LBP and a range of psychological factors. Specifically, the study aimed at exploring the relative participation of personality, social support, disease-related cognitive appraisals and coping styles in accounting for the differences in psychosocial functioning of patients with LBP.

One-hundred-twenty patients with LBP took part in the study and completed a battery of psychological questionnaires: NEO-Five Factors Inventory, Ways of Coping Questionnaire, Disease-Related Social Support Scale, Disease-Related Appraisals Scale and Psychosocial Functioning Questionnaire (PFQ). The PFQ dimensions were used as dependent variables in a series of stepwise regression analysis models with the scores from other questionnaires entered as independent variables.

A cognitive appraisal of the disease in terms of an obstacle was strongly related to all domains of functioning; however, other appraisals (threat, challenge, harm, profit and overall disease importance) were uniquely associated with particular domains of functioning. Deprivation of social support was a significant predictor of distress experienced in interpersonal context and of sense of being disabled. Among basic personality traits, agreeableness was negatively associated with distress in interpersonal context, and conscientiousness was positively related to acceptance of life with the disease. Problem-focus coping was linked to higher acceptance of life with the disease.

Among sociodemographic variables, older age and lower educational level were related to greater subjective feelings of being disabled. Pain severity was found unrelated to any of psychosocial functioning domains. Different aspects of psychosocial functioning are best accounted for by diverse patterns of psychological factors, which suggests involvement of different psychological mechanisms in development of LBP-related disability.

The Effects of Slow Breathing on Affective Responses to Pain Stimuli: An Experimental Study.

Pain; Volume 149 (1); April 2010; pages 12-18

This study examined whether breathing rate affected self-reported pain and emotion following thermal pain stimuli in women with fibromyalgia syndrome (FM: $n = 27$) or age-matched healthy control women (HC: $n = 25$). FM and HC were exposed to low and moderate thermal pain pulses during paced breathing at their normal rate and one-half their normal rate. Thermal pain pulses were presented in four blocks of four trials. Each block included exposure to both mild and moderate pain trials, and periods of both normal and slow paced breathing. Pain intensity and unpleasantness were recorded immediately following each pain trial, and positive and negative affect were assessed at the end of each block of trials.

Compared to normal breathing, slow breathing reduced ratings of pain intensity and unpleasantness, particularly for moderately versus mildly painful thermal stimuli. The effects of slow breathing on pain ratings were less reliable for FM patients than for HCs. Slow versus normal breathing decreased negative affect ratings following thermal pain pulses for both groups, and increased positive affect reports, but only for healthy controls with high trait negative affect. Participants who reported higher levels of trait positive affect prior to the experiment showed greater decreases in negative affect as a result of slow versus normal breathing. These experimental findings provide support for prior reports on the benefits of yogic breathing and mindful Zen meditation for pain and depressed affect. However, chronic pain patients may require more guidance to obtain therapeutic benefit from reduced breathing rates.

Experiences of individuals with chronic low back pain during and after their participation in a spinal stabilisation exercise programme – A pilot qualitative study *Manual Therapy*; 15(2); Pages 173-178; April 2010

Spinal stabilization exercises are commonly used in the management of low back pain (LBP). There is limited evidence relating to patients' experiences of their involvement in such programs. The aim of this study was to explore the experiences of a sample of individuals with chronic LBP who participated in a randomized controlled trial (RCT) investigating the most efficacious dosage and frequency of spinal stabilization exercises. The qualitative study involved nine participants who took part in focus group discussions. The data were analyzed using thematic content analysis and provided insights into the experiences of the participants.

Four themes emerged: Physical dimensions of the LBP experience, emotional and psychological dimensions of the LBP experience and perceived effects of the program and lastly, the impact of the treatment program on participants' knowledge, understanding and adherence. In conclusion participants' experiences were not limited to the positive effects of stabilization exercises on pain, functional disability and quality of life, but also reflected increases in confidence, the formulation of self help strategies and the ability to exert better control over their LBP. The findings highlight the importance of well planned associated educational support packages in the treatment of LBP paving the way for future qualitative research.

The initial effects of different rates of lumbar mobilisations on pressure pain thresholds in asymptomatic subjects *Manual Therapy*; 15(2); Pages 173-178; April 2010

Lumbar mobilizations are commonly used in clinical practice to reduce pain and increase function. Mobilizations to the cervical spine have been shown to reduce pain using pressure pain thresholds (PPTs). Yet there is no evidence to confirm that this happens in the lumbar spine. Furthermore little is known about the effects of different treatment doses on the amount of hypoalgesia produced. It is unknown if changing the rate of application of mobilizations has an effect on hypoalgesia. The aim of this study was to investigate the immediate effects of lumbar posteroanterior mobilizations performed at different rates on PPT and the extent of the hypoalgesia.

A repeated measures, single blind, randomized-trial was conducted on 30 asymptomatic subjects. PPTs were measured at 4 sites in the upper and lower quadrants, before and after the application of lumbar posteroanterior mobilizations performed at 2 Hz, 1 Hz and quasistatic. The results demonstrated an immediate and significant improvement in PPT measures ($P = 0.000$) irrespective of the rate or site tested. The effects were both local and widespread. There was no significant difference in PPT between the rates of mobilizations.

This study provides new experimental evidence that lumbar posteroanterior mobilizations produce an immediate and significant widespread hypoalgesic effect, regardless of the rates of mobilization in asymptomatic subjects.

Is insufficient quantity and quality of sleep a risk factor for neck, shoulder and low back pain? A longitudinal study among adolescents. *European Spine Journal*; Volume 19; 4(4); April 2010; pages 641-649

The quantity and quality of adolescents' sleep may have changed due to new technologies. At the same time, the prevalence of neck, shoulder and low back pain has increased. However, only a few studies have investigated insufficient quantity and quality of sleep as possible risk factors for musculoskeletal pain among adolescents. The aim of the study was to assess whether insufficient quantity and quality of sleep are risk factors for neck (NP), shoulder (SP) and low back pain (LBP). A 2-year follow-up survey among adolescents aged 15–19 years was (2001–2003) carried out in a subcohort of the Northern Finland Birth Cohort 1986 ($n = 1,773$). The outcome measures were 6-month period prevalences of NP, SP and LBP. The quantity and quality of sleep were categorized into sufficient, intermediate or insufficient, based on average hours spent sleeping, and whether or not the subject suffered from nightmares, tiredness and sleeping problems. The odds ratios (OR) and 95% confidence intervals (CI) for having musculoskeletal pain were obtained through logistic regression analysis, adjusted for previously suggested risk factors and finally adjusted for specific pain status at 16 years. The 6-month period prevalences of neck, shoulder and low back pain were higher at the age of 18 than at 16 years. Insufficient quantity or quality of sleep at 16 years predicted NP in both girls and boys. Similarly, insufficient sleep at 16 years predicted LBP in both girls and boys, but SP only in girls. After adjustment for pain status, insufficient sleep at 16 years predicted significantly only NP and LBP in girls. Insufficient sleep quantity or quality was an independent risk factor for NP and LBP among girls. Future studies should test whether interventions aimed at improving sleep characteristics are effective in the prevention and treatment of musculoskeletal pain.

Relationships between pain thresholds, catastrophizing and gender in acute whiplash injury

Manual Therapy; 15(2); Pages 154-159; April 2010

The mechanisms underlying sensory hypersensitivity (SH) in acute whiplash associated disorders (WAD) are not well understood. We examined the extent of the relationships between the sensory measures of pressure pain threshold (PPT) and cold pain threshold (CPT), catastrophizing, pain and disability levels and gender in acute WAD. Thirty-seven subjects reporting neck pain following a motor vehicle accident were examined within five weeks post-injury. Measures of neck pain and disability (Neck Disability Index, NDI) and catastrophizing (Pain Catastrophizing Scale, PCS) were taken. CPT was assessed in the cervical spine and PPTs were assessed in the cervical spine (PPT_{cx}) and at a remote site (PPT_{distal}). CPT and PCS were moderately correlated; however there were no significant relationships between PPT (cervical and distal) and PCS. Both CPT and PPT_{cx} were significantly correlated with NDI but PPT_{distal} was not. Finally, gender modulated the relationships between sensory measures, catastrophizing, and pain and disability levels.

In conclusion, subjects with higher levels of catastrophizing presented with sensory hypersensitivity to cold stimuli in the acute phase of whiplash. Differences between genders are in accordance with the growing body of evidence suggesting that the relationships between some psychological factors and injury-related symptoms are modulated by gender.

ASSOCIATION BETWEEN CHANGES IN ABDOMINAL AND LUMBAR MULTIFIDUS MUSCLE THICKNESS AND CLINICAL IMPROVEMENT AFTER SPINAL MANIPULATION

Koppenhaver S, Childs JD, Gill S, Teyhen DS, Fritz J, Hebert J, Kawchuk G, Parent EC

US Army/Baylor University, San Antonio, TX; University of Utah, Salt Lake City, UT; Murdoch University, Perth, Western Australia, Australia; University of Alberta, Edmonton, Alberta, Canada

PURPOSE/HYPOTHESIS: Recent evidence suggests that the effects of spinal manipulation therapy (SMT) may be primarily mediated by neurophysiologic mechanisms. Deficits in abdominal and lumbar multifidus (LM) muscle function have been linked to low back pain (LBP). However, it is unknown whether SMT affects the function of these muscles and whether any such changes are related to clinical improvement after SMT. The primary purpose of this study was to examine the relationship between clinical improvement and changes in abdominal and LM muscle activity after SMT.

NUMBER OF SUBJECTS: Eighty-one participants with LBP.

MATERIALS/METHODS: All participants underwent a standard baseline examination including ultrasound imaging of the abdominal and LM muscles. Abdominal and LM muscle function was assessed by measuring muscle thickness at rest and during submaximal muscle contractions. After the baseline examination, all participants received SMT to the lumbosacral spine. Assessment of clinical status and reassessment of abdominal and LM muscle function was then performed immediately after SMT, and 3 to 4 days and 1 week later. The Global Rating of Change questionnaire was used to quantify participants' subjective perception of overall clinical improvement. Stepwise hierarchical multiple linear regression was performed to examine the multivariate relationship between change in muscle function and clinical improvement, and to determine the most parsimonious set of muscle variables.

RESULTS: Data from 78 patients who completed the study were analyzed (34.4 \pm 12.6 years; 65.7% women; 25.9 \pm 5.7 body mass index; 32.1% \pm 11.5% Oswestry disability score). One-week change in contracted LM and TrA muscle thickness both significantly contributed to the prediction of clinical improvement after SMT ($P < .01$). The direction of the β coefficients indicated that larger increases in contracted LM thickness, and larger decreases in contracted TrA muscle thicknesses were associated with larger clinical improvements. After controlling for the effects of age and sex, change in LM and TrA muscle thickness resulted in an R^2 change of 0.31, representing 31% of the variance of Global Rating of Change scores.

CONCLUSIONS: These findings provide evidence that clinical improvement after SMT is associated with an increased ability to contract the LM muscle and a decreased contraction (ie, "bracing") of the TrA muscle.

CLINICAL RELEVANCE: These findings support the notion of a neurophysiologic mechanism of action of SMT and provide preliminary evidence that clinicians should consider SMT in patients with LBP and altered trunk muscle function.

ASSOCIATION BETWEEN SPINAL STIFFNESS AND OUTCOMES IN SUBJECTS WITH LOW BACK PAIN RECEIVING MANIPULATION

Fritz J, Hebert J, Koppenhaver S, Teyhen DS, Childs JD, G Kawchuk

Physical Therapy, The University of Utah, Salt Lake City, UT; Doctoral Program in Physical Therapy, US Army-Baylor University, San Antonio, TX; Physical Therapy, University of Alberta, Edmonton, Alberta, Canada

PURPOSE/HYPOTHESIS: Spinal manipulation (SM) using high-velocity, low-amplitude techniques is a treatment with some evidence of effectiveness for low back pain (LBP), yet the mechanism of the clinical effects are unclear. Many theories focus on SM's effects on spinal stiffness, however support for these theories is mostly anecdotal. The purpose of this study was to examine the stiffness characteristics of subjects with LBP undergoing SM, and evaluate the association between stiffness and clinical outcomes.

NUMBER OF SUBJECTS: Fifty-one subjects with nonradicular LBP, 24 male (mean age, 33.3; SD, 12.8 years; mean initial Oswestry (OSW), 32.2, SD, 11.9)

MATERIALS/METHODS: All subjects had an examination including self-report forms (OSW and fear-avoidance beliefs questionnaire [FABQ]), then underwent pre and post SM stiffness assessments using an assisted indentation instrument with documented reliability. Session 2 occurred 3 to 4 days later and included a second SM treatment. Session 3 occurred 1 week after baseline and involved a stiffness assessment and readministration of self-report forms. The slope of the force displacement curve from the indentation data was calculated as a measure of global stiffness (GS). Mean stiffness (N/mm) during maximum indentation force was calculated to measure maximal stiffness (MS). Descriptive statistics were calculated for baseline variables including GS and MS. Immediate change in stiffness with SM was computed from pre and post-SM measures at session 1.

Sustained stiffness changes were computed from the session 1 pre-SM and session 3 measurements. Association between stiffness and outcome was examined with linear regression. OSW change from baseline to session 3 was the dependent variable. Baseline OSW, age, sex and BMI were entered as control variables. Baseline GS and MS, immediate and sustained GS and MS changes were considered for stepwise entry in step 2 to evaluate if stiffness characteristics related to outcome beyond control variables. Step 3 considered additional prognostic variables (symptom duration, FABQ, leg symptoms) for stepwise entry to determine the relative contribution of stiffness with other prognostic variables in explaining outcome. A significance level of 0.05 was required for entry and 0.10 or greater removed a variable from the model.

RESULTS: Immediate changes in GS ($P = .047$) and MS ($P = .04$) with SMT were observed. Sustained stiffness changes were not significant. The stiffness variables that were associated with change in OSW after entering the control variables were the immediate change in GS ($P = .001$) and the sustained change in MS ($P = .005$). No additional variables entered the final model.

CONCLUSIONS: An association between changes in stiffness and outcomes was identified in subjects with LBP receiving SM. The effect of SM on stiffness may explain why the treatment is beneficial for some patients.

CLINICAL RELEVANCE: Identification of the mechanisms by which SM benefits patients with LBP may help to develop more effective treatment protocols and provide an important biomarker for research.

THORACIC MANIPULATION IMPROVES PAIN, RANGE OF MOTION, AND SELF-REPORTED FUNCTION IN PATIENTS WITH MECHANICAL NECK PAIN: A SYSTEMATIC REVIEW

Cross KM, Kuenze C, Hertel J, Grindstaff TL

Kinesiology, University of Virginia, Charlottesville, VA; Physical Therapy, Creighton University, Omaha, NE

PURPOSE/HYPOTHESIS: Indirect manual therapy treatments, such as thoracic spine manipulation, have been proposed as a treatment strategy for cervical spine pain. There is a growing body of literature supporting the use of thoracic mobilization as a safe treatment for patients with mechanical neck pain. The purpose of this systematic review is to evaluate the effects of thoracic manipulation on pain, range of motion, and self-reported function in patients with mechanical neck pain.

NUMBER OF SUBJECTS: Five randomized controlled trials.

MATERIALS/METHODS: Six online databases (CINAHL, Cochrane Library, PubMed, PEDro, Sport Discus, and Web of Science) were comprehensively searched from their respective inception to November 2009. The primary search terms included “thoracic mobilization”, “thoracic spine mobilization” and “thoracic spine manipulation”. Combining the primary search with “cervical pain” and “neck pain” further restricted the search. Of the 44 studies assessed for inclusion, 5 randomized controlled trials comparing the treatment of mechanical neck pain with thoracic manipulation to nonmanipulation treatment were included. Two reviewers independently scored the quality of the studies that met the inclusion criteria using the PEDro scale. The median PEDro score was 7 (range, 6-8). Common items deducted from the scores involved blinding of the subject and the therapist. Pain was considered our primary outcome with cervical range of motion and self-reported function considered secondary outcomes. Effect sizes (95% CI) for the pre-to-post change scores using Cohen’s d formula were calculated for pain, range of motion, and self-reported function at all stated time intervals. Between group mean differences (95% CI) for all cervical ROM were also calculated.

RESULTS: Effect size point estimates for the global pain change scores were large across all studies (range, 1.58 to 3.86). The effect size point estimates for change scores among all ROM measures (range, 1.10 to 2.54) and the change scores among the self-reported function indices (range, 1.59 to 3.46) were also large. Between group mean differences in ROM improvement (in degrees) of cervical flexion and extension ranged from 8.1 to 12.0 and 7.0 to 11.4 respectively, while cervical rotation improvements varied from 7.7 to 12.5.

CONCLUSIONS: While optimal treatment parameters for mechanical neck pain have not been delineated, thoracic manipulation may provide both immediate and short-term improvement in patients’ pain, cervical ROM, and self-reported function.

CLINICAL RELEVANCE: Thoracic manipulation should be considered as a treatment option by clinicians when treating patients diagnosed with mechanical neck pain. The manipulation techniques described in the literature are nonspecific, and they may provide a treatment window of pain relief and improved cervical mobility to permit the integration of therapeutic exercise.

DESCRIPTION OF CLINICAL OUTCOMES AND UTILIZATION OF PHYSICAL THERAPY SERVICES OF PATIENTS WITH THORACIC SPINE PAIN

Magel J, Brennan G, Fritz J

Intermountain Orthopedic and Spine Therapy, Intermountain Healthcare, Salt Lake City, UT; Intermountain Rehab Agency, Intermountain Healthcare, Salt Lake City, UT; Department of Physical Therapy, University of Utah, Salt Lake City, UT

PURPOSE/HYPOTHESIS: Sparse evidence exists describing the physical therapy clinical outcomes of patients with a main complaint of thoracic spine pain with or without compression fracture. Little is known regarding prognostic factors that predict clinical outcome for the same patients. The purpose of this retrospective cohort study was to report outcomes following physical therapy for patients with thoracic spine pain with and without thoracic compression fracture and to identify prognostic factors that predict clinical outcome.

NUMBER OF SUBJECTS: Seven hundred forty-seven.

MATERIALS/METHODS: Six hundred ninety-four patients were classified as having thoracic spine pain with no compression fracture (TNoCF) (45.1% female). Mean age was 37.7 (□16.1). Fifty-three patients had thoracic spine pain with compression fracture (TCF) (52% female). Mean age was 45.7 (□18.3). Patients were classified as TNoCF if the therapist judged that the thoracic spine or ribcage was the primary pain generator and as TCF if their pain was due to a thoracic compression fracture. Data were gathered from 39 therapists working in 14 clinics between Jan 1, 2002 and May 13th, 2010. For all patients, scores on the Oswestry Disability Index (ODI) and a numeric pain rating (NPR) were obtained at initial and final physical therapy visits and the change between visits was calculated. The percentage of patients who achieved a minimal clinically important difference (MCID) on the ODI was determined for both groups. Data on number of physical therapy visits and length of stay (LOS) were calculated. Stepwise linear regression was used to identify prognostic factors that might explain the average difference score in ODI. Baseline ODI was controlled while age, gender and baseline pain were entered into the equation.

RESULTS: There were no significant differences in any outcome between males and females in either the TNoCF or TCF groups. In the TNoCF group the mean change in ODI was 14.5 (□15.7), average change in NPR was 2.4 (□2.6), average visits were 5.1 (□3.2), and mean LOS was 26.3 days (□28.6). Sixty-two percent of the patients achieved 1 MCID for the ODI defined as an 8 percentage point change. After accounting for baseline ODI, only age significantly added to the explained variability in ODI change ($P < .01$, R^2 for final model = .27). In the TCF group the mean change in ODI was 10.6 (□15.6), average change in NPR was 1.8 (□2.2), average visits were 5.3 (□3.2), and mean LOS was 29.0 days (□21.3). Fifty-six percent of the patients who had a compression fracture achieved 1 MCID for the ODI. Stepwise linear regression did not identify any factor that accounted for the variability in ODI score.

CONCLUSIONS: Clinically meaningful changes may be expected for the majority of patients receiving care for pain originating in the thoracic spine in patients with or without compression fracture.

CLINICAL RELEVANCE: The results of this study may help therapists estimate the prognosis of patients receiving nonstandardized physical therapy for thoracic spine pain.

EFFECTIVENESS OF LUMBAR MANIPULATION IN PATIENTS MEETING A CLINICAL PREDICTION RULE (CPR): AN EVIDENCE-BASED REVIEW

Ide-Don J, Allen DD

University of California San Francisco / San Francisco State University, San Francisco, CA

PURPOSE/HYPOTHESIS: Past reviews assessing the effectiveness of lumbar manipulation in the treatment of low back pain (LBP) have had mixed results. A major limitation of past reviews has been inclusion of studies using nonclassified, heterogeneous samples. A clinical prediction rule has been developed and validated that identifies patients with LBP likely to respond to lumbar manipulation. The effectiveness of lumbar manipulation in the subgroup of patients meeting the CPR has been independently evaluated in a number of studies; however, no review of these studies has been performed. Purpose of this evidence-based review is to determine the effectiveness of lumbar manipulation in decreasing pain and disability in a subgroup of patients meeting the CPR.

NUMBER OF SUBJECTS: Five studies were included in the review, including 3 randomized clinical trials, 1 prospective cohort study, and 1 case series.

MATERIALS/METHODS: A systematic search of online databases was conducted using keywords. Studies published before December 2009 were included if they met specific inclusion criteria defined by the authors. All studies applied lumbar manipulation in patients meeting the CPR and included standardized pain or disability outcome measures. Statistical analyses of pain and disability outcomes were performed for individual studies. Statistics included single-group effect sizes, 2-group effect sizes, number needed to treat (NNT), and 95% confidence intervals. Meta-analyses were performed when permitted by calculating combined single-group and 2-group effect sizes.

RESULTS: Combined single-group effect sizes for pain and disability were significant and large, indicating significant decreases in pain and disability associated with lumbar manipulation in patients with LBP meeting the CPR. Combined 2-group effect sizes for pain and disability were small and insignificant, indicating other treatments may be as effective as lumbar manipulation in this subgroup.

CONCLUSIONS: Lumbar manipulation is highly effective at decreasing pain and disability in the subgroup of patients with LBP meeting the CPR. However, the CPR is not exclusive; patients within the subgroup may also respond to other treatment approaches.

CLINICAL RELEVANCE: The findings of this review support the use of lumbar manipulation as the primary treatment option specifically in the subgroup of patients meeting a CPR. If a patient meets the CPR, physical therapists should strongly consider using lumbar manipulation. However, physical therapists should not blindly apply lumbar manipulation in the treatment of this subgroup; clinical reasoning should be applied with the consideration of other treatment options.

IMPLEMENTING CRITERIA-BASED TREATMENT APPROACH FOR INDICATING ARTHROSCOPIC SURGERY FOR KNEE OSTEOARTHRITIS

Christensen J

The Orthopedic Specialty Hospital, Salt Lake City, UT

PURPOSE/HYPOTHESIS: Arthroscopic debridement procedures for knee osteoarthritis (OA) are prevalent within the United States at significant cost to the healthcare system. Current evidence indicates minimal benefit to patients to improve pain and function. The application of a criteria-based decision making model is a necessary step to determine if a specific subgroup of knee OA patients will benefit from arthroscopic debridement. Purpose was to compare retrospectively outcomes of patients who had arthroscopic debridement surgery versus nonsurgical patients on the basis of published criteria to indicate the need for surgery.

NUMBER OF SUBJECTS: One hundred one patients diagnosed with knee OA.

MATERIALS/METHODS: Two groups of patients, surgical (n = 50) and nonsurgical (n = 51), were randomly selected retrospectively, and their clinical outcomes analyzed. All patients completed a numeric pain scale (NPRS) and Knee Outcome Score (KOS) at baseline and final visit. Patients were compared on the basis of whether or not they had surgery for knee OA. Fifty patients had surgery (64% female, mean age, 50.1 years \pm 9.54) and 51 patients were treated nonsurgically (73% female, mean age, 60.3 years \pm 10.7). Baseline variables were examined to determine equivalence between the groups for age, gender, initial pain and disability. Outcome variables collected were KOS and NPRS. The relevance of 3 evidence-based practice (EBP) criteria for surgery was used to explore differences in outcomes between surgical and nonsurgical groups. Patients in each group were analyzed on the basis of having either ≥ 2 or < 2 EBP criteria. The criteria were acute onset, recent trauma, and radiographic findings. The primary aim of the study was examined using ANCOVA after adjusting for the baseline factors of age, initial NPRS and KOS scores.

RESULTS: There were no differences between the groups for the baseline characteristics ($P > .05$). After controlling for age and baseline scores of NPRS and KOS using ANCOVA, patients in the nonsurgical group who had ≥ 2 criteria to indicate surgery had significantly greater improvement in the KOS change score (mean difference, 11.8%; 95% CI: 1.14, 21.2; $P = .03$). There was no difference in the KOS change score for patients in the surgical group on the basis of ≥ 2 or < 2 EBP criteria.

CONCLUSIONS: In the nonsurgical group, we observed a statistically significant difference in change in disability in patients with ≥ 2 EBP criteria, which is counterintuitive to current published guidelines. In the surgical group, differences in change in disability did not appear related to the number of EBP criteria indicating appropriateness for surgery. The presence of the EBP criteria did not seem to influence the treatment decision related to having surgery or the degree of success of the surgery in terms of disability.

CLINICAL RELEVANCE: There is a need to determine systematically and prospectively the preoperative factors that will identify patient likely to benefit most from arthroscopic debridement surgery.

INSTRUMENT-ASSISTED CROSS FIBER MASSAGE ALTERS REGIONAL MICROVASCULAR MORPHOLOGY IN HEALING KNEE LIGAMENTS SUGGESTING POSSIBLE ANGIOGENESIS

Loghmani MT, Herriott A, Kastner K, Risner K, Koeppen W, Warden SJ

Department of Physical Therapy, Indiana University, Indianapolis, IN

BACKGROUND & PURPOSE: Ligament injuries are a common condition treated by clinicians. Prior studies revealed instrument-assisted cross fiber massage (IACFM) accelerates the return of mechanical properties and improves regional blood flow at delayed time points during early knee medial collateral ligament (MCL) healing using an established animal injury model. The purpose of this study was to investigate the effects of IACFM on microvascular morphology in healing rodent knee MCL injuries as a potential contributor to the beneficial effects of IACFM on ligament healing previously observed. It was hypothesized that IACFM-treated knee ligaments would demonstrate altered regional vascular morphology when compared to the contralateral nontreated injured hindlimbs.

CASE DESCRIPTION: Nineteen female Sprague-Dawley rats (280-300 g) underwent surgical transection of bilateral MCLs. IACFM using a rigid tool was initiated 7 days postoperatively and administered for 1 minute to 1 MCL 3 times/wk for 3 weeks with the contralateral injured untreated MCL serving as an internal control. Animals were perfused with a radiopaque silicone rubber containing lead chromate at 4 weeks postinjury. Perfused MCLs and periarticular tissue were then harvested and imaged using micro-computed tomography. Microvasculature morphology parameters were assessed from the whole tissue, and femoral, middle and tibial subregions, including vessel volume normalized to tissue volume, vessel number, vessel thickness a.k.a. diameter, vessel separation, and the frequency distribution of vessel diameter. Intervention effects were assessed using paired *t* tests ($P \leq .05$).

OUTCOMES: A higher proportion of vessel diameters within the 5.9 μm to <41.2 μm range was demonstrated in the tibial subregion of IACFM-treated hindlimbs compared to nontreated hindlimbs ($P < .02$). A significant difference was not observed in other microvasculature morphology measures (all $P > .05$).

DISCUSSION: A significant increase in the distribution of small arteriole-sized blood vessels was found in the distal portion of IACFM-treated injured MCLs as compared to nontreated contralateral injured controls suggesting possible angiogenesis. This finding is important in that arterioles regulate blood flow through the capillary beds they supply. Interestingly, vascular expansion was only found in the MCL tibial region. This finding may be related to greater localization of treatment pressure and consequent tissue compression in the region of the MCL distal bony insertion. This study provides additional insight into possible mechanisms underlying the increased regional blood flow and accelerated healing previously found in IACFM-treated ligaments. Preliminary findings are positive in that manual therapies offer a conservative approach in the management of soft tissue injuries; however, further studies are needed to understand vascular properties of healing connective tissue in response to a mechanical stimulus.

GLUTEAL MUSCLE ACTIVATION IN FEMALE RUNNERS WITH AND WITHOUT PATELLOFEMORAL PAIN SYNDROME

Willson JD, Kernozek TW, Arndt RL, Reznichak D, Straker S

Health Professions, University of Wisconsin-La Crosse, La Crosse, WI; Gundersen Lutheran Sports Medicine, La Crosse, WI

PURPOSE/HYPOTHESIS: Patellofemoral pain (PFPS) remains a common running-related injury, particularly among females. Hip and knee joint motions in the transverse and frontal plane that decrease retropatellar contact area during running may contribute to this injury. The gluteus maximus (GMAX) and gluteus medius (GMED) are primary movers of the hip in the transverse and frontal plane. However, the timing and magnitude of GMAX and GMED recruitment during running are unclear among runners with PFPS. Knowledge of such factors may provide a foundation for interventions to modify abnormal running kinematics in this population. Our purpose was to compare the timing and magnitude of GMAX and GMED activation between females with and without PFPS during running. We also aimed to examine the association between gluteal recruitment parameters and hip and knee transverse and frontal plane joint excursion during running among females with PFPS.

NUMBER OF SUBJECTS: Twenty female runners with PFPS, 20 healthy female runners

MATERIALS/METHODS: GMAX and GMED activity were recorded at 1080 Hz using surface electromyography during 5 running trials at 3.7 m/s as 3-D kinematic data were collected at 120 Hz by an 8 camera motion analysis system. Gluteal muscle activation variables of interest were activation onset relative to heel strike, activation duration, peak activation, and average activation level from the beginning to end of the activation phase. Hip and knee transverse and frontal plane joint excursions were calculated during the loading phase (heel strike to peak vertical ground reaction force) of each running trial. Independent *t* tests were used to compare muscle activation parameters between groups ($\alpha = 0.05$). The association between GMED and GMAX muscle activation parameters and hip and knee joint transverse and frontal plane excursions was quantified among the PFPS participants using Pearson correlation coefficients.

RESULTS: GMED activation for females with PFPS occurred 24 ms later ($P = .03$, effect size = 0.76) and activation duration was 42 ms shorter than healthy females during running ($P = .01$, effect size = 0.88). No differences in GMED or GMAX magnitude or GMAX timing between groups were observed. Greater hip adduction excursion was moderately correlated with delayed onset relative to heel strike for both the GMED ($r = 0.49$, $P = .048$) and GMAX ($r = 0.52$, $P = .022$). Greater hip internal rotation excursion was moderately correlated with delayed GMAX activation onset ($r = 0.48$, $P = .05$).

CONCLUSIONS: Females with PFPS demonstrated delayed and abbreviated GMED activation during running compared to a healthy female cohort. Further, altered running kinematics thought to increase retropatellar stress such as increased hip adduction and internal rotation excursion appear to be associated with delayed GMED and GMAX activation prior to heel strike during running.

CLINICAL RELEVANCE: Physical therapy interventions that increase GMED and GMAX anticipatory muscle activation during running may minimize altered running kinematics typically observed in females with PFPS.

LATERAL TILTING OF THE PATELLA: THE INFLUENCE OF PATELLA HEIGHT AND TROCHLEAR GROOVE DEPTH

Noehren B, Duncan S, Lattermann C, Powers C

Physical Therapy, University of Kentucky, Lexington, KY; Orthopaedic Surgery, University of Kentucky, Lexington, KY; Biokinesiology and Physical Therapy, University of Southern California, Los Angeles, CA

PURPOSE/HYPOTHESIS: Excessive lateral tilting of the patella has been linked to lateral patella compression syndrome and is thought to be one factor that may underlie the development of patellofemoral pain (PFP). Although excessive lateral tilting of the patella is a common finding in persons with PFP, the underlying cause of this anomaly is not fully understood. From a structural standpoint, 2 structural predispositions have been discussed in the literature: (1) patella alta, and (2) trochlear dysplasia. Both of these conditions result in diminished patella stability typically afforded by the lateral femoral condyle of the distal femur. To date, a clear understanding of how altered bony structure of the distal femur relates to lateral patella tilt is lacking. The purpose of the current study was to assess the association between patella height, trochlear groove depth and lateral patella tilt (LPT).

NUMBER OF SUBJECTS: Ten subjects with a diagnosis of PFP and 10 pain-free controls participated. Subjects in both groups were between the ages of 18 and 45.

MATERIALS/METHODS: Axial and lateral x-rays of the patellofemoral joint were obtained in weight bearing with the knee flexed to 30°. The vertical height of the patella was quantified using the Insall-Savati ratio (ISR) which measures the length of the patella tendon relative to the length of the patella. The depth of the trochlear groove was assessed by measuring the sulcus angle (SA) which was quantified as the angle formed by the intersection of lines defining the medial and lateral slopes of the trochlear groove. LPT was quantified as the angle formed between a line drawn along the lateral facet of the patella and a line along the posterior aspects of the medial and lateral femoral condyles. Using this measure, a smaller angle was representative of greater LPT. The relationship between the ISR, SA, and LPT was assessed using Pearson product moment correlations.

RESULTS: Significant correlations were found between the ISR and LPT ($r = -0.56, P = .01$) as well as the SA and LPT ($r = -0.63, P = .003$).

CONCLUSIONS: Our results confirm the premise that LPT is associated with structural factors thought to diminish the bony stability afforded by the distal femur. More specifically, increasing LPT was associated with increasing height of the patella (ie, patella alta) as well as a more shallow trochlear groove. It should be noted however, that these indices only account for 31% to 40% of the variance in LPT.

CLINICAL RELEVANCE: Given the relationship between bony structure and LPT, clinicians should recognize the possibility that conservative interventions aimed at correcting LPT (ie, patella taping, patella mobilization, etc) may have a limited influence on patella alignment.

SKELETAL MUSCLE BLOOD FLOW OF THE GASTROCNEMIUS DOES NOT DECREASE WITH ICE APPLICATION

Saliba S, Selkow NM

Human Services, University of Virginia, Charlottesville, VA

PURPOSE/HYPOTHESIS: Cryotherapy application decreases blood flow to the skin as part of thermoregulation. However, it is unknown whether ice application causes similar microvascular responses in skeletal muscle. Contrast-enhanced ultrasonography (CEU) is an innovative method to measure capillary blood flow using microbubble infusion. We hypothesized that cold would decrease the skeletal muscle blood flow and temperature of the medial gastrocnemius during cryotherapy.

NUMBER OF SUBJECTS: Sixteen healthy adults (age, 22.8 \pm 2.8 years; height, 165.9 \pm 12.0 cm; weight, 65.9 \pm 15.5 kg; skinfold, 22.4 \pm 7.4 mm).

MATERIALS/METHODS: Participants filled out health history questionnaires and skinfold over the gastrocnemius was measured. Subjects were excluded if they had a lower extremity injury within the past 6 weeks or if they had cardiovascular disease. Using an 18 gauge needle, an implantable thermocouple (Physitemp, IT-21, Clifton, NJ) was inserted 1 cm into the muscle to measure temperature (based on skinfold). After waiting 10 minutes for temperature to stabilize, baseline CEU measurements were obtained. A solution of 0.9mL of microbubbles (Definity) was mixed with 21mL of saline and was infused via IV at 1.5 mL/min for 3 min. CEU measurements were obtained with continuous infusion of microbubbles for 7 to 10 minutes depending on a heart-rate trigger connected to a 3 lead ECG. The intervention was randomized to ice (750 g crushed ice) or sham (750 g candy corn) in a cross over design and application time was dependent on the skinfold, which ranged from 10 to 60 minutes. Two minutes prior to the end of the treatment, a second CEU measurement was taken (immediate post). The last CEU measurement was taken 20 to 80 minutes after the treatment was removed (rewarm), again depending on the subcutaneous tissue thickness. The second treatment was carried out at least 48 hours later and was the same, except the opposite treatment was applied. Two 2-by-3 repeated measure ANOVAs were used to determine effect of ice on blood flow (dB/s) and temperature ($^{\circ}$ C).

RESULTS: There was no significant difference in blood flow between ice at baseline (3.14 \pm .21 dB/s) and immediate post (2.79 \pm .28 dB/s) ($P = .293$) or between baseline and rewarm (3.01 \pm .27 dB/s) ($P = .747$). There was a significant temperature difference between ice at baseline (36.4 $^{\circ}$ C \pm 1.8 $^{\circ}$ C) and immediate post (27.0 $^{\circ}$ C \pm 5.1 $^{\circ}$ C) ($P < .001$) and between baseline and rewarm (29.8 $^{\circ}$ C \pm 2.1 $^{\circ}$ C) ($P < .001$).

CONCLUSIONS: Skeletal muscle blood flow did not significantly *decrease* with ice application compared to a sham condition. Although the intramuscular temperature decreased, other factors besides temperature may have a greater effect on skeletal muscle perfusion. Although most clinicians believe that intramuscular blood flow decreases with cryotherapy, maintaining perfusion may be advantageous since maintaining flow would provide adequate nutrition to the tissues.

CLINICAL RELEVANCE: Cold has many applications including pain and temperature reduction however, cryotherapy does not decrease intramuscular blood flow.

ACCURACY OF RECALLING THE INTENSITY OF WORST BACK PAIN IN THE PAST WEEK

Horn ME, Bishop MD

Department of Physical Therapy, University of Florida, Gainesville, FL

PURPOSE/HYPOTHESIS: Obtaining reports of pain intensity is an important aspect of the patient history taking process in any examination of a patient with musculoskeletal pain. Commonly collected measures include the current pain intensity that patient is experiencing during the history interview, as well as measures of best pain and worst pain, often within the past week. Clinicians rely on the accuracy of patient recall when obtaining this information. Our purpose was to examine the recall of best and worst pain intensity ratings.

NUMBER OF SUBJECTS: Sixty previously healthy adults (36 female, 24 male, mean age, 22.4 years) volunteered to undergo experimental induction of acute low back pain (LBP) using an eccentric exercise protocol to induce delayed onset muscle soreness. Subjects were excluded if they met any of the following criteria: previous participation in a conditioning program specific to trunk extensors, any current back pain, any chronic medical conditions that may affect pain perception, muscle damage, or major psychiatric disorder, history of previous injury including surgery to the lumbar spine, renal malfunction, cardiac condition, high blood pressure, osteoporosis, or liver dysfunction.

MATERIALS/METHODS: Pain intensity ratings were collected at 24 hours and 48 hours after the exercise protocol using a visual analogue scale anchored at one end with no pain and at the other with worst imaginable. Participants returned for follow-up at 96 hours and 1 week postinduction of LBP. At those visits participants rated 'best in the past week' and 'worst in the past week' related to pain intensity. Ratings of best pain in the past week were compared to the baseline pain ratings, reported prior to exercise, using repeated-measures analysis of variance. Ratings of worst pain in the past week were compared to the peak pain ratings reported at either 24 or 48 hours after exercise using repeated-measures analysis of variance. Paired-tests were used to decompose any significant effects. Intraclass-coefficients (ICC) were used to examine the stability of sets of ratings over time.

RESULTS: Peak pain intensity ranged from 0 to 68 mm on the 100 mm VAS. Statistical differences were identified between the peak reported pain intensity and the worst pain in the past week ($P < .001$). Generally, participants underestimated their worst pain as the recall became temporally more distant from peak pain. Consequently, worst pain ratings had fair ICC values (0.6). Best pain ratings were consistent and not statistically different over time and very reliable (ICC = 0.9).

CONCLUSIONS: Participants' recall of worst pain was less reliable than best pain.

CLINICAL RELEVANCE: Reliance on worst pain as an anchor may provide inaccurate results. Clinicians should be aware that this recall of peak pain intensity decays over time, especially in acute pain.

EFFECT OF FEAR-AVOIDANCE, SOMATIZATION, AND DEPRESSIVE SYMPTOMS ON DISCHARGE FUNCTIONAL STATUS IN PATIENTS WITH LUMBAR IMPAIRMENTS

Hart DL, Werneke MW, George SZ

Consulting and Research, Focus On Therapeutic Outcomes, Inc, White Stone, VA; Physical Therapy, CentraState Medical Center, Freehold, NJ; Department of Physical Therapy, Center for Pain Research and Behavioral Health, Brooks Center for Rehabilitation Studies, University of Florida, Gainesville, FL

PURPOSE/HYPOTHESIS: Purpose was to determine if adding assessments of fear-avoidance of physical activities, somatization and depressive symptoms to risk-adjustment models improved prediction of discharge functional status (FS) in patients with nonspecific lumbar spine impairments treated by physical therapists. We hypothesized that all 3 variables would improve predictions because patients who fear physical activities, have depressive symptoms or experience somatization will tend to have lower FS at completion of therapy.

NUMBER OF SUBJECTS: Data from adults (n = 446) with lumbar syndromes (mean \pm SD, 51 \pm 18; min, 18 years; max, 90 years; 47% male) were assessed.

MATERIALS/METHODS: Eight therapists in 8 outpatient clinics managed patients using a standardized process based on Mechanical Diagnosis and Therapy treatment methods. Examination techniques included classifying patients by pain pattern (PPC including centralization [CEN], noncentralization [Non-CEN], not able to be classified [NC]), fear-avoidance beliefs of physical activities (FABQ including low versus elevated) and use of SCL-90-R for quantification of depressive symptoms (DEP including low versus high) and somatization (SOM including low versus high). Depression and somatization data were transformed into a variable of future risk of long-term back-related functional limitations via the SCL Back Pain Prediction Model (SCL BPPM including low, intermediate, high). Intake FABQ, DEP and SOM were entered sequentially into a multiple linear regression model of discharge FS that controlled for intake FS, age, symptom acuity, surgery, payer, gender, number of comorbid conditions and PPC. In a separate model, we supplanted SCL BPPM for DEP and SOM. Model power (R-squared values) was assessed for each model to determine the effect of adding each variable on the prediction of discharge FS.

RESULTS: Initial model without FABQ, DEP or SOM was strong (R-squared = 0.493) and supported intake FS, age, acuity, surgery, number of comorbid conditions and PPC affected discharge FS. Sequentially adding FABQ, DEP and SOM slightly increased power (0.495, 0.497, 0.500, respectively). The model with FABQ and SOM was stronger (0.500) than the model with FABQ and DEP (0.497). The strongest model (0.501) contained FABQ and SCL BPPM.

CONCLUSIONS: Clinical logic suggests including fear-avoidance beliefs of physical activities, depressive symptoms and somatization when predicting FS change, but the improved predictive power was small in a risk-adjustment model that contains the 5 most predictive variables: intake FS, PPC, surgery, acuity and age.

CLINICAL RELEVANCE: Fear-avoidance beliefs, depressive symptoms and somatization slightly increased the amount of variance explaining discharge FS when patients received therapy directed by a treatment-based classification approach. Future studies should explore the predictive value of multilevel classification processes and the complex interactions between demographic, clinical and psychosocial domains for patients with lumbar impairment being treated by physical therapists.

INVESTIGATION OF FEAR-AVOIDANCE BELIEFS AND CLINICAL OUTCOMES ACROSS MULTIPLE ANATOMICAL LOCATIONS

George SZ, Stryker S

Physical Therapy Department, University of Florida, Gainesville, FL; Physical Therapy, Life's Work Physical Therapy, Portland, OR

PURPOSE/HYPOTHESIS: Fear-avoidance beliefs were first studied in low back pain. Early results from cervical spine, knee, and shoulder patients suggest fear-avoidance beliefs have the potential to influence pain and function in these anatomical locations. However, there are very few prospective studies in this area. The purpose of this study was to investigate if fear-avoidance beliefs had a consistent influence on clinical outcomes and treatment parameters for different anatomical locations of musculoskeletal pain.

NUMBER OF SUBJECTS: Three hundred thirteen patients (mean age, 45.5 years; 115 males, 198 females) seeking outpatient physical therapy for lumbar spine (n = 79), cervical spine (n = 63), lower extremity (n = 113), or upper extremity (n = 58) complaints.

MATERIALS/METHODS: During the intake session patients completed the Fear-Avoidance Beliefs Questionnaire physical activity (FABQ-PA) and work (FABQ-W) scales, modified for the appropriate anatomical location. Patients rated their pain intensity and provided self report of function on the Therapeutic Associates Outcomes System (TAOS) Functional Index at intake and discharge. Treatment related parameters collected included number of visits and calendar days in physical therapy. FABQ-PA and FABQ-W scores were compared across anatomical location with ANOVA (total scores) and chi-square (rates of elevated scores). Then, repeated-measures, mixed model ANOVA was used to investigate changes in pain intensity and function from intake to discharge (within factor) based on elevated fear-avoidance beliefs and anatomical location (between factors). Finally, the number of visits and days in therapy were compared across elevated fear-avoidance beliefs and anatomical location (between factors) by ANOVA.

RESULTS: Similar FABQ-PA total scores and rates of elevated FABQ-PA and FABQ-W scores were observed across the 4 anatomical locations ($P > .05$). Lower FABQ-W total scores were associated with lower and upper extremity conditions ($P < .05$). Findings for pain intensity and functional outcomes were similar for each anatomical location. Elevated fear-avoidance beliefs were associated with higher intake scores ($P < .05$), larger improvements ($P < .05$), and similar discharge scores ($P > .05$) for pain intensity and function, when compared to those with lower fear-avoidance beliefs. Visits and calendar days of physical therapy did not differ across anatomical location or fear-avoidance belief level ($P > .05$).

CONCLUSIONS: Rates of elevated FABQ-PA and FABQ-W scores were similar across 4 anatomical locations. Elevated fear-avoidance beliefs were associated with higher intake scores and larger improvements for the 4 anatomical locations.

CLINICAL RELEVANCE: Elevated fear-avoidance beliefs had similar influence on clinical outcomes and treatment parameters regardless of anatomical location. Therefore, the influence of fear-avoidance beliefs on outcomes is not specific to the lumbar spine, suggesting wide spread measurement may be warranted for patients with musculoskeletal pain.

C-REACTIVE PROTEIN AND OBESITY MEASUREMENTS AS PREDICTORS OF LOW BACK PAIN

Briggs M, Givens D, Taylor C

OSU Sports Medicine, The Ohio State University, Columbus, OH; Division of Physical Therapy, The Ohio State University, Columbus, OH; Division of Medical Dietetics, The Ohio State University, Columbus, OH

PURPOSE/HYPOTHESIS: Low back pain (LBP) and obesity are thought to be linked, although the evidence is controversial. Central adiposity is associated with chronic elevated levels of C-Reactive Protein (CRP). Comorbidities such as cancer, asthma, COPD, metabolic syndrome, atherosclerosis, and heart disease are all associated with elevated levels of CRP and obesity. Upper extremity musculoskeletal injury has been associated with increased levels of CRP; however, it is unknown whether LBP is associated with CRP levels, independent of obesity or other comorbidities. Therefore, the purpose of this study was to identify a relationship between LBP and obesity and to investigate the relationship of systemic inflammation and the presence of LBP.

NUMBER OF SUBJECTS: Data from 15,322 participants from the 1999 to 2004 National Health and Nutrition Examination Survey (NHANES) were used to obtain a representative sample.

MATERIALS/METHODS: The presence or absence of LBP was determined from self-reported history of LBP or physical limitations as a result of LBP within the past 3 months. Body mass index (BMI: kg/m²) data were computed for each participant. These data were recoded into weight categories of underweight (<18.5), normal weight (18.5-24.9), overweight (25-29.9) and obese (>30). Waist circumference (WC) measurements determined central adiposity. To standardize gender differences in the WC thresholds for risk, the proportion of the measured WC value to the threshold value (male: 102 cm, female: 88 cm) was computed. Participants were stratified into categories of above or below the gender-specific WC recommendation. Systemic inflammation was assessed using venipuncture. Elevated CRP (>3.0 mg/dL) and fibrinogen (>410 mg/dL) Covariance was used to examine means differences in obesity, central adiposity and inflammation by history of LBP. Chi-square analyses and odds ratios were computed to assess proportional differences and likelihood of obesity by history of LBP. Logistic Regression was performed to predict the presence of LBP based on sex, age, income, obesity, CRP and fibrinogen.

RESULTS: Nearly 40% (n = 5,857) of the participants reported LBP. Those with LBP were more likely to be obese (34.8%, $P < .001$) and to have central adiposity (55%, $P = .004$) than those without LBP (28.3% and 47.3%, respectively). For every 1% increase in WC, the odds of having LBP increased by 1.5%. Those with LBP were more likely to have elevated levels of CRP (1.8%, $P = .02$) compared to those without LBP (1.2%). For every 1mg/dL increase in CRP levels, the odds of having LBP increased by 15%. Sex was not a significant factor ($P > .05$), independent of other factors.

CONCLUSIONS: These results identify independent associations between obesity, CRP, and LBP. The presence of obesity is predictive of LBP and high levels of CRP are associated with increased LBP risk.

CLINICAL RELEVANCE: The associations of LBP, obesity, and CRP demonstrate a link between musculoskeletal dysfunction and the potential for long-term health consequences.

SMUDGING OF THE MOTOR CORTEX REPRESENTATION OF THE PARASPINAL MUSCLES IN LOW BACK PAIN

Hodges PW, Tsao H, Danneels L

School of Health and Rehabilitation Sciences, The University of Queensland, Brisbane, Queensland, Australia; Physiotherapy, University of Ghent, Ghent, Belgium

PURPOSE/HYPOTHESIS: Discrete areas of the motor cortex control individual components of the paraspinal muscle complex in healthy people. This is consistent with differential control of these muscle components during functional tasks (Moseley et al, 2002, *Spine*, 27:E29-36). Differential control is lost in people with persistent or recurrent low back pain (LBP) episodes. Disorganization or “smudging” of discrete areas of sensory cortex has been associated with painful conditions that involve compromised independent control of the fingers (Byl et al, 2000, *J Hand Ther*, 13:302-4). Here we studied whether LBP is associated with loss of discrete organization of the representation of the paraspinal muscles on the motor cortex.

NUMBER OF SUBJECTS: Nineteen (8 pain-free controls & 11 low back pain patients)

MATERIALS/METHODS: The organization of the motor cortex was mapped by excitation with transcranial magnetic stimulation (TMS) using a figure-of-eight coil at points on a 5x5 cm grid on the scalp (aligned to the vertex) with motor evoked potentials (MEP) recorded in paraspinal muscles with surface electromyography (EMG) electrodes over the paraspinal muscles at L4 (which record from multiple paraspinal components simultaneously), and separately in short/deep (multifidus) and long/superficial (longissimus) paraspinal muscles with fine-wire intramuscular electrodes. MEPs were evoked during contraction of the paraspinal muscles at ~20% of maximum voluntary contraction that was achieved by leaning forward with the back straight in people with and without a history of LBP (persistent or recurring episodes over the preceding 18 months).

RESULTS: In pain-free individuals 2 discrete area of cortical representation were identified in the surface EMG recordings with centers of gravity at approximately 1 to 2 cm and approximately 4 cm anterior to vertex (both ~2 cm lateral to vertex). Intramuscular EMG recordings revealed single areas of representation with that of the multifidus approximately aligned to the posterior site and that of longissimus at the anterior site. In contrast, the centre of gravity of representations of multifidus and longissimus were both located ~2.5 cm anterior and ~2.5 cm lateral to the vertex and did not differ from each other ($P = .35$) in the LBP group. **CONCLUSIONS:** These data provide novel evidence of loss of discrete organization (ie, “smudging”) of the motor cortex in people with persistent LBP. This may contribute to loss of differential control of paraspinal muscles and a subsequent compromise to the optimal control of spine motion and position.

CLINICAL RELEVANCE: The results of this study provide a possible explanation for movement changes observed in some groups with low back pain. The smudging of the cortical representation of the trunk muscles provides directions for consideration of novel treatments to restore control of the trunk.

FATIGABILITY ASSESSMENT OF THE LUMBAR EXTENSORS IN PERSONS WITH CHRONIC LOW BACK PAIN: AN EMG SPECTRAL ANALYSIS USING INTRAMUSCULAR ELECTRODES

Beneck G, Kulig K

University of Southern California, Los Angeles, CA

PURPOSE/HYPOTHESIS: The lumbar extensors have been reported to be generally more fatigable in persons with chronic low back pain. However, morphologic studies of lumbar multifidus suggest that atrophy tends to be localized rather than generalized. The purpose of this experiment was to examine the fatigability of the lumbar extensors in healthy persons and persons with chronic low back pain. It is hypothesized that the deep fibers of the multifidus will be more fatigable in persons with chronic low back pain.

NUMBER OF SUBJECTS: Fourteen individuals (7 males, 7 females) with chronic, unilateral (nonradicular) low back pain (>1 year) were matched for age, height, weight and activity level, with 14 healthy individuals. Ages ranged between 23 and 42 years. Individuals with back pain had minimal disability (Oswestry Disability Index, mean \pm SD, 14.9% \pm 6.3%).

MATERIALS/METHODS: Electrical activity was recorded using fine-wire intramuscular electrodes of the deep and superficial multifidus at the L4 level, and the longissimus thoracic at the L4 and T10 levels on the painful side. Ultrasonic imaging was used for guidance of the insertions and confirmation of electrode placement. In this study, muscle isometric fatigability was tested with horizontal trunk hold. To ensure that the trunk does not move during the test, a scoliometer was taped to the subject's back and a plumb bob hung from the subject's neck over the surface of a table. A power spectral analysis was performed to calculate the median frequency slope for the first 50 seconds of the fatigue test. The median frequency slope was then normalized to the initial median frequency. The inter-day test-retest intraclass correlation (3, 1) reliability coefficient of the normalized median frequency (NMF) slope was 0.735 for the deep multifidus and 0.799 for superficial multifidus.

RESULTS: There were no significant differences in NMF slope values between the low back pain and control groups ($P = .925$). Without significant main effects, no post hoc analyses were warranted.

CONCLUSIONS: Normalized median frequency slopes were not different between groups or between muscles. These findings do not support the hypothesis that the deep multifidus is more fatigable in the region of low back pain. However, given the multitude of lumbar extensor muscles, increased fatigability of deep multifidus may have gone undetected if the remaining extensor muscles accepted a greater share of the trunk load.

CLINICAL RELEVANCE: Previous studies of lumbar extensor fatigability lacked control of subject activity level, thus difference in general fatigability may be related more to activity level than low back pain. Assumptions of localized muscular fatigability in persons with low back pain are not supported by this study.

SELECTIVE IMPAIRMENT OF FEEDFORWARD ACTIVITY IN PERSONS WITH CHRONIC LOW BACK PAIN

Beneck G, Kulig K University of Southern California, Los Angeles, CA

PURPOSE/HYPOTHESIS: One reason for chronic low back pain may be impaired performance of the muscles such as lumbar multifidus, which control intervertebral motion. Early activation of the lumbar extensors stiffens the spine so that it can better resist perturbations. A delay in timing of contraction may reduce this stiffening effect. Morphologic studies of lumbar multifidus in persons with low back pain suggest that multifidus function may be most impaired in the deep fibers. The purpose of this experiment is to examine the timing of the lumbar extensors in healthy persons and persons with chronic low back pain. It is hypothesized that (1) activation of the deep fibers of the multifidus will be delayed, and (2) that the feed forward mechanism will be compromised in persons with chronic LBP.

NUMBER OF SUBJECTS: Fourteen individuals (7 males, 7 females) with chronic, unilateral (nonradicular) low back pain (>1 year) were matched for age, height, weight and activity level, with 14 healthy individuals. Ages ranged between 23 and 42 years. Individuals with back pain had minimal disability (Oswestry Disability Index, mean \pm SD, 14.9% \pm 6.3%).

MATERIALS/METHODS: Electrical activity was recorded using fine-wire intramuscular electrodes of the deep and superficial multifidus at the L4 level, and the longissimus thoracic at the L4 and T10 levels. The lumbar extensors were activated with a sudden release of a load applied to the trunk in the posterior direction. The load was released under 2 conditions, anticipated and unanticipated. The EMG data were filtered and rectified prior to analysis with an algorithm which determined the onset time. To determine the latency, the release time of the load was subtracted from the onset time. Between-day reliability of the multifidus latency was ICC_{3,5} = 0.896 and 0.889 for the deep and superficial multifidus, respectively, in the anticipated condition, and ICC_{3,5} = 0.887 and 0.796 for the deep and superficial multifidus, respectively in the unanticipated condition.

RESULTS: The study design was not sufficiently powered to show group difference (ANOVA) in latencies across muscles in either the unanticipated ($P = .125$) or anticipated ($P = .103$) conditions. A chi-square analysis testing for an association between group and the number of subjects with at least one trial which achieved feedforward activity showed a significant association with the control group in the deep multifidus only ($P < .043$). When the number of trials was totaled for all subjects that achieved activity prior to the load release, feedforward activity was associated with the control group in both the deep multifidus ($P < .001$) and the T10 longissimus thoracic ($P = .024$).

CONCLUSIONS: Persons with chronic low back pain may have a selective reduction in feedforward activation of the deep multifidus.

CLINICAL RELEVANCE: A lack of feedforward activity may diminish the capacity of deep multifidus to stiffen intervertebral movement. As a result, the lumbar spine may be more susceptible to injury with anticipated spinal loading.

THE TEMPORAL DEVELOPMENT OF MUSCLE FATTY INFILTRATES IN WHIPLASH

Elliott JM, Pedler A, Sterling M

CCRE-Spine; Centre for Magnetic Resonance; Centre of National Research on Disability and Rehabilitation Medicine, The University of Queensland, St Lucia, Queensland, Australia; Centre of National Research on Disability and Rehabilitation Medicine, The University of Queensland, Herston, Queensland, Australia

PURPOSE/HYPOTHESIS: MRI findings of fatty changes in the neck muscles are featured in chronic whiplash and established by 3-months. It is currently unknown how soon following injury these changes occur and whether they represent a generic finding or occur only in those with a more complex presentation and poor recovery. The purpose was to quantify the temporal development of muscle fatty infiltrates (MFI) with an established MRI measure in subjects with acute whiplash.

NUMBER OF SUBJECTS: A total of 56 volunteers (14 male and 42 female) with acute whiplash (<2 weeks) were recruited through referral from an emergency medicine department and the popular press. Subjects were included provided they had neck pain as a result of their motor vehicle crash (MVC). Subjects were excluded if they had been previously diagnosed with a neurological or metabolic disorder, had a history of a previous MVC, neck pain requiring treatment in the past 5 years or were pregnant. *Sixteen subjects had not completed all time points at the time of this submission.

MATERIALS/METHODS: A MRI measure for quantifying MFI was performed in 40 subjects at 2-weeks, 3- and 6-months postwhiplash. Subjects were classified at 6-months using scores on the Neck Disability Index: recovered (<8%), mild pain and disability (10%-28%) or moderate/severe pain and disability (>30%). A measure of deep muscle MFI was produced by combining MFI for the deep multifidii bilaterally (C3-C7) as these muscles have previously demonstrated the highest levels of MFI when compared to the superficial muscles. Repeated-measures linear mixed models were created to determine the fixed effects of time and group and the interaction effect of time*group on the dependent variable; deep MFI. Age and body mass index (BMI) were included as covariates. Planned pairwise comparisons were performed to assess significant differences between groups at each time point.

RESULTS: There was a significant main effect for group ($P<.001$) and a significant interaction effect for group*time ($P<.001$) for the deep MFI values. Age and BMI did not influence deep MFI. There was no group difference in deep MFI at 2-weeks post injury. However, by 3-months, deep MFI had increased in the moderate/severe group and were significantly higher in comparison to both the recovered ($P<.001$) and mild ($P = .003$) groups. These differences persisted at 6-months. No differences in deep MFI were found between the mild and recovered groups throughout the study.

CONCLUSIONS: MFI in the deep cervical extensors occur soon following whiplash but only in those with persistent moderate/severe symptoms. The findings suggest the presence of a more severe injury in this group and represent the first objective MRI marker for the observation of such changes in whiplash.

CLINICAL RELEVANCE: The value of these findings is potentially of great importance when considering the optimal recovery of patients with whiplash. Studies are underway to (1) better investigate the underlying mechanisms and (2) to help develop more informed treatment strategies for those who transition to persistent pain.

IS PHYSICAL ACTIVITY LEVEL (PAL) A PROGNOSTIC FACTOR FOR RECOVERY IN INDIVIDUALS WITH LOW BACK PAIN (LBP) AFTER DISCECTOMY?

Alodaibi F, Fritz J, Hebert J

Physical Therapy, University of Utah, Salt Lake City, UT; School of Chiropractic and Sports Science, Murdoch University, Murdoch, Western Australia, Australia

PURPOSE/HYPOTHESIS: There is limited evidence for the prognostic value of PAL in individuals with LBP, however the association between PAL and prognosis after discectomy has not been examined. Our purpose was to examine the relationship between PAL and outcome measures after discectomy. We hypothesized that individuals with higher activity level would have improved prognosis when compared to individuals with lower activity levels.

NUMBER OF SUBJECTS: Forty-seven subjects (25 male, 22 female). The mean and standard deviation values for the participants were age (41.8 \pm 9.1), BMI (29.3 \pm 6.3), baseline Oswestry disability index (ODI) (42.2 \pm 14.9), baseline average pain rating scale in back (4.2 \pm 2.5) and leg (5.4 \pm 2.6).

MATERIALS/METHODS: We used data from a randomized trial conducted on subjects scheduled for discectomy. All subjects underwent 8 weeks of rehabilitation after surgery. Presurgical baseline measures included age, BMI, average pain in leg and back, ODI, fear avoidance belief questionnaire (FABQ), pain catastrophizing scale (PCS), and PAL measured with the International Physical Activity Questionnaires (IPAQ). From the IPAQ, subjects were categorized into 3 activity levels (low or no activity, moderate, or high activity level). Bivariate correlation between categorical activity levels and FABQ, ODI, PCS was assessed after controlling for potentially influential prognostic variables (BMI and age). For the sake of exploring the prognostic value of the categorical activity levels on the 10-week ODI, we performed a hierarchical linear regression using the 10-week ODI as the dependent variable. Baseline variables including BMI, pain in back and leg, and baseline ODI were entered in the first step. IPAQ category was entered in the second step to evaluate if PAL was related to outcome after controlling for other potentially influential variables.

RESULTS: Subjects' presurgical PAL classification according to the IPAQ category was: 21% high, 19% moderate, and 60% low or no activity level. In terms of the bivariate correlation after controlling for age and BMI, activity level categories were moderately correlated to baseline ODI ($r = -0.34$, $P = .04$) and helplessness element in PCS ($r = -0.35$, $P = .03$). However, activity level categories had low correlation to baseline FABQ score for both physical activity ($r = -0.25$, $P = .13$) and work scales ($r = 0.024$, $P = .88$). The results of the linear regression showed a significant association between activity level categories and outcome after controlling for influential baseline variables ($P = .02$).

CONCLUSIONS: Despite a small sample, we found significant relationships between PAL and concurrent measures of disability and pain catastrophizing. PAL also seems to influence prognosis following discectomy. These findings need to be validated in future studies with larger number of subjects.

CLINICAL RELEVANCE: The results of this analysis suggest higher physical activity levels may be associated with improved outcomes following discectomy. Further research is needed to determine if interventions to enhance PAL can improve outcomes.

PERSONS WITH POSTERIOR TIBIAL TENDON DYSFUNCTION HAVE DIMINISHED HIP MUSCLE PERFORMANCE

Noceti-DeWit LM, Popovich J, Reischl S, Kulig K, Kim D

Department of Biokinesiology and Physical Therapy, University of Southern California, Los Angeles, CA; Temple University School of Podiatric Medicine, Philadelphia, PA

PURPOSE/HYPOTHESIS: The purpose of this investigation was to characterize hip and calf muscle performance in persons with posterior tibial tendon dysfunction (PTTD), and compare them to age-matched controls.

NUMBER OF SUBJECTS: Thirty-four women, 17 with stage I PTTD (mean \pm SD age, 52.1 \pm 7.5 years; weight, 82.0 \pm 18.5 kg; height, 1.65 \pm 0.05 m; 24-hour activity level, 42.2 \pm 13.8 METS) and 17 asymptomatic controls (mean \pm SD age, 50.7 \pm 5.5 years; weight, 74.5 \pm 16.6 kg; height, 1.66 \pm 0.06 m; 24-hour activity level, 48.9 \pm 11.2 METS), participated.

MATERIALS/METHODS: Bilateral isometric hip extensor and abductor strength and endurance were measured using a stationary dynamometer. Calf muscle performance was assessed using single-heel-raises. Six-minute walk test (6MWT) and pain after 6MWT were also examined. The Foot Functional Index-revised (FFI-r) was also administered. A 2-way (group \times side) ANOVA with repeated measures determined differences between groups and sides. Independent *t* tests were performed to determine differences in the 6MWT, pain and FFI-r between groups.

RESULTS: There was no difference in body weight and height, or activity level between groups. No significant difference was found between sides for isometric hip extension and abduction torque and no interaction between group and side was indicated. There was a significant difference in isometric hip extension between groups ($P = .012$), with the PTTD subjects on average demonstrating 0.49 Nm/kg decrease in isometric hip extension torque than controls. Isometric hip abduction was also significant between groups ($P = .031$), with the PTTD subjects demonstrating 0.29 Nm/kg decrease in isometric hip abduction torque. No significant difference was found between sides for hip extension and abduction endurance and no interaction between group and side was indicated. There was a significant difference in hip extension between groups ($P = .028$). On average, individuals with PTTD performed approximately 18 less repetitions in hip extension than controls. Hip abduction was significant between groups ($P = .028$), showing that individuals with PTTD performed approximately 6 less repetitions in hip abduction. There was no interaction between group and side for calf power. There was a significant group main effect ($P < .001$) and side main effect ($P < .001$), indicating individuals with PTTD performed less repetitions than controls, and both groups performed less repetitions on the involved (or nondominant) limb. Significant differences between groups were evident for the 6MWT ($P = .016$), pain after 6MWT ($P = .005$), and all, but one, composite and discrete scores of the FFI-r (at or below $P = .001$).

CONCLUSIONS: Overall, women with PTTD demonstrated less hip extension torque and endurance (33.8% and 38.5%, respectively) and hip abduction torque and endurance (28.5% and 27.0%, respectively) than controls. A 62.9% decrease in calf muscle performance was present in women with PTTD when compared to their age-matched controls.

CLINICAL RELEVANCE: Interventions for patients with PTTD should include assessment and treatment of bilateral hip muscle performance.

THE RELATIONSHIP BETWEEN STATIC FOOT POSTURE AND FOOT MOBILITY

Cornwall MW, McPoil T

Physical Therapy and Athletic Training, Northern Arizona University, Flagstaff, AZ; Physical Therapy, Regis University, Denver, CO

PURPOSE/HYPOTHESIS: It is not uncommon for a person's foot posture and/or mobility to be assessed during a clinical examination. The exact relationship, however, between static foot posture and foot mobility is not known. The purpose of this study was to determine the type and magnitude of association between static foot posture and foot mobility.

NUMBER OF SUBJECTS: The static foot posture and foot mobility of the right extremity of 203 healthy individuals was assessed.

MATERIALS/METHODS: Foot posture was characterized using linear measures of foot length, width and height as well as the Foot Posture Index (FPI). The subject's foot mobility was assessed using 3 linear measurements; the Difference in Dorsal Arch Height between weight bearing and non-weight bearing (DAHDIFF), the Different in Midfoot Width between weight bearing and non-weight bearing (MFWDIFF) and the Foot Mobility Magnitude (FMM). The FMM is a composite measure of both DAHDIFF and MFWDIFF and involves taking the square root of the sum of each variable after it has been squared. All of these variables have previously been shown to have good intra-rater and interrater reliability. Pearson Correlation Coefficients and a series of one-way analysis of variance tests (ANOVA) were performed to determine the relationship between foot posture and foot mobility. A forward step-wise multiple regression analysis was also performed to further investigate the relationship between foot posture and mobility. An alpha level of .05 was used for all test of statistical significance.

RESULTS: The result of the Pearson Correlation analysis showed that all of the static foot posture variables were significantly ($P < .01$) positively correlated with each of the foot mobility variables, except for Dorsal Arch Height (DAH) and DAHDIFF. The results of the ANOVA tests showed that regardless of the variable used to quantify foot mobility, static foot posture was significantly different ($P < .05$) between each of the subgroups. The forward step-wise regression analysis showed that Midfoot Width (MFW), Dorsal Arch Height Ratio (DAHR), DAH and FPI were each linearly correlated with DAHDIFF ($R = .424$), MFWDIFF ($R = .818$) and FMM ($R = .739$).

CONCLUSIONS: The results of this study demonstrate that those individuals with a greater DAH and/or a wider MFW also showed greater mobility in their foot. In addition, those individuals with higher FPI values demonstrated greater mobility and those with lower FPI values demonstrated less mobility. The amount of foot mobility that an individual has can be predicted reasonably well using either 3 or 4 static foot posture variables.

CLINICAL RELEVANCE: Because of the relationship between static foot posture and mobility, it is recommended that both be assessed as part of a comprehensive evaluation of an individual with foot problems.

DYNAMIC PLANTAR PRESSURE CHANGES DURING LOADED GAIT

Goffar SL, Reber RJ, Christiansen BC, Miller RB, Naylor JA, Rodriguez BM, Walker MJ, Teyhen DS
Doctoral Program in Physical Therapy, US Army-Baylor University, San Antonio, TX

PURPOSE/HYPOTHESIS: Lower extremity overuse injuries are a detriment to military readiness. Extreme values of arch height and heavy loads carried by military personnel are associated with an increased risk of overuse injuries. Little is known regarding the impact of load carriage on plantar pressure distributions. This study was conducted to determine how load carriage affects plantar pressure distributions during gait in individuals with varying arch types.

NUMBER OF SUBJECTS: Participants were healthy service members ($n = 115$; 18 female; 31.3 ± 5.6 years of age; 86.0 ± 11.0 kg) of at least 70 kg.

MATERIALS/METHODS: Participants were categorized by arch type based upon accepted cutoff values for Arch Height Index (AHI). AHI was calculated by dividing arch height by heel-toe length (28 high, 61 normal, 26 low arched right feet). Plantar pressure measurements were obtained using an in-shoe pressure measurement system while the subjects wore combat boots. Subjects walked for approximately 30 seconds at 3.0 mph on a treadmill under each of 3 levels of load: uniform without additional load, 20-kg, and 40-kg load. A mean of 9.8 ± 0.6 steps were analyzed for each load condition. Maximum force (MaxF) and force time integral (FTI) were calculated for the plantar foot using a 9 sector mask. Changes in each were analyzed with a 3×3 repeated-measures ANOVA across the levels of load carriage and arch type.

RESULTS: There was a significant interaction between arch type and load for MaxF ($P = .001$) and FTI ($P \leq .005$) in the medial midfoot. Although MaxF and FTI increased in all regions of the foot with load ($P < .001$) regardless of foot type, the forces in the medial midfoot were greater in those with low arches. There was a significant interaction between arch type and load for MaxF ($P = .004$) in the medial forefoot; indicating increased MaxF in high arched feet relative to normal and low arched feet ($< .001$) across all loads. The reverse was true at the great toe region ($P \leq .004$). The relative distribution of pressure increased proportionately in all regions of the foot regardless of foot type for all load conditions.

CONCLUSIONS: Higher forces in the medial midfoot in low arched feet may be related to the increased surface area in this region or may represent increased pronation. However, the relative increases in medial midfoot forces in low arch feet did not increase disproportionately with increases in load compared to normal or high arched feet. Force distributions in the first ray differed based on foot type. Those with high arched feet had greater forces in the medial forefoot region, while those with normal or low arched feet had greater forces in the great toe region, regardless of load. These differences in force distributions may demonstrate different strategies to generate a rigid lever during toe-off.

CLINICAL RELEVANCE: Regardless of foot type, increases in load did not alter the relative distribution of pressure over the plantar foot. These findings possibly indicate a negligible impact of loads ≤ 40 kg on footwear and orthoses prescription. However, differences in dynamic plantar pressure during gait based on foot type were supported.