

ABSTRACTS: AAOMPT CONFERENCE, 2006

The following abstracts are to be presented at the 12th annual meeting of the American Academy of Orthopaedic Manual Physical Therapists held in Charlotte, North Carolina from October 20-22, 2006. Presentations are either by poster or platform. Inclusion of an abstract in this supplement does not constitute a peer-reviewed journal publication. The publication of abstracts alerts readers to research that is presently being conducted. It is hoped that the research presented here in brief will eventually be submitted as full-length manuscripts for review and potential publication.

CASE REPORT: DIAPHRAGM INACTIVITY AS A POTENTIAL SOURCE OF ANTERIOR KNEE PAIN

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Purpose: Many patients seek the care of a physical therapist for anterior knee pain. There are many sources for that pain, both around the knee and throughout the kinetic chain. One potential source could be the diaphragm due to its anatomical attachment on the anterior vertebral body, which is the same location as the iliopsoas. The purpose of this case report is to discuss the treatment approach for a patient with anterior knee pain and an underactive diaphragm. **Methods:** The patient was a 31-year old female who presented with anterior knee pain following a run at an increased pace. Initially the patient presented with an acute knee synovitis. The synovitis was resolved through treatment that included massage and active range of motion. Despite the decreased effusion and increased range of motion the patient continued to have anterior knee pain during functional weight bearing activities. Further examination revealed an underactive diaphragm and an overactive iliopsoas. Treatment for these impairments included muscle re-education of the diaphragm and inhibition of the iliopsoas, especially during her running activities. **Results:** Following successful recruitment of the diaphragm and inhibiting the iliopsoas the patient was able to return to pain free running. **Conclusion/Clinical Relevance:** The iliopsoas functions as a hip flexor, but also has an influence on the lumbar spine. Its attachment on the lumbar spine is in a similar location as the diaphragm. If the patient is not utilizing the diaphragm correctly or sufficiently, the hypothesis was made that the iliopsoas would attempt to compensate, thus potentially contributing to the functional weight-bearing anterior knee pain.

COMPARISON OF CLINICAL TEST AND REAL TIME ULTRASOUND EVALUATION OF MUSCLE CONTRACTION IN NORMALS AND PATIENTS WITH LOW BACK PAIN

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Purpose: To compare abdominal muscle activity measured using the Stabilizer™ and Real Time Ultrasound (RTUS) during graded lumbar stabilization exercise testing. **Methods:** The subjects were 39 volunteers: 19 healthy and 20 with low back pain (LBP). Subjects performed graded exercise testing while maintaining the Stabilizer at 40 (mmHg). Exercises included the abdominal drawing-in maneuver (ADIM) and the first four components of the Abdominal Muscle Strength Test (AMST). Data were collected during one session for healthy subjects and over three treatment sessions for LBP subjects. Only the best exercise sequence progression was used for data analysis in the LBP group. RTUS images were obtained on the right side of healthy subjects and the symptomatic side for LBP subjects. Images were obtained with abdominal muscles relaxed and contracted at each level of exercise testing. Changes in relative thickness of the transversus abdominis (TrA), external oblique (EO), and internal oblique (IO) were used to estimate the contribution of each muscle during the lumbar stabilization test. The preferential activation ratio was used to determine the relative contribution of the TrA compared to the EO and IO muscles. Mann-Whitney U-tests were used to examine differences in preferential activation ratios between groups at each exercise test level. **Results:** Interrater reliability of measures of RTUS on the same images ranged from 0.94 to 0.99. After three training sessions, only

7 LBP subjects were able to progress through all five levels of exercise testing. Mann-Whitney U values for preferential activation ratios showed no significant differences at any test level between groups. **Conclusions/Clinical Relevance:** Similar preferential activation ratios between groups indicate individuals with LBP, who were able to successfully progress through exercise testing, were able to recruit abdominal muscles in similar manner as healthy subjects. This may have occurred due to subjects performing each exercise while maintaining the Stabilizer at 40 (mmHg). Future studies should determine differences in preferential activation ratios of individuals who are not able to progress through exercise testing. Individuals with LBP, who are able to maintain pressure in the Stabilizer at 40 (mmHg), are likely recruiting abdominal muscles during lumbar stabilization exercises in a similar manner as healthy individuals. RTUS may be used to visualize abdominal muscle contractions and objectively quantify the relative contribution of each muscle during lumbar stabilization exercises.

THE USE OF PASSIVE SLUMP STRETCHING AS AN INTERVENTION IN THE TREATMENT OF A PATIENT WITH SIGNS AND SYMPTOMS CONSISTENT WITH ADVERSE NEURAL TENSION: A CASE REPORT

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Purpose: This case report describes the treatment of a patient presenting with adverse neural tension with a past medical history of surgical intervention for a varicocele. **Methods:** A 24-year old male student presented to a university outpatient physical therapy clinic with complaints of local right sacrococcygeal regional pain with forward-bending activities. His past medical history was negative for trauma to this region and positive for surgical intervention secondary to a left-sided varicocele. He developed pain localized to his right sacrococcygeal region with forward-bending movements, following a prolonged period of sitting three weeks earlier. A neurovascular examination of the lower quarter was insignificant for upper and lower motor neuron involvement. Passive straight-leg raise testing (SLR) was ~60° bilaterally, suggesting bilateral hamstring tightness. Initial significant findings included: 1) positive slump test (right: on initiation of knee extension; left: ~45° of knee extension), 2) decreased ability to initiate left trunk rotation in a slump test position secondary to reproduction of current local symptoms, 3) reproduction of current local symptoms with initiation of passive cervicothoracic flexion, 4) Modified Oswestry Disability Questionnaire (ODQ) scored at 30%, 5) Fear-Avoidance Beliefs Questionnaire work subscale score (FABQW: 29) and activity subscale score (FABQA: 20). The patient was seen two times per week for six weeks. Interventions consisted of passive slump stretching, passive slump stretching combined with left trunk rotation, modified SLR passive hamstring stretching, and passive/active neural mobilizations. **Results:** Upon discharge the patient demonstrated: 1) a negative slump test (symptoms described as posterior calf muscle-pulling with passive dorsiflexion of

the ankle), 2) ~75% passive left trunk rotation in a slump test position, 3) asymptomatic passive cervicothoracic flexion, 4) decreased scores on the ODQ (8%), FABQW (4), and FABQA (1) demonstrating marked improvement in function and fear-avoidance beliefs. **Conclusion/Clinical Relevance:** Improvements were demonstrated in objective outcome measures and functional questionnaire scores. This case report suggests the possible benefit of the slump test position as an examination procedure and intervention in a patient presenting with signs and symptoms consistent with adverse neural tension in the absence of a positive SLR. The decision to apply interventions is based on suggested impairments in the subjective interview and physical examination. The patient response to prior sessions and continual re-evaluation supported the decision to continue with the treatment approach.

MANUAL THERAPY INDUCED ANALGESIA: A COMPARISON OF HEALTHY SUBJECTS AND THOSE WITH LOW BACK PAIN

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Purpose: Specific manual therapies (spinal manipulative therapy (SMT) and neural mobilization) have demonstrated efficacy in the treatment of low back pain (LBP), yet exact mechanisms remain largely unexplained. A recent study by our group reported a neurophysiological effect in healthy individuals receiving manual therapy. Specifically, healthy individuals receiving SMT to their low back experienced significantly greater C-fiber mediated analgesia than those riding a stationary bike. The present study furthered our investigation of this neurophysiological effect by comparing manual therapy induced analgesia in healthy individuals and those with LBP. We hypothesized that a similar analgesic effect would occur in both healthy individuals and those with low back pain following a manual therapy intervention. **Methods:** 29 subjects were included in this study from ongoing pilot studies. Twenty subjects were pain free (6 males, 14 females, mean age = 24.1 years). Nine subjects were experiencing LBP (1 male, 8 females, mean age = 41.2 years, mean LBP duration = 59.8 months). Healthy subjects were recruited from graduate level classes and subjects with LBP were recruited from physical therapy clinics. Previously established protocols assessed A and C-fiber mediated pain sensitivity using thermal stimuli. Pain sensitivity was assessed prior to and following the application of manual therapy to the lumbar spine. Subjects receiving SMT were re-assessed immediately after manipulation, whereas subjects receiving neural mobilization were re-assessed at 4 weeks. Repeated measure ANOVAs evaluated the interaction between pre and post pain sensitivity and group (healthy or low back pain). Group differences in pain sensitivity were investigated by post-hoc testing, as appropriate. **Results:** A significant group by time interaction was observed in A-mediated pain perception at 47°C (F = 10.63, p < 0.01), but not 49°C. (F = 2.75, p = 0.11). Paired t-tests indicated that significant analgesia was induced for healthy subjects (mean difference = 23.5, 95% CI = 15.4 to 31.6), but not for LBP subjects (mean difference =

- 4.4, 95% CI = -26.4 to 17.6). A significant group by time interaction was observed in the C-fiber mediated pain perception ($F = 4.28, p = 0.05$). Significant analgesia was observed in the healthy subjects receiving manual therapy (mean difference = 10.2, 95% CI = 4.3 to 16.1), but no analgesia was noted in the LBP subjects (mean difference = -6.8, 95% CI = -33.4 to 19.8). **Conclusion/Clinical Relevance:** Healthy subjects demonstrated significant analgesia for both A δ and C-fiber mediated pain sensitivity following manual therapy interventions. Unexpectedly, subjects with LBP demonstrated no change in A and C-fiber mediated pain sensitivity. A reduction in C-fiber mediated pain perception has been proposed to partially account for the clinical effectiveness of manual therapy. Clinical intervention studies have generally reported more robust effects in patients with acute (shorter duration) LBP than those with chronic (longer duration) LBP. Neuroplastic changes in the central nervous system (i.e., central sensitization) are speculated to result from continued exposure to tonic nociceptive input, especially when the input involves C-fibers. These neuroplastic changes are believed to be present in chronic LBP, but not in acute LBP. Therefore, we speculate that the differential effects we observed may be a preliminary indication that C-fiber mediated pain sensitivity for patients with chronic LBP is not effectively modulated by manual therapy. In contrast, there seems to be the potential to modulate C-fiber activity in pain free subjects. To properly test this hypothesis, future studies will test the analgesic response of subjects with acute LBP.

EFFECT OF NEURODYNAMIC INTERVENTION ON PAIN PERCEPTION: A RANDOMIZED, SINGLE BLIND TRIAL

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Purpose: Neurodynamic techniques are a group of manual intervention techniques purported to address neural tension dysfunction in the nervous system. The effectiveness and efficacy of one such technique, slump treatment (ST), has been demonstrated in groups of patients complaining of low back and leg pain although the mechanism by which these favorable results are derived is unclear. Previous work in animal models and cadavers indicates that, collectively, this set of techniques increase mechanical tension in the targeted peripheral nerves as well as cause motion along the path of the nerve. Our purpose was to add to this work and investigate if neurodynamic techniques impact in vivo neural function by determining the effect of ST on the response to standardized pain stimuli. **Methods:** 36 subjects (22.8 \pm 2.8yrs; 14 women), free of lower extremity or lumbar spine pain, volunteered for this study. All read and signed a consent form approved by the local institutional review board. Subjects were randomized to one of three groups: normal activity (control), neurodynamic (ST) or sham group (static stretch "SS"). Subjects in the slump group performed slump technique twice a day for eight weeks. Subjects in the sham group performed a static hamstring stretch without trunk or neck flexion, or ankle dorsiflexion. Psychological factors known to influence pain perception were measured by validated self-report questionnaires. Psychophysical mea-

asures of pain perception were collected at baseline, four and eight weeks using standardized protocols. Numeric ratings of pain were given in response to standard thermal stimuli applied to the posterior calf under two conditions. Ratings of first pain, mediated by A-delta input, were given to single pulses of 45°C, 47°C, 49°C and 51°C presented in a randomized order. Ratings of second pain were recorded in response to trains of ten thermal pulses of 49°C given at 3Hz to the posterior leg. Second pain is considered mediated by C-fiber input and the slope of the second-pain rating curve can be considered a proxy measure of temporal summation. One-way analysis of variance (ANOVA) technique was used to compare groups based on psychological factors at baseline. First pain responses for each temperature were analyzed using two-way mixed model ANOVA techniques. Slopes of the second pain curves were the dependent variable in a second mixed model ANOVA. We were primarily interested in interaction effects (time x group) in both these analyses. **Results:** The groups did not differ on psychological and psychophysical measures at baseline. Both intervention groups trended to significant differences from the control group at two months at 47°C and 49°C on the "first pain" stimulus at two months. However, intervention groups were not different from each other. No interaction or main effects were apparent for the slope of second pain ratings. **Conclusions/Clinical Relevance:** We draw several conclusions from these data. First, in contrast to the control group whom appeared to habituate to first pain stimulus over time, the intervention groups' responses to standardized pain stimuli remain elevated at two months. This indicates a possible net effect of relative hyperalgesia for subjects performing the interventions. Second, as the pain response from slump was not different from the sham technique in our study, the observed difference from controls may be related to general factors rather than specific effects of the technique on peripheral nerve function. Neurodynamic intervention techniques do not appear to affect pain perception as measured using psychophysical techniques differently from sham techniques in healthy subjects. Clinically noted benefits may occur through mechanisms other than modification of peripheral pain perception although parallel findings in a group of patients with pain is required to confirm this assertion. Future research will test those subjects with positive signs of neurodynamic dysfunction.

UNDERSTANDING BELIEFS ASSOCIATED WITH THRUST JOINT MANIPULATION AND PROFESSIONAL DEGREE PHYSICAL THERAPIST STUDENT TRAINING

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Purpose: This qualitative study explores beliefs, values and experiences of PT academic faculty (AF) and clinical instructors (CIs) associated with thrust joint manipulation (TJM) as it relates to PT entry-level education. The Normative Model of Physical Therapist Professional Education, Version 2004 lists spinal and peripheral joint thrust and non-thrust mobilization/manipulation techniques as interventions appropriate

for entry-level PT students. However, approximately 43% of AF surveyed in 2002 stated that TJM was not an entry-level student skill, and a subsequent 2004 survey of CIs associated with PT programs that teach TJM revealed that 70% of the CIs did not provide TJM training to students. Of the CIs providing TJM training, 30% did not allow students to utilize TJM with patients. Due to limitations associated with pen/paper survey research the respondents' reasons/rationale behind their belief that TJM was not an entry-level skill could not be investigated in depth. **Methods:** Four full-time PT AF responsible for teaching manual therapy content and five CIs working in outpatient orthopaedic patient care settings were recruited from various geographic regions. All participants questioned whether TJM was a PT entry-level skill. Using qualitative research methodology, data was triangulated via information questionnaires and 2 interviews jointly conducted by 2 investigators. Data collection tools were developed in consultation with content experts including participant background data, interview guiding questions and interview closing remarks. The initial interviews (1-1.5 hours in length) were audiotaped, and transcribed verbatim. All authors independently reviewed each typed transcript, followed by a group discussion via a teleconference. By consensus, initial themes were identified, and lists of clarification/affirmation questions were developed for the follow-up phone interviews (approximately 30 minutes). Second interview summaries were immediately typed and reviewed by all authors. Following each interview the data was reviewed independently by the investigators, followed by group discussion. Upon completion of the interviews all transcripts and summaries were again reviewed by authors, followed by group discussions, which identified 15 common informational themes (noted by key words). These words were used by 2 research assistants to independently find relevant narrative text in transcripts and summaries, organized into files for further analysis. Investigators independently reviewed the files and then collectively combined the information into 4 themes: patient safety/liability; student training/TJM skill set; therapist background/experiences; and patient expectations. **Results:** All nine participants stated initially they would not allow students to use TJM. However, as the interviews progressed the majority (7) ended up stating that TJM was, should be, or could be entry-level, but with certain reservations as follows: 1) potential patient injury (especially cervical spine) due to lack of student preparation; 2) fear of medical-legal action if patient was injured or being sued by other state regulatory bodies for inappropriate use of TJM by the PT; 3) lack of CI comfort using TJM techniques due to lack of supervised training and negative personal TJM experiences (as a patient or student) --concerning negative personal experiences, these CIs expressed a dislike of feeling out of control and a painful episode following the TJM-- and 4) patients may not expect to receive TJM from a PT or may have had previous bad TJM experiences at the hands of a chiropractor. One interviewee (CI) was adamantly opposed to TJM being an entry-level skill, stating "manipulation is a highly technical manual skill requiring lots of experience and practice and is not a skill for everyone". Another CI felt that "students should be introduced to TJM but work on developing their non-thrust skills instead of trying to practice TJM". Last, five participants were not familiar with literature supporting

the use of TJM. **Conclusions:** Various factors appear to influence attitudes related to TJM use by entry-level PT students. APTA has developed evidenced-based resources to promote safe and appropriate use of TJM under the assumption that TJM is an entry-level skill. Our results suggest that besides promoting evidence supporting its use, addressing other factors influencing beliefs and attitudes will be important to promote the desired student clinical education experiences. For example, the importance of early positive personal TJM experiences as well as patient willingness to receive TJM treatment cannot be underscored. **Funding Source:** American Academy of Orthopaedic Manual Physical Therapists, Steens USA Physical USA Grant, 2004

A CLINICAL PREDICTION RULE FOR CLASSIFYING PATIENTS WITH NECK PAIN WHO DEMONSTRATE SHORT-TERM IMPROVEMENT WITH THORACIC SPINE THRUST MANIPULATION

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Purpose: Evidence suggests that thoracic spine thrust manipulation can improve outcomes of care in patients with neck pain, while avoiding the small risks of serious complications from cervical spine thrust manipulation. Clinical prediction rules (CPR) are increasingly popular tools to assist clinicians in the decision-making process to match patients to specific interventions from which they are likely to benefit. The purpose of this study was to develop a CPR to identify patients with neck pain likely to experience a dramatic improvement from thoracic spine thrust manipulation. **Methods:** Consecutive patients referred to physical therapy with a primary complaint of neck pain were screened for eligibility. Eligible patients who consented to participate provided demographic information and completed a variety of self-report measures including a body diagram to assess the distribution of symptoms, Numeric Pain Rating scale, the Neck Disability Index, and Fear-Avoidance Beliefs Questionnaire. Patients then received a standardized history and physical examination consisting of a variety of tests and measures commonly used to assess and classify patients with neck pain. Immediately following the examination all patients received a standardized treatment regimen consisting of thoracic spine thrust manipulation, a general cervical mobility exercise, and advice to maintain usual activity within the limits of pain. Patients were then scheduled for a follow-up session within 2-4 days at which time they again completed the self-report measures as well as the Global Rating of Change (GROC). It was determined *a priori* that patients who rated their perceived recovery on the GROC as "a very great deal better", "a great deal better", or "quite a bit better" (i.e., a score of +5 or greater), at the second session were categorized as a success and their participation in the study was complete. Patients whose scores on the GROC did not exceed the +5 cut off at the 2nd session received the thrust manipulations as in the 1st treatment and were scheduled for a follow-up within 2-4 days. At the start of the 3rd session patients again

completed the GROC and were judged to be a success based on the previously described criterion. If the patient still did not meet the threshold for success, they were categorized as having a non-successful outcome. Sensitivity, specificity, and positive and negative likelihood ratios were calculated for all potential predictor variables. Univariate techniques and step-wise logistic regression were used to determine the most parsimonious set of variables for prediction of treatment success. Variables retained in the regression model were used to develop a multivariate CPR for classifying patients with neck pain likely to benefit from thoracic spine thrust manipulation. **Results:** 78 patients were included in data analysis of which 42 experienced a successful outcome. A clinical prediction rule with six variables (symptom duration < 30 days, no symptoms distal to the shoulder, looking up does not aggravate symptoms, Fear-Avoidance Beliefs Physical Activity subscale score <12, decreased upper thoracic spine kyphosis (T3-T5), and cervical extension < 30 degrees) was identified. If 3 of the 6 variables were present (+LR 5.5), the probability of experiencing a successful outcome improved from 54% to 86%. **Conclusion/Clinical Relevance:** The CPR provides the ability to *a priori* identify patients with neck pain likely to experience a dramatic response with thoracic spine thrust manipulation. However, this is only the first step in the process of developing and testing a CPR. Future studies are necessary to validate the results and should include a long-term follow-up and a comparison group to further investigate the predictive value of the variables in the CPR.

SHORT-TERM RESPONSE OF THORACIC SPINE THRUST VERSUS NON-THRUST MANIPULATION IN PATIENTS WITH MECHANICAL NECK PAIN: PRELIMINARY ANALYSIS OF A RANDOMIZED CLINICAL TRIAL

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Purpose: Over 50% of the general population has experienced neck pain within the last 6 months and the costs associated with managing these patients are substantial. Evidence supports the use of manual physical therapy interventions, specifically manipulation, directed at the thoracic spine in patients with neck pain. However, it is unclear whether thoracic spine thrust manipulation is more beneficial than non-thrust, lower velocity mobilization techniques. The purpose of this study was to compare the effectiveness of thoracic spine thrust versus non-thrust manipulation in patients with a primary complaint of mechanical neck pain. **Methods:** Consecutive patients 18–60 years of age referred to physical therapy by their primary care practitioner with a complaint of mechanical neck pain who satisfied eligibility criteria were invited to participate. Patients with contraindications for thoracic spine manipulation were excluded. All patients were screened prior to participation and received a standard history and physical examination by a licensed physical therapist. Self-reported outcome measures included the Neck Disability Index (NDI), a pain diagram, the Numeric Pain Rating Scale (NPRS) and the

Fear Avoidance Beliefs Questionnaire. Following the baseline evaluation patients were randomized to receive either thoracic spine thrust or non-thrust manipulation followed by a basic range of motion exercise. A second physical therapist performed the manipulation techniques according to the patient's group assignment and then instructed the patient in the range of motion exercises, which were also performed home 2-3 times daily. Patients were re-examined 48 hours after the initial examination by a physical therapist that was blinded to group allocation. Baseline variables were compared between groups using independent t-tests for continuous data and Chi-square tests of independence for categorical data. The primary aim (effects of treatment on pain and disability) was examined with 2-way repeated-measures analysis of variance (ANOVA), with treatment group (thrust versus non-thrust manipulation) as the between subjects variable and time (baseline and 48 hours) as the within subjects variable. Separate ANOVAs were performed with pain (NPRS) and disability (NDI) as the dependent variable. For each ANOVA, the hypothesis of interest was the 2-way interaction (group X time). Planned pair-wise comparisons were performed at the follow-up period using the Bonferroni equality at an alpha level of 0.05. **Results:** 45 patients, mean age 44.2 (SD=12.8) (58% female), satisfied the eligibility criteria, agreed to participate, and were randomized into the thrust (n=23) or non-thrust manipulation group (n=22). Baseline characteristics between the groups were similar for all variables (P>0.05), with the exception of the number of patients on workers compensation (n=7 vs. 1 in the thrust vs. non-thrust manipulation group, respectively, P= 0.023). The overall 2-way group X time interaction for the repeated-measures ANOVA was statistically significant for disability (P< 0.001) and pain (P<0.001). Post-hoc comparisons demonstrated that patients receiving thrust manipulation experienced greater improvements in pain (NPRS; 2.5, 95% CI, 1.9, 3.0) and disability (NDI; 15.1, 95% CI, 11.7, 18.6 and respectively) compared to patients receiving non-thrust manipulation (NPRS; 0.30, 95% CI, 0.26, 0.86 and NDI; 3.8, 95% CI, 0.23, 7.3). **Conclusions/Clinical Relevance:** The results of this study provide evidence that thoracic spine thrust manipulation results in greater short-term reductions in pain and disability than thoracic non-thrust manipulation in patients with neck pain. Considering the extremely low risks associated with thoracic spine thrust manipulation, physical therapists should consider performing thoracic spine thrust manipulation over non-thrust manipulation techniques in patients with mechanical neck pain to maximize short-term outcomes. Further research is necessary to determine longer-term treatment effects.

REAL-TIME UPDATES OF META-ANALYSES OF MANUAL THERAPY TREATMENT OF LOW BACK PAIN SUPPORTED BY A BIOMEDICAL ONTOLOGY

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Purpose: Clinical guidelines on the management of low back pain have been issued in various countries and by various

agencies throughout the world. Guidelines are created using systematic reviews and meta-analyses (when available). Meta-analyses are significantly affected by reporting delays, irregular updates, and publication biases. Meta-analyses are typically updated every 5 years while Guidelines require 5 to 8 years. Ontologies, such as the *Trial Bank Project*, are computerized processing methods, which are designed as Clinical Decision Support Systems (CDSS) or mechanisms to enhance a clinician's ability to make real-time decisions at the point of care. The purpose of this study was to develop a new ontology that allows real-time meta-analytic updates for manual therapy trials to encourage the use of the Journal of Manual and Manipulative Therapy (JMMT) as a dispensatory access port. **Methods:** The Centers of Excellence in Surgical Outcomes (CESO) from Duke University and the National Center for Biomedical Ontology (NCBO) have created a meta-analytic ontology for scientific texts (W3C XML schemata and Topic Maps) as well as an open source Web application, called Manuscript Architect, which allows for reporting of real-time updates for manual therapy trials. The ontology was tested across a limited number of present meta-analyses for concurrent validity. **Results:** The ontology replicated the findings of the published meta-analyses and allowed for continuous real-time updates without the requirement of the original databases from the studies. Unlike the *Trial Bank Project* that requires extensive recoding and submission in participatory journals (and the complete database of information), our ontology allows real-time updates using any acceptably targeted clinical trial using "tags" identified within the converted XML document. **Conclusion:** A real-time ontological meta-analysis allows real-time updates for Guideline development and provides dispensation of CDSS data for all who have access to the JMMT website. This suggests that the lag time in creation of Guidelines could potentially be reduced, secondary to the elimination of the 5-year wait for meta-analysis updates. We conclude that we were successful in creating an ontological software program that allows real-time meta-analysis updates and plan to use this software to provide open access to the data collected on the JMMT website.

CORTICOSTEROIDS COMBINED WITH MANUAL PHYSICAL THERAPY AND EXERCISE FOR SUBACROMIAL SHOULDER PAIN: A CASE SERIES

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Purpose: Shoulder pain is the third leading cause of musculoskeletal primary care consultation. However, there is only limited evidence supporting any individual treatment strategy. This case series describes outcomes of a multimodal approach involving corticosteroid injection (CSI) followed immediately by manual physical therapy and a home exercise program. **Methods:** Subjects were three consecutively referred patients diagnosed with subacromial origin shoulder pain. Interven-

tions consisted of manual physical therapy within seven days of CSI; each patient received six treatments directed to movement impairments found in the shoulder, cervical and thoracic spine. Treatment included cervical and thoracic mobilization, graded shoulder mobilization and a home program. Outcome measures included two questionnaires: Disabilities of the Arm, Shoulder and Hand (DASH) and the Shoulder Pain and Disability Index (SPADI). **Results:** Two subjects experienced greater than the twelve-point minimal clinically important difference (MCID) reported for the DASH, and all three surpassed the 10% MCID for the SPADI. **Conclusions/Clinical Relevance:** Although these limited results suggest a meaningful change, it is unclear whether the inclusion of CSI is more advantageous than outcomes reported in clinical trials without CSI. Further research is warranted to assess the effects of CSI combined with manual physical therapy and exercise. The incidence of adverse side effects from CSI ranges from 5% to 22% and includes minor pain and facial flushing as well as severe tendon rupture and fracture. Therefore, the use of CSI must be established as worth its risks in the treatment of subacromial shoulder pain. None of the three subjects experienced any adverse reactions.

THE EFFECTS OF TIBIO-FEMORAL JOINT TRACTION MOBILIZATION ON PATIENTS WITH LIMITED PASSIVE KNEE FLEXION: A CASE SERIES.

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Purpose: Limited passive knee flexion can occur due to degenerative conditions or traumatic injuries to the bone or soft tissues within or surrounding the knee joint resulting in pain and loss of function. The literature indicates that conventional rehabilitation programs for knee pathology include exercises to restore range of motion and strength, decrease pain and swelling, and promote healing. There is limited literature on manual therapy intervention aimed at restoring motion deficits affecting the knee. No literature could be found on the use of translatory mobilization techniques in cases of restricted knee flexion. Tibiofemoral (TF) joint traction mobilization is a translatory manual therapy technique developed to reduce pain, swelling, and improve joint motion. The purpose of this case series was to determine the effectiveness of TF joint traction mobilization in improving knee flexion while not significantly increasing pain in 14 patients with limited passive knee flexion. **Methods:** Passive range of motion measures were taken at the end of available passive knee flexion prior to application of the TF joint traction mobilization, and at 2 minutes, 4 minutes, and 6 minutes post-mobilization. Visual analog scale (VAS) measures for pain were taken in prone with the knee joint in the resting position, at the end range of passive knee flexion, during the application of TF joint traction mobilization at the end range of passive knee flexion, and again in the resting position immediately post-traction mobilization. Outcome measures included passive knee flexion measured with a standard goniometer, knee pain measured with a 10-cm VAS, and function measured with

a modified version of the Patellofemoral Disability Index. **Results:** The average improvement in passive knee flexion range of motion was 27.0° (range: 13° to 70°). The average VAS score reported at the end range of passive knee flexion was 2.4 (range: 0.0 to 10.0). The average VAS score reported during TF traction mobilization at the end range of passive knee flexion was 1.4 (range: 0.0 to 5.4). The average improvement on the modified version of the Patellofemoral Disability Index was 36% (range: 5.9% to 76.5%). **Conclusion/Clinical Relevance:** TF joint traction mobilization assisted in improving knee joint passive flexion motion, reduced pain at the end range of available passive knee flexion and may have assisted in improving functional status in 14 patients with limited passive knee flexion. **Acknowledgements:** The authors would like to thank Mike Pollizzie, MPT, OMPT, CSCS and William Farr, MPT, OMPT.

DEVELOPMENT OF A CLINICAL PREDICTION RULE TO IDENTIFY PATIENTS WITH KNEE OSTEOARTHRITIS WHO DEMONSTRATE A FAVORABLE SHORT-TERM RESPONSE TO HIP MOBILIZATION

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Purpose: To develop a clinical prediction rule (CPR) for identifying patients with knee osteoarthritis (OA) who will respond favorably to short-term hip mobilizations. **Methods:** 60 subjects (33 male and 27 female, mean age = 65.8 years, SD=7.2 years, range 51-79) with a clinical diagnosis of knee osteoarthritis (OA) participated in this study. This study used an exploratory, pretest-posttest design in conjunction with clinical prediction rule criteria. After giving informed consent, all subjects completed a Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scale and Patient Specific Functional Scale (PSFS). Subjects then underwent a standardized physical examination of bilateral hips and knees. For reliability purposes, a second examiner repeated all procedures on the first 25 subjects. Following examination procedures, each subject performed a squat test and sit-to-stand task and rated their pain during activity using a Numeric Pain Rating Scale (NPRS). All subjects then received three 30-second bouts of four hip mobilization procedures. Subjects returned 48 hours later and repeated all outcome measures to include the Global Rating of Change scale (GROC) along with the physical examination and the functional tests. Descriptive statistics were computed for demographic variables as well as self-report measures. The NPRS ratings obtained following the two functional tests were summed to form a composite score. Subjects were considered a success based on the following outcomes at 48 hours: 1) a $\geq 30\%$ reduction in the composite NPRS or 2) a $\geq +3$ GROC score. Sensitivity (Sn), specificity (Sp), and likelihood ratios (LRs) were calculated for all clinical examination variables. Variables with useful likelihood ratios were entered into a

binary logistic regression model to specify the CPR. Diagnostic indices (Sn, Sp, and LRs) were then calculated for incremental levels of positive CPR findings. Intra-class correlation coefficients and the Kappa statistic were used to compute inter-rater reliability. **Results:** 68% of subjects were classified as a success. The following five variables were retained by the logistic regression model and comprised the CPR: pain or paraesthesiae in the ipsilateral hip/groin region, pain in the ipsilateral anterior thigh, ipsilateral knee flexion passive ROM < 122 degrees, ipsilateral hip internal rotation passive ROM < 17 degrees, and pain with ipsilateral hip distraction. When any two variables are present the +LR=12.9 (95% CI 0.8-205.6) and the probability of success increases to 97%. The reliability for continuous clinical exam variables varied and ranged from poor to good. **Conclusion/Clinical Relevance:** A level I CPR consisting of history and physical examination variables is predictive of patients with knee OA who respond to hip mobilization. If validated, this CPR could improve clinicians' decision-making and efficiency in examining and treating patients with knee OA.

RESOLUTION OF CHRONIC NON-CERVICOGENIC DIZZINESS FOLLOWING MANUAL PHYSICAL THERAPY DIRECTED AT THE RIBCAGE: A CASE REPORT

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Purpose: Recent evidence has suggested the importance of regional interdependence in the management of musculoskeletal injuries. The purpose of this case study is to describe the outcomes of a patient with non-cervicogenic dizziness, which was treated with manual physical therapy (MPT). **Methods:** A 50-year old female diagnosed with a cervical strain presented to an outpatient physical therapy clinic. The patient reported an insidious onset of neck and upper back pain that began at age of 14 and that more recently (past 14 years) had been associated with daily headaches (HA) and unremitting dizziness. The physical examination revealed a normal neurosensory screen, general cervical and scapulothoracic strength of 4/5, and a negative dizziness test (active head rotation). Active cervical (extension/rotation/flexion) and thoracic (extension) range of motion (ROM) was limited. Adverse neural tension signs (median bias and slump tests) were present and brought on arm discomfort, increased HA intensity, C6-T2 and upper lumbar "stiffness," but no dizziness provocation. Segmental mobility testing revealed hypomobility in the upper to lower cervical spine as well as the upper and mid thoracic spine, 1st rib, and posterior rib cage. Postero-anterior mobility assessment at the T2 and T4 costotransverse and costovertebral junctions revealed both hypomobility and reproduction of severe dizziness (brief bursts, severe, room-spinning vertigo). Based on the initial findings, it was hypothesized that chronic osseous restrictions in this region was contributing to the dizziness. The patient was treated with MPT techniques designed to improve articular motion and overall cervical

and thoracic ROM. The physical therapy program included thrust and non-thrust mobilization/manipulation directed at the identified spinal/rib impairments, upper extremity neural mobilization, myofascial release, a supervised strength and conditioning program, and a home exercise program designed to improve posture, muscle flexibility, and mobility of the cervical and thoracic spine. At the baseline examination the patient completed several self-report outcome measures including a Numerical Pain Rating Scale (NPRS) and the Neck Disability Index (NDI). At the final PT visit and at an 8-week follow-up, the patient again completed the NPRS, NDI and a Global Rating of Change (GROC) at discharge from PT. **Results:** Following 11 visits over a 6-week time period, the patient demonstrated clinically meaningful improvements in both pain and disability (the NDI improved from 20/50 to 2/50; the NPRS improved from 6/10 to 0/10). Further, the patient reported that she was “a very great deal better” on the GROC scale. Additionally, the patient made steady gains throughout the course of treatment with regards to tenderness, cervico-thoracic ROM and functional activities. The patient’s dizziness symptoms did not respond to manual treatment of the cervical spine, but rapid positive improvement occurred after assessment and treatment of the rib dysfunctions. At discharge, the patient’s neck pain, headaches and dizziness had fully resolved. Improvements in pain, function and disability were maintained at 8 weeks after discharge in all categories except NDI, which had further improved to 0%. The patient has returned to leading an active lifestyle including mountain biking, skiing and traveling. **Conclusion/Clinical Relevance:** The outcomes of this case study suggest that chronic dysfunction of the costotransverse and costovertebral complex may be potential sources of chronic dizziness. Further studies are needed to identify a subgroup of patients that could benefit from manual physical therapy to this region.

TREATMENT OF HIP & GROIN PAIN WITH MANUAL PHYSICAL THERAPY: A CASE REPORT

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Purpose: A recent review of the literature reveals a paucity of evidence regarding the conservative management, of patients with hip pain. The purpose of this case study is to describe the manual physical therapy (MPT) approach for an individual presenting with hip passive range of motion (PROM) impairments and functional limitations. **Methods:** A 42-year old female was referred to physical therapy with complaints of constant aching in the left posterior hip and frequent sharp, shooting groin pain during pivoting while weight bearing. The patient reported an insidious onset of groin pain, 6 weeks prior to her initial physical therapy examination. Functional limitations included an inability to reciprocally climb stairs or sleep on either side due to groin pain. Physical examination revealed marked left hip PROM limitations in all planes except extension and external rotation. The patient demon-

strated a guarded end feel, and reproduction of sharp groin pain at end range in all planes. Special tests included the hip flexion, adduction, and IR (FADIR) test, which replicated the patient’s groin pain. Manual muscle testing of left hip adduction and flexion was weak (3-/5) and painful. The left iliopsoas, quadratus lumborum, hip adductor, and piriformis muscles were hypertonic and tender to palpation. Plain film radiographs and a non-contrast MRI of the left hip, was negative. Differential diagnosis included a hip labral tear or other internal derangement. Treatment included 10 sessions over the course of 5 weeks utilizing an impairment-based MPT approach. The first 4 sessions focused on hip mobilizations, soft tissue, and neuromuscular techniques. On the 5th visit a sustained long axis traction mobilization was applied through the available abduction ROM to the left hip with the goal of reducing the compressive force within the joint and increasing pain free PROM. Subsequent sessions focused on a functional exercise progression emphasizing closed chain exercises, active hip range of motion, and strengthening against gravity. Outcomes were assessed initially, at visit 6, and at discharge. Outcome measures included PROM, the numerical pain rating scale (NPRS), the Lower Extremity Functional Scale (LEFS), and the Global Rating of Change scale (GROC). **Results:** On re-assessment following the long axis hip traction mobilization (visit 5), the patient reported a NPRS of 0 (range 0-10) and full, pain free AROM in all planes was restored. The GROC was reported as “a great deal better”. The patient was discharged after 10 sessions with noted improvement in her outcome measures. The LEFS was 0 at initial examination, 65 at discharge, and 63 at the 9-month follow up. The GROC upon discharge was “a very great deal better” and this score was maintained at 9 months post-discharge. **Conclusion/Clinical Relevance:** This patient’s symptom presentation is consistent with those described by other authors treating patients, who present with internal derangement or labral tears of the hip. This patient experienced a clinically meaningful improvement, maintained at 9-month follow-up in PROM, pain as reported on a NPRS, and with regard to GROC and LEFS score following MPT to the hip. The key technique in her management appeared to be the long axis traction mobilization at visit 5, after which her pain significantly decreased and her hip motion was restored. The results of this case study do not provide a causal link between the intervention and outcomes; however, the results suggest further research is warranted.

TREATMENT OF SUBACROMIAL IMPINGEMENT SYNDROME WITH MANUAL PHYSICAL THERAPY AND EXERCISE DIRECTED TO THE UPPER QUARTER: A CASE REPORT

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Purpose: Results from recent clinical trials suggest that thrust and non-thrust mobilization/manipulation of the cervical and thoracic spine, either in isolation or in combination with manual therapy and exercise targeted to the shoulder,

improve pain and disability in patients with shoulder pain and subacromial impingement. This case report describes the evaluation of, and treatment to the upper quarter of a patient with subacromial impingement syndrome (SIS). **Methods:** The subject was a 62-year old female with a 6-month history of left shoulder pain. The patient presented with signs and symptoms consistent with SIS, including limited shoulder range of motion, pain with resisted rotator cuff testing, and a positive Hawkins sign. The patient also presented with cervical and thoracic spine impairments, including limited active range of motion, segmental spinal hypomobility, and postural deviation on initial examination. Twelve visits of physical therapy were completed over a 5-week period. Treatment consisted of manual physical therapy (MPT) interventions, including soft tissue mobilization, muscle stretching, and joint non-thrust and thrust mobilization/manipulation of the identified impairments detected in the cervical and thoracic spine and glenohumeral joint. A therapeutic exercise program was completed in the clinic and at home, consisting of strengthening, stretching, and self-mobilization exercises to the identified upper quarter impairments. Outcomes were assessed at the initial examination, 3 weeks after initial examination, and at discharge 5 weeks after the initial examination. Outcome measures included the Disabilities of the Arm Shoulder Hand questionnaire (DASH), a Numerical Pain Rating Scale (NPRS), and a generic Global Rating of Change (GROC) scale. **Results:** The DASH score improved from 40.8% at baseline to 13.3% at discharge. The GROC at discharge was reported as a "very great deal better". The NPRS was 6/10 at baseline and 0/10 at discharge. The patient was seen 3 months later for an unrelated condition and reported no shoulder pain or functional limitations at that time. **Conclusion/Clinical Relevance:** MPT interventions and exercise, directed toward the shoulder, cervical, and thoracic spine resulted in decreased pain and improved functional ability in a patient presenting with SIS. With a case report we cannot infer causal relationships; however, this case report is consistent with recent literature supporting the use of MPT to the cervical and thoracic spine in patients with shoulder pain/SIS. Further research is necessary to determine which sub-group of patients with shoulder pain would benefit from MPT interventions targeted to the thoracic and cervical spine.

MOBILIZATION WITH MOVEMENT AS PART OF A COMPREHENSIVE PHYSICAL THERAPY PROGRAM FOR A PATIENT WITH SHOULDER IMPINGEMENT: A CASE REPORT

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Purpose: Shoulder impingement is a common complaint among patients seeking physical therapy. Abnormal joint mechanics of the scapula may contribute to this disorder. Mobilization with movement (MWM) is a manual therapy technique that purportedly helps to restore normal joint mechanics and improve scapular positioning and movement.

The purpose of this case report is to describe the clinical decision making process used in selecting and implementing a MWM technique, as well as describe outcomes achieved for a patient with shoulder impingement. **Methods:** Our subject was a 48-year old man with a complaint of right shoulder pain of insidious onset several weeks prior. His symptoms increased with lifting and overhead activities, including such movements performed while playing tennis and basketball. His symptoms eased with rest and ice. He denied any current cervical pain or radicular symptoms. Radiographs showed mild degenerative changes to include a Type II acromion. His goals were to return to playing basketball and tennis without pain. The physical examination consisted of an assessment of posture, cervical and shoulder range of motion (ROM), assessment of scapulohumeral rhythm, shoulder girdle manual muscle testing, passive mobility of the joints of the shoulder girdle, and special tests to rule in or rule out shoulder impingement, cervical radiculopathy, and rotator cuff tear. Impairments identified on the exam included decreased shoulder ROM, hypomobile glenohumeral and acromioclavicular joints, and rotator cuff and scapular stabilizer weakness. Additionally, we hypothesized that abnormal scapular mechanics were contributing to our patient's shoulder pain. Our intervention included a shoulder girdle MWM technique as described by Mulligan. We selected the MWM technique based on objective measurements that confirmed shoulder impingement. We also chose this technique based on our assessment of poor shoulder girdle mechanics, including scapular winging and increased scapular protraction. Other interventions included glenohumeral and acromioclavicular joint mobilizations, rotator cuff and scapular stabilizer strengthening, and modalities to reduce pain and inflammation that may have been present. **Results:** The Disability of Arm, Shoulder, and Hand scale (DASH) and Global Rate of Change Scale (GROC) were used to assess change in patient status. His initial DASH score was 14.2 and his final DASH score was 3.7. He reported his GROC as "a great deal better" and also returned to playing tennis and basketball without pain. **Conclusion/Clinical Relevance:** This case study suggests that perhaps an MWM shoulder girdle technique may be useful as part of an intervention program for patients with shoulder impingement. Future research should be performed to determine which patients with shoulder impingement will respond the most favorably with the inclusion of this technique within a comprehensive intervention program.

THORACIC SPINE THRUST MANIPULATION AND THERAPEUTIC EXERCISE IN THE TREATMENT OF SUBACROMIAL IMPINGEMENT SYNDROME: A CASE REPORT

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Purpose: Shoulder impingement syndrome (SIS) is one of the most common disorders seen in the outpatient physical therapy clinic. There exists considerable controversy surrounding the optimal treatment of SIS. Recent evidence has shown that thrust manipulation procedures directed at the thoracic spine in

patients with shoulder dysfunction results in superior outcomes compared to usual medical care. The purpose of this case report is to describe the management and outcomes of a patient with SIS treated with thoracic spine thrust manipulation techniques in conjunction with specific therapeutic exercise. **Methods:** The patient was a 53-year old female who was referred to physical therapy by her orthopedic surgeon with the diagnosis of right SIS. The patient reported having a 4-week history of right shoulder pain that was exacerbated during various functional activities that required reaching behind her back or above shoulder level. Her sleep was markedly interrupted due to her shoulder pain. The physical therapy examination revealed a painful arc during active abduction of right shoulder at 120 degrees. Pain and weakness upon resisted muscle testing of shoulder abduction. The following special tests were found to be positive on the right; Drop Arm test, Yergason, Kennedy-Hawkins sign, and Neer impingement sign. Hypomobility was identified in the thoracic spine with posterior anterior spring testing from T5-T10. During the initial examination the patient completed several self-report measures including the Pain Diagram, Numeric Pain Rating Scale (NPRS), Disability of the Arm Shoulder and Hand questionnaire (DASH), and Global Rating of Change (GROC). Following the initial examination the patient was treated with high velocity thrust manipulation techniques targeting the middle thoracic spine. The patient was also instructed in posture education, received posterior/inferior glenohumeral capsular stretching, pectoralis muscle stretching, and prone middle and lower trapezius, serratus, supraspinatus, and shoulder external rotator strengthening. The patient received 4 physical therapy treatments over a 28-day period. At the time of discharge (4th visit) patient again completed the self-report outcome measures as well as GROC. **Results:** Based on the self-report measures the patient demonstrated a clinically meaningful reduction in pain and improvement in function since beginning physical therapy. Her DASH score improved from a 37% to a 0%, pain at its worst went from a 3 to a 0 on the NPRS, and on the GROC she reported that she was a very great deal better. **Conclusion/Clinical Relevance:** This case report provides further evidence suggesting that thoracic spine thrust manipulation in conjunction with specific therapeutic exercise may be an effective treatment intervention for the management of patients with SIS.

CHANGES IN LATERAL ABDOMINAL MUSCLE FUNCTION AFTER SPINAL MANIPULATION: A CASE SERIES

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Purpose: A clinical prediction rule (CPR) has been developed and validated that accurately identifies a subgroup of patients with low back pain (LBP) likely to benefit from spinal manipulation; however, the mechanism of spinal manipulation remains unclear. The purpose of this case series was to document immediate changes in lateral abdominal muscle thickness using real-time ultrasound imaging (USI) after spinal manipulation in a subgroup of patients positive on the rule. **Methods:** Case series involving nine patients (5 female, 4 male) with a primary

complaint of LBP who met both factors (LBP < 16 days and no symptoms below the knee) in the modified CPR predicting successful outcome from spinal manipulation. Mean age was 32 ± 4 years. Mean duration of LBP was 8 ± 1.4 days and the mean Oswestry Disability Index score was 32.9 ± 5.1. Lateral abdominal muscle thickness at rest and during an abdominal drawing in maneuver (ADIM) was assessed immediately before and after the supine lumbopelvic technique using USI. To help control for a possible learning effect, subjects completed a 15-minute training session of the ADIM prior to assessment. Descriptive statistics (measures of central tendency and variability) were used for data analysis. **Results:** The majority of patients (7 of 9) demonstrated an increase in Transversus Abdominis (TrA) muscle thickness during the ADIM (average increase of 1.12 mm, SEM = 0.20 mm), with no change being observed in 7 of 9 patients' Internal Oblique (IO) muscle thickness. Additionally, a decrease in the resting thickness was observed in the TrA in 7 patients (average decrease of 0.53 mm, SEM = 0.13 mm) and the IO in 5 patients (average decrease of 0.98 mm, SEM = 0.21 mm). These changes exceeded the threshold of measurement error. **Conclusions/Clinical Relevance:** This is the first case series to quantify the short-term influence of spinal manipulation on lateral abdominal muscle thickness. These changes provide preliminary evidence to suggest spinal manipulation may influence muscle function. The observed changes in muscle thickness could indicate an improvement in muscular function of the lateral abdominal muscles after spinal manipulation. Given the immediacy of re-assessment and because we accounted for a potential learning effect with the pre-measurement training session, it is unlikely that other factors could account for this change. Future research is needed to determine if the changes in muscle thickness are associated with improvement in pain and disability and to further explore the mechanism of spinal manipulation.

IDENTIFICATION OF POTENTIAL FACTORS SUGGESTING DOUBLE CRUSH PHENOMENON: TWO CASE REPORTS

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Purpose: Peripheral entrapment neuropathy (PEN) in the upper and lower extremities is a well-documented clinical condition associated with multiple etiologies, as well as combined mechanical and physiological changes of the nervous system. Clinicians often manage patients with multiple, chronic pain complaints suggestive of minor peripheral nerve entrapments. It has been suggested that the presence of minimal chronic nerve compression creates a condition whereby a second site of compression anywhere along the nerve causes further rapid loss of neural function. This condition has referred to as the 'double crush phenomenon.' While the causes of double crush have been fairly well delineated, the clinical presentation has yet to be clarified and agreed upon. The purpose of these two case reports is to describe patient pain patterns, interview and examination findings suggestive of multiple, minor peripheral nerve injury/PEN and possible double crush presentation.

Methods: Patient 1 was a 28-year old male, two weeks status post right ankle sprain that occurred while playing basketball. He presented wearing an Air splint cast on the injured ankle and using a standard cane for ambulation. He complained of right ankle, lumbar, and posterior thigh symptoms. Patient 2 was a 45-year old male bus driver. He presented with right shoulder pain that began insidiously three weeks before. Areas of symptoms included right shoulder pain and stiffness, lumbar stiffness, and occipital headache. Both patients in these case reports presented with multiple sites of pain, paraesthesiae and other symptoms, specifically reporting peripheral areas of burning or shooting pain and stiffness/pain in spinal regions. Both patients related a history of previous spine surgery, insidious onset of symptoms and chronic tissue injury. Physical examination revealed antalgic posture, active/passive range of motion limitations, neurodynamic restrictions, a positive Tinel sign, allodynia, hyperalgesia, and associated "joint signs." Neurological examination and electromyography/nerve conduction studies were found to be negative. **Results:** The findings presented in these two case reports are consistent with typical findings associated with double crush phenomenon. Similarities between the case histories, onset of multiple symptomatic sites and examination findings are discussed and compared to previous research. **Conclusions/Clinical Relevance:** The clinical manifestation of PEN, though variable, is well documented. Underlying pathophysiological changes within the peripheral nervous system support a model of neuritis as a contributing factor in the manifestation of local entrapments. The contributing factors creating pathophysiological change of the neuron leading to PEN and progressing to a double crush phenomenon are also clearly understood. The development of these entrapment neuropathies has been linked to inflammatory and ischaemic tissue reactions that create pathomechanical and pathophysiological changes either locally or more systemically within the nervous system. The double crush concept may be an overlooked, yet common clinical entity in some patient populations. Its full appreciation requires a broad understanding of peripheral nerve anatomy, nerve physiology and pathophysiology, neurodynamics, and the clinical manifestations of peripheral nerve entrapment within the context of chronic pain and associated somatic movement dysfunction. It appears to closely parallel clinical presentation of peripheral entrapment neuropathy, developing into multiple entrapments somewhat insidiously, often in patients with a history of previous injury, degenerative joint changes or surgery. Facilitating pattern recognition of double crush lesions may allow for more efficient and effective patient management of these chronic painful conditions, leading to improved outcomes related to patient function.

A PILOT STUDY OF THE ATM2™ (ACTIVE THERAPEUTIC MOVEMENT) DEVICE FOR USE IN THE TREATMENT OF LOW BACK PAIN

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Purpose: To determine if 1) the ATM2™ (a standing treatment table) was more effective than a mat exercise for decreasing LBP and increasing lumbar range of motion and 2) the

ATM2™ impacts reprogramming of the CNS firing pattern of the transverse abdominis (TrA) in subjects with low back pain (LBP). Clinical evidence has been documented for the efficacy of the ATM2™ when used with patients who have LBP; however, no published studies have been done. **Methods:** 16 subjects (8 female, 8 male), 8 with LBP and 8 without LBP were recruited. Subjects with LBP were in the chronic stage. Subjects were randomly assigned to the ATM2 intervention first or the mat exercise first. Pain provoking lumbar movement was determined and range of motion (ROM) and pain level was documented. Surface electrodes measured trunk muscle activity during the intervention. After each intervention pain level and ROM was reassessed. **Results:** Change in ROM was found to be significant ($p = 0.001$). The ATM2 group gained an average of 0.25 cm. The mat exercise group lost an average of 0.13 cm. A 2-way ANOVA at a level of 0.82 determined pain status was not a factor in ROM. Pain level between the two interventions was insignificant at $T = 0.12$. EMG recordings did not show the TrA as contracting before other trunk muscles at a significant level. **Conclusions:** The ATM2™ was shown to be effective in increasing lumbar ROM whereas the mat exercise was not. The 2 interventions did not differ significantly in reducing LBP complaints. The ATM2™ does not appear to impact CNS reprogramming of the TrA muscle.

A COMPREHENSIVE APPROACH OF MANUAL PHYSICAL THERAPY AND EXERCISE FOR PATELLOFEMORAL PAIN: A CASE SERIES

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Purpose: Physical therapists often encounter patients with patellofemoral pain syndrome (PFPS) yet there is currently no consensus as to the most effective management strategies. The purpose of this case series is to describe the outcomes of patients presenting to physical therapy with PFPS who were treated with manual physical therapy and exercise. **Methods:** Five consecutive patients referred to physical therapy with PFPS were included in this case series. To be eligible to participate, patients had to meet at least two of the following criteria: anterior knee pain, clicking or crepitus with squatting, ascending or descending stairs, or with prolonged sitting. This case series was approved by the Institutional Review Board at Franklin Pierce College and all patients provided informed consent prior to participation. All participants were treated with manual physical therapy, which included both mobilization and high velocity thrust manipulation directed at the lumbopelvic region, hip, and knee followed by therapeutic exercises directed at strengthening the core stabilizers and various muscles throughout the lower extremity. Four of five participants completed the Numeric Pain Rating Scale, the Kujala Anterior Knee Pain questionnaire, and the Lower Extremity Functional Scale (LEFS) at initial evaluation, the fourth visit, and at discharge. Four participants also completed the Global Rating of Change (GROC) at discharge. **Results:** Two females and three males with a median age of 15 years

(range 14-50) and median duration of knee pain symptoms for 8 months (range 3-24) participated in this case series. The participants were seen an average of 9 visits (SD 3.78) over an average of 8 weeks (SD 4.62). At the fourth treatment session, the median Kujala score was 70% (range 37-97%) with a median increase of 12% (range 1-26). Two of five participants surpassed the minimal clinically important difference (MCID) of 14 points by the time of the fourth visit. The Kujala scores increased at discharge with a median score of 88.5% (range 78-100%) and median increase of 23% (range 8-47%). One participant withdrew from the study after four treatments due to a lack of transportation to physical therapy. At discharge three of the four remaining participants surpassed the 14-point MCID. The median change in the LEFS score at the fourth visit was 6 points (range -7-16 points), and two of five participants surpassed the MCID of 9 points. At discharge the median LEFS score increased to 72 (range 61-77), a median increase of 14 points (range 4-33), and three of four participants surpassed the 9-point MCID. Numeric pain rating scores (NPRS) decreased a median of 4 points (range 2-5). At discharge, one patient reported his pain was "about the same," one patient reported his pain was "moderately better," and two patients reported their pain was "a great deal better" on the GROG. **Conclusion/Clinical Relevance:** All patients that participated in this case series demonstrated decreased pain and a clinically significant improvement in function. Although a cause-and-effect relationship cannot be inferred by a case study, the outcomes achieved by patients in this study are consistent with studies incorporating manual physical therapy and exercise in a regional interdependence approach to the management of conditions of the lower extremity. Patients presenting with patellofemoral pain syndrome may benefit from a combination of manual physical therapy and exercise directed at the lumbopelvic region, hip and knee to decrease pain and increase function.

COMPARING THE ANATOMICAL ACCURACY OF THE POSTERIOR SUPERIOR ILIAC SPINE TO THE ILIAC CREST AS A REFERENCE LANDMARK FOR VERTEBRAL LOCATION IN THE LUMBAR SPINE: A RETROSPECTIVE RADIOGRAPHIC STUDY

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Purpose: The iliac crest, a commonly used anatomical landmark in lumbar spine palpation, has been identified to correspond close to the L4 spinous process or the L4/L5 lumbar disc space in approximately 80% of the population. The level where this landmark crosses the spine can vary with age, disc height, and sex. The purpose of this study was to compare the anatomical accuracy of the posterior superior iliac spine (PSIS) to the iliac crest as a potential landmark used for exact identification of vertebral levels in the lumbar spine. **Methods:** The study design used was a retrospective radiographic study. One hundred computerized tomographic images

were reviewed retrospectively in a 3-dimensional setting. Two horizontal lines were constructed on each image: Line 1 - A line connecting the right and left sides of the most superior aspect of the iliac crest and Line 2 - A line connecting the right and left sides of the most inferior aspect of the PSIS. The vertical distance between each horizontal line and its respective dorsal bony landmark was measured: (1) Vertical Distance 1 in mm (*D1*): the distance between Line 1 and the inferior edge of the L4 spinous process; and (2) Vertical Distance 2 in mm (*D2*): the distance between Line 2 and the inferior edge of the S2 spinous process. Data were collected regarding where each respective line crossed the spine and the absolute distance between each line and its respective landmark. **Results:** Frequency distribution demonstrated that Line 2 corresponded to the S2 spinous process in 81% of the subjects and Line 1 corresponded to the L4 spinous process in 59% of subjects. The independent sample t-Test revealed that *D2* (Mean 6.21, SD 3.79) was significantly shorter than *D1* (Mean 12.48, SD 8.12), suggesting that Line 2 was closer to the spinous process of S2 versus Line 1 to the spinous process of L4 ($t = 6.998; p < 0.01$). The Chi square statistic showed that Line 2 crossed the spinous process of S2 more frequently than Line 1 crossed the spinous process of L4 ($\chi^2 = 12.72, p < 0.01$). Intra-tester reliability (Intraclass Correlation Coefficient) was 0.84 for *D1* and 0.83 for *D2*. Intratester reliability for frequency scores (Cohen's Kappa) was excellent for both Line 1 ($K = 0.96$) and Line 2 ($K = 0.96$). **Conclusion/Clinical Relevance:** The study findings support the association between the PSIS (Line 2) and the spinous process of S2. The relationship between the PSIS and the spinous process of S2 is more accurate and consistent when compared to the relationship between the iliac crest (Line 1) and the spinous process of L4. The PSIS reference line may potentially be used to improve the accuracy of both static and dynamic palpation of the lumbosacral spine.

ENDURANCE TIMES OF TRUNK MUSCLES IN HIGH SCHOOL WEIGHTLIFTING PARTICIPANTS

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Purpose: Despite its increased emphasis, trunk endurance (TE) normative values have been capricious, largely due to the variability of participant demographics. Normative values for active high school individuals have not been established. The purpose of this study was twofold: 1) to evaluate the relationship between anthropometric measurements and trunk endurance in participants involved in a high school weightlifting class, and 2) to establish normative ratios for this specific population. **Methods:** 35 participants (mean age 16.3 ± 0.71 years, height 173.4 ± 9.0 cm, and weight 67.9 ± 14.5 kg) were evaluated for endurance measurements of trunk flexion, extension, and bilateral side bending. Additional assessments included height, weight, gender, age, trunk length, hand dominance, and body mass index. Statistical analysis included descriptive statistics for TE values. Paired t-tests were performed to assess differences of the timed scores

between extension and flexion, as well as left and right side bending. The relationship between different variables was examined using Pearson's product-moment correlation. **Results:** Descriptive analysis of mean TE included the following: extension 113.86±45.59 seconds, flexion 186±77.26 seconds, left side bending 59.77±20.14 seconds, and right side bending 57.37±20.38 seconds. Paired t-tests to assess differences of the timed scores showed significant differences between flexion and extension ($P<0.001$). No difference was found between left and right side bending ($P=0.158$). Trunk length was correlated with right side bending TE ($r = 0.37$, $P<0.05$). Although these results were significant, trunk length only accounted for 14% (r^2) of the total variance. **Conclusions/Clinical Relevance:** The results of this study provide evidence of differences in TE times as compared to previously accepted normative values. Trunk length is also a clinical variable to consider for right side bending trunk endurance. Determination of a difference between trunk flexion and extension endurance is clinically relevant for this population to avoid muscle imbalances and possible injury. The fact that these results differ from previously established normative values should alert the clinician to monitor for trunk muscle imbalances in active, asymptomatic high school individuals. Trunk extension endurance values may be less than previously reported.

THE EFFECTIVENESS OF TRANSLATIONAL MANIPULATION UNDER INTERSCALENE BLOCK FOR THE TREATMENT OF ADHESIVE CAPSULITIS OF THE SHOULDER: A PROSPECTIVE CLINICAL TRIAL

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Purpose: Translational manipulation under anaesthesia has been shown in several case series to improve range of motion and function in patients with adhesive capsulitis (AC) of the shoulder. However, this form of intervention has not been directly compared to traditional manual physical therapy treatment in a prospective trial. The purpose of this clinical trial was to determine whether translational manipulation under anaesthesia combined with joint mobilization and exercise is more effective than joint mobilization and exercise alone in treating patients with AC. **Methods:** The study design used was a non-randomized, controlled trial. Subjects were 17 consenting patients (10 female, 7 male) with a primary diagnosis of AC. Mean age was 53 years (range: 40-76 years). Mean duration of symptoms was 22 weeks (range: 6-74 weeks), and the mean Shoulder Pain and Disability Index (SPADI) score was 56 (range: 11-89). Patients in the treatment group received an initial session of translational manipulation under interscalene block, followed by six additional sessions of impairment-based mobilization and a standardized therapeutic exercise program for the involved upper quarter. Patients in the comparison group received seven sessions of impairment-based mobilization, and the same standardized therapeutic exercise program for the involved upper quarter. Outcome measures

taken at baseline and 3 weeks as well as 3, 6, and 12 months by a blinded evaluator included SPADI scores and shoulder combined passive range of motion (CROM). The Friedman ANOVA was used to assess the change in outcome measures over time for each group. The Mann-Whitney U test was used to compare outcome measures between groups. **Results:** Both groups showed improved SPADI and CROM outcomes across all follow-up times compared to baseline. The treatment group showed a greater improvement (57%) in SPADI scores than the comparison group (35%) at 3 weeks ($p=0.021$), but no subsequent between-group differences were significant. Between-group differences in average CROM scores were not significant at any follow-up time point. **Conclusions/Clinical Relevance:** Patients with AC who undergo translational manipulation under anaesthesia may experience a more rapid reduction of pain and disability than those patients receiving manual therapy and exercise alone. This is the first study to prospectively compare translational manipulation with a comparison treatment in patients with AC. Translational manipulation may be a useful adjunct to joint mobilization and exercise in treating patients with AC.

MANUAL PHYSICAL THERAPY EXAMINATION, INTERVENTION, AND OUTCOME FOR A PATIENT WITH SIGNS AND SYMPTOMS OF LATERAL FEMORAL CUTANEOUS NERVE ENTRAPMENT (MERALGIA PARESTHETICA): A CASE REPORT

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Purpose: The purpose of this case report is to describe a manual physical therapy examination, intervention and outcome for a patient with anterior lateral hip pain with signs and symptoms of lateral femoral cutaneous nerve entrapment (meralgia paresthetica). **Methods:** The patient was a 38-year old white female, who had a gradual onset of right anterior lateral hip pain and numbness that had progressively worsened following a motor vehicle accident involving a moose. Postural examination findings indicated an anterior pelvic tilt with an increased lumbar lordosis. During sacroiliac (SI) examination, four special tests were found to be positive; standing flexion test, prone knee flexion test, supine-to-long-sit test, and palpation of the PSIS in sitting test. All four special tests indicated anterior rotation of the right innominate bone. The Thomas test was positive for tight hip flexors and iliotibial band on the right side. Neural tension testing of prone knee flexion with added hip extension/adduction provoked a burning sensation in the lateral thigh with limited passive range of motion. Palpation revealed tenderness at the entrapment site over the right anterior superior iliac spine and hypertonicity of the right hip musculature. The patient was treated in physical therapy 18 times over a 6-week period with sacroiliac manipulation, myofascial manipulation, neural mobilization techniques, therapeutic exercises, and postural education. **Results:** The outcome measures of this patient were determined using

the Visual Analog Scale (VAS), McGill Pain Questionnaire, the Lower Extremity Functional Index (LEFI) score, and a functional task analysis of repeated forward bending and lifting weighted boxes. The VAS for pain improved from 6/10 to 0/10 with all activities, hobbies and work functions. The McGill Pain Questionnaire patient report of "burning", "aching", and "numb" were completely resolved. The LEFI score improved from 25% disability to 0% disability. The patient's functional task analysis resulted in symptom-free repeated forward bending and lifting up to 40 pounds required for her work activities. **Conclusion/Clinical Relevance** This successful outcome was based on a thorough manual physical therapy examination and intervention program that targeted multiple impairments. A thorough examination, a targeted intervention program, and functional outcome measures should be guided by the best available evidence when possible. A targeted intervention strategy that focused on sacroiliac manipulation, myofascial manipulation, therapeutic exercises and postural education can lead to a successful functional outcome for patients who have signs and symptoms of lateral femoral cutaneous nerve entrapment.

INTEGRATION OF MOBILITY AND STABILITY APPROACHES IN A PATIENT DIAGNOSED WITH CERVICAL RADICULOPATHY

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Purpose: Cervical spine pain is a common musculoskeletal impairment that may affect 10% of the general population. This condition occurs half as frequently as low back pain and slightly more often in women than men. The purposes of this single case design included the following: (1) to describe the outcomes of a patient diagnosed with cervical radiculopathy, (2) to introduce the Lifeware Functional Assessment form for assessing patients with neck pain, and (3) to introduce an algorithm for examination of the cervical spine. **Methods:** The patient was a 40-year old male referred to physical therapy with a diagnosis of cervical radiculopathy. The patient described left sided cervical pain of 3 months duration, which he stated commenced insidiously. Upon further questioning, the patient described a motorcycle accident 6 months prior that involved the patient tipping his motorcycle to the left, subsequently sliding along the road surface sustaining abrasions to the left side of the body. Although he did not recall losing consciousness, the patient reported striking the left side of his head at impact. He was wearing a helmet and reportedly did not experience neck pain at that time of the accident. The patient completed the Lifeware Functional Assessment form prior to the physical examination procedures. The patient described left cervical spine pain rated 7/10 on the Visual Analog Scale (VAS) and moderate disability was indicated on the Neck Disability Index (NDI). His left upper extremity symptoms were located along the radial aspect of the left forearm to the dorsum of the thumb. These symptoms were described as varying between sharp pain and numbness. The physical examination included a structural examination, measures of active and repeated movements,

passive intervertebral motion testing, a neurological examination, assessment of deep neck flexor strength and endurance, special tests including foraminal closure and cervical spine compression, and palpation. The patient's posture was characterized by a slouched sitting position and forward head position in standing. The cervical active range testing as measured with a single inclinometer demonstrated pain during flexion, extension, and during rotation to the left. All three of these movements caused a peripheralization of symptoms to the left upper extremity. Repeated movements of the cervical spine in the sagittal plane including retraction, retraction with extension, flexion, and protrusion. All of these movements peripheralized symptoms both in weight-bearing and non-weight-bearing positions. Repeated sidebending of the cervical spine to the left decreased the numbness in the left forearm. Cervical spine stability testing for transverse ligament and alar ligament laxity, odontoid fracture, and vertebrobasilar insufficiency were negative. Although these tests have questionable reliability and validity, they were employed because instability and vertebrobasilar insufficiency were not expected and also to document that these safety measures were performed. This patient's signs and symptoms were consistent with a left C6 radiculopathy with signs of posterior derangement, hypermobility in cervical sidebending left at C5-C6, and adverse neural tension in both upper extremities (left > right). This patient was seen for three visits in physical therapy over a 4-week period and was instructed in postural correction and a home exercise program that was consistent with the clinical interventions. Initial treatment consisted of instruction of correct sitting postures, repeated cervical rotation left to be performed for 10 repetitions hourly (with the left arm across chest). On the second visit, the patient received passive overpressure in cervical rotation left at C5-C6 for three sets of 10 repetitions. The patient's symptoms responded favorably (i.e., with centralization to the cervical region) and this was followed by supine traction, retraction with extension. The patient was also instructed in performance of the deep neck flexor contraction exercise for three sets of 10 repetitions, three times daily. Neural mobilization of the left median nerve was also instituted on the second visit for three sets of 10 repetitions and a home exercise stretch for median nerve mobilization was also given at that time. The patient was also instructed in the addition of deep neck flexor training against the wall as a home exercise. The third visit in physical therapy consisted of the patient performing seated neck retraction with extension without a reproduction of symptoms. The patient was instructed in deep neck flexor training from prone on elbows. **Results:** The following were the patient's findings at discharge: VAS 0/10; no complaints of numbness; NDI 0% (at 5 month follow-up); full cervical active range of motion without peripheralization of symptoms; no reproduction of symptoms with repeated cervical movements including flexion, sidebending left, rotation left; normal neurological findings; ability to maintain a 10-second hold of deep neck flexor contraction at 30 (mmHg); absence of hypermobility in sidebending left at C5-C6. **Conclusion/Clinical Relevance:** This patient demonstrated a positive outcome in physical therapy in terms of range of motion, strength, and function. Although definitive conclusions cannot be drawn from this single case design, the results may point toward an integra-

tion of exercise and manual physical therapy approaches in patients diagnosed with cervical radiculopathy.

AN IMPAIRMENT-BASED TREATMENT APPROACH TO EARLY REHABILITATION OF PATIENTS WITH TOTAL KNEE ARTHROPLASTY: A CASE SERIES

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Purpose: The purpose of this case series is to describe a short-term, impairment-based physical therapy program incorporating manual physical therapy techniques for patients during early rehabilitation after total knee arthroplasty (TKA). The effectiveness of manual physical therapy techniques in TKA rehabilitation remains largely unknown. **Methods:** Subjects were five consecutive post-operative TKA patients (mean age 59.8 years; SD 6.79) receiving outpatient physical therapy. All patients received manual physical therapy and exercise for 8 clinic visits over 5 to 8 weeks. Patients performed additional exercises at home. Outcome measures included: the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores, the Timed Up and Go (TUG) test, range of motion (ROM), and an eleven point numeric pain rating scale (NPRS). The Global Rating of Change (GROC) scale was administered to all patients on the last visit. **Results:** All patients demonstrated a clinically meaningful improvement in function on the WOMAC, and TUG scores that were equal to or better than those in similar aged healthy adults. Four of the 5 patients reported an improvement of at least "a great deal better" (+6), on the GROC. **Conclusion/Clinical Relevance:** Patients in this case series treated with manual physical therapy and exercise during the early rehabilitation period following TKA demonstrated clinically meaningful improvements in pain, function, and disability. Manual physical therapy and exercise may be useful during rehabilitation of this patient population. Larger cohort designs and subsequent clinical trials with longer-term follow up are needed to determine the effectiveness of manual physical therapy and exercise in these patients compared to current standard of care rehabilitation strategies.

THE DOUBLE CRUSH SYNDROME: A COMMON OCCURRENCE IN CYCLISTS WITH SYMPTOMS OF ULNAR NERVE NEUROPATHY

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Purpose: The incidence of ulnar nerve neuropathy in cyclists is high and is referred to as "cyclist palsy". The frequency of occurrence of a double crush syndrome in cyclists with ulnar nerve neuropathy is unknown. The purpose of this study was

to evaluate the incidence of double crush syndrome in cyclists with ulnar nerve neuropathy. **Methods:** The study design used was a case-control study. Cyclists were categorized into two groups based on history, symptoms, motor, sensory, and provocative clinical testing: (1) ulnar nerve neuropathy group [ULN (+)], and (2) no ulnar nerve neuropathy group [ULN (-)]. Both groups were examined clinically for the presence of a proximal dysfunction based on results from the following tests: (1) thoracic outlet syndrome provocation testing: Elevated Arm Stress Test and Modified Cyriax Release Test; (2) presence of an elevated first rib: cervical rotation lateral flexion test; (3) presence of proximal symptoms: reports of neck pain and shoulder pain. Chi-square analyses were performed. **Results:** Seventy cyclists (140 upper limbs) with a mean of age of 36 years (± 11.3) participated. Nineteen upper limbs were excluded, leaving 61 upper limbs in the ULN (+) group and 60 in the ULN (-) group. A significantly greater number of cyclists with ULN (+) presented with positive provocative testing for TOS (elevated arm stress test $p < 0.05$; Cyriax release test $p < 0.05$) and with symptoms of neck pain and shoulder pain ($p < 0.05$) than did cyclists with ULN (-). **Conclusion/Clinical Relevance:** A significantly greater number of cyclists with ulnar nerve neuropathy presented with symptoms associated with proximal dysfunctions suggestive of double crush syndrome. Evaluation of proximal structures involved with thoracic outlet perturbations in cyclists with ulnar nerve neuropathy should not be overlooked.

MANUAL FORCES APPLIED BY PHYSICAL THERAPISTS DURING CERVICAL MOBILIZATION

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Purpose: To measure and describe the manual forces physical therapists apply to the cervical spine during passive joint mobilization. **Methods:** Subjects consisted of 116 physical therapist clinicians. An instrumented table fitted with seven biaxial load cells was used to measure cervical mobilization forces in three planes. Each therapist applied Maitland grades I through IV postero-anterior mobilization to C2 and C7 on an asymptomatic volunteer, both centrally and unilaterally (one right and one left). Therapists repeated the first technique they applied to the same volunteer after 20 minutes. Prior to mobilization, the stiffness of the C2 and C7 spinal levels of each volunteer was measured with a machine that recorded force and displacement while applying five consecutive mechanical oscillatory mobilizations at 1 Hz. Data for mobilization forces and stiffness were captured using a Powerlab® data acquisition system. Therapist and volunteer characteristics, including age, gender, height, and weight were recorded. Therapists were also surveyed about their years of experience, previous training, use of cervical mobilization, history of thumb pain, work setting, and interpretation of mobilization grades. The mean peak force, mean force amplitude and oscillation frequency were calculated over 10 seconds of mobilization for each grade of each technique. Stiffness

values for C2 and C7 were determined by the slopes of the linear portions of the force-displacement curves. Statistical analyses were performed in SPSS 14.0. Intra-class correlation coefficients were used to determine the repeatability of mobilization forces. Means and standard deviations were calculated for mean peak force, mean force amplitude and oscillation frequency for each technique, grade and force direction. Linear regression analysis examined the effect of subject stiffness on applied mobilization forces. **Results:** When performing the same technique, there was considerable variation between therapists across all force variables and force directions (ICCs [2,1] for mean peak force in the vertical, caudad-cephalad and mediolateral directions were 0.32, 0.48 and 0.32, respectively, with 95% confidence intervals (CI) from 0.20 to 0.69; for mean force amplitude 0.20, 0.33, and 0.26 with 95% CI from 0.12 to 0.54, and for oscillation frequency 0.03, 95% CI 0.01 to 0.07). However, intra-therapist reliability was high across all force variables and directions (ICCs [2,1] for mean peak force in the three directions were 0.93, 0.90, 0.84 with 95% CI from 0.87 to 0.94; for mean force amplitude 0.90, 0.90, and 0.87, 95% CI from 0.85 to 0.92; and for oscillation frequency 0.88, 95% CI 0.69 to 0.94). Mean peak forces were generally lower than those previously reported for lumbar spine mobilizations; for example, the vertical mean peak force for a grade III mobilization applied centrally to C7 was 68.8 N (SD 35.5), whereas previously reported vertical mean peak lumbar mobilization forces for grade III techniques are above 100 N. **Preliminary analysis** suggests subject stiffness has some association with applied cervical mobilization forces, but only when higher grades of mobilization are applied. **Conclusions/Clinical Relevance:** Cervical mobilization forces vary considerably when applied by different therapists performing the same technique, but intra-therapist repeatability is high. Manual forces applied to the cervical spine are lower than previously reported lumbar mobilization forces. These results identify and describe the manual forces applied during cervical mobilization, forming the basis for further research and training programs aimed at optimizing manual therapy treatment for cervical spine disorders.

THE SHORT TERM EFFECTS OF LUMBO-SACRAL THRUST MOBILIZATION/MANIPULATION ON PATIENTS WITH KNEE OSTEOARTHRITIS PRESENTING WITH LUMBO-SACRAL IMPAIRMENTS

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Purpose: Knee osteoarthritis (OA) is commonly encountered by physical therapists. Preliminary evidence suggests that a multimodal treatment program including exercise and manual physical therapy (MPT) interventions, including thrust and non-thrust mobilization/manipulations to the spine and lower extremities, can yield beneficial results. The purpose of this case series is to: 1) describe the outcomes achieved by 4 patients with knee OA who were treated with MPT and exercise,

and 2) describe the immediate effects of lumbosacral thrust manipulation on functional squat range of motion (ROM) and numeric pain rating scale (NPRS) scores. **Methods:** 4 patients diagnosed with knee OA using the criterion established by the American College of Rheumatology were retrospectively included in this case series. Patients completed baseline self-report measures of disability and pain including the Patient Specific Functional Scale (PSFS), and the NPRS. All patients were treated with MPT including thrust and non-thrust mobilization/manipulations and exercise directed at identified impairments of the lumbo-sacral region and lower quarter. Throughout the course of care, during at least one treatment session, each patient received a lumbo-sacral manipulation. During the treatment session that included lumbosacral thrust manipulation, within-session changes in functional squat ROM and NPRS scores were recorded immediately following lumbosacral manipulation. **Results:** Immediately following lumbo-sacral manipulation all patients demonstrated immediate and clinically significant improvements in pain by reporting a 3-5 point change in NPRS scores or improved functional squat ROM. At discharge, all patients demonstrated meaningful improvements in pain levels by reporting equal to or greater than a 2 point improvement in NPRS scores, while also reporting a greater than or equal to a 2 point change in perceived disability as measured by the PSFS. Additionally, all patients reported their overall changes since baseline as +5, "a great deal better" or +4, "moderately better" on the Global Rating of Change (GROC) scale. **Conclusion/Clinical Relevance:** This case series suggests that patients with knee OA treated with MPT including thrust and non-thrust mobilization/manipulation and exercise may achieve positive outcomes in pain, disability, and perceived recovery. The minimal clinically important difference (MCID) for decreases in pain as measured by the NPRS is between 1.45 – 2.0, while improvements in PSFS scores of 2 points is considered clinically significant, and a change in GROC scores equal to or greater than +3 "somewhat better" is also clinically significant. It is noted that all patients in this case series met or exceeded the minimally clinical important difference for all collected outcome measures. This small case series provides preliminary evidence of positive effects on pain and functional squat ROM following lumbosacral thrust and non-thrust manipulation for patients with knee OA. Further research is needed to establish whether thrust and non-thrust mobilization/manipulation to the lumbo-sacral area is effective and cost-efficient care compared to interventions directed at only the area of primary complaint.

THE INFLUENCE OF MIND/LEARNING STYLES ON STUDENT PERFORMANCE IN A MANUAL THERAPY/ORTHOPAEDIC PHYSICAL THERAPY COURSE

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Purpose: The purpose of this study was to: (1) determine the different types of Mind/Learning styles employed by entry-level MPT-students enrolled in a Manual Therapy/Orthopaedic

course (i.e., Musculoskeletal Evaluation and Treatment III) at Florida A & M University and (2) determine if performance in the course could be predicted by Mind/Learning style. The influence of learning styles has a direct influence on how adult students understand and learn new materials and problem solve. Learning styles have been shown to influence the performance of students on professional licensure exams. To date, little work has been done in this area with PT-students. **Methods:** Subjects were nine graduate students enrolled in the Manual Therapy/Orthopaedic course. The MPT-students first completed a self-assessment instrument known as the Gregorc Style Delineator™. The students used the instrument to determine their predominant learning style(s) as “Concrete Sequential”, “Abstract Sequential”, “Abstract Random” or “Concrete Random”. Students were asked to participate in this study and were given the informed consent form to sign if they agreed to participate. Those who agreed to participate submitted their scores to the primary investigator. The scores were then compared to the scores the students got on their practical exams and lecture (multiple choice) exams from the MSE III course that was conducted in the previous semester. Reverse Stepwise Multiple Regression Analysis was used to determine if the performance on practical and lecture exams could be predicted by the learning style. **Results:** The predominant learning styles among the students were Abstract Sequential & Concrete Sequential. There was one student whose learning style was Concrete Random and no students in the Abstract Random category. Although certain trends were noted in the data, it was not statistically significant. **Conclusion:** The results suggest that the Mind/Learning Styles may not be a factor in the performance of students in the MSE III course; however, given the small sample size, this may not be an accurate assessment of the outcome.

OUTCOMES ACHIEVED BY PATIENTS STATUS POST ANKLE SPRAIN TREATED WITH MANUAL PHYSICAL THERAPY AND EXERCISE INTERVENTIONS: A PRELIMINARY REPORT

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Purpose: Studies have investigated the effectiveness of manual physical therapy interventions for patients with ankle disorders, but the results have been contradictory and inconclusive. The purpose of this preliminary report is to describe short-term outcomes achieved by patients after inversion ankle sprain treated with a manual physical therapy treatment approach. Based on these data, we intend to develop a clinical prediction rule (CPR) to identify patients most likely to experience rapid and dramatic improvements from this intervention. **Methods:** A prospective cohort of consecutive patients aged

16 – 60 with a primary history of Grade I-II inversion ankle sprain within the last year and pain scores over the past week of > 3/10 on a 10 point numeric pain rating scale (NPRS) were invited to participate. Subjects were recruited from 4 different clinical sites across the United States. Eligible patients, who consented to participate completed a series of self-report measures, then underwent a detailed standardized history and physical examination consisting of a variety of tests and measures commonly used to assess patients who have experienced an ankle sprain. Regardless of the results of the clinical examination, all patients received a standardized treatment regimen consisting of manual physical therapy (including both thrust and non-thrust manipulation), exercise, and a standard “RICE” program. At the follow-up session 2 business days later, patients again completed the self-report measures and depending on response to treatment, were either considered to have experienced a successful outcome or underwent a second treatment session. At the third and final session (4 business days later), patients completed the self-report measures and were again classified as having experienced a successful outcome or not. We based the reference standard for success on the well-accepted patient-reported global rating of change (GROC). Success was defined a priori as a patient report of “quite a bit better”, “a great deal better”, or “a very great deal better” compared to the initial examination (GROC scores of 5-7). Patients also completed the Foot and Ankle Ability Index (FAAI), Lower Extremity Functional Scale (LEFS), and NPRS at the initial exam and follow-up visits to compare differences in improved function between those who experienced a successful outcome and those who did not. Descriptive statistics were calculated to describe baseline characteristics and outcomes achieved by all subjects, as well as individually for those meeting and not meeting the threshold for success. **Results:** 17 subjects (10 females; mean age 32.1 (12.2) years) have enrolled to date. 71% of all subjects (n=12) met the threshold for success. Of the 5 subjects who did not meet this threshold, 2 subjects reported being “moderately better” (GROC=4), 1 reported being “about the same” (GROC=0), and 2 worsened (GROC=-4). One of the subjects who worsened reported reinjuring his ankle while snowboarding during the course of the study. Baseline self-report outcomes values and improvements in self-report variables are included in the table below (Note: Values in table represent means (standard deviation) unless otherwise noted). **Conclusions/Clinical Relevance:** The results of this analysis demonstrate that patients can achieve clinically meaningful improvements in pain, function, and disability after an ankle sprain when treated with a program including manual physical therapy interventions, exercise, and a “RICE” protocol. Upon completion of the study, we will attempt to develop a CPR for predicting those patients most likely to experience a successful outcome from this intervention. The criteria in the CPR may be used in future clinical trials to improve the power of clinical research in patients with ankle sprain and serve as the basis for a future validation study.

	All Patients (n=17)	Success (n=12)	Non-Success (n=5)
Age	32.1 (12.2)	33.5 (12.8)	28.6 (7.0)
Duration current symptoms (days) – median (range)	32.3 (1 – 316)	32.2 (7 – 316)	25.2 (1-67)
Body Mass Index	27.2 (5.4)	29.0 (5.3)	23.5 (3.5)
Baseline FAAI Activities of Daily Living Subscale	67.2 (14.0)	66.4 (12.3)	69.3 (19.0)
Improvement in FAAI Activities of Daily Living Subscale – mean (95% CI)	14.2 (7.8-20.7)	16.2 (7.6-24.7)	9.5 (-2.8-21.8)
Baseline FAAI Sports Subscale	30.3 (20.0)	31.6 (21.4)	27.3 (18.1)
Improvement in FAAI Sports Subscale – mean (95% CI)	21.1 (10.4-31.8)	26.5 (13.7-39.2)	8.3 (-14.5-31.1)
Baseline LEFS (%)	47.6 (9.6)	47.1 (8.6)	48.8 (12.9)
Improvement in LEFS (%) – mean (95% CI)	12.9 (7.3-18.6)	15.8 (8.2-23.3)	6.2 (1.9-10.5)
Baseline NPRS (average pain)	4.7 (2.0)	4.6 (1.9)	4.8 (2.4)
Improvement in NPRS – mean (95% CI)	2.6 (1.6-3.7)	3.2 (2.0-4.3)	1.4 (-1.6-4.4)
Final GROC score	3.9 (3.3)	5.5 (0.5)	0.0 (4.0)

THORACIC COSTOTRANSVERSE JOINT PAIN PATTERNS IN ASYMPTOMATIC SUBJECTS

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Purpose: Determine the pain referral patterns of costovertebral joints thru provocative intra-articular injection. **Methods:** Eight asymptomatic volunteers received a combined total of 21 intra-articular costovertebral joint injection attempts. Two volunteers underwent right-sided T2, T4, and T6 costovertebral joint injections, one volunteer received only a single right-sided T4 costovertebral joint injection, and one volunteer received right T2 and T4 costovertebral joint injections. Four volunteers underwent left-sided T3, T5, and T7 costovertebral joint injections. Fluoroscopic imaging was utilized to identify and isolate each costovertebral joint, as well as guide placement of a 25 gauge, 3.5-inch spinal needle into the costovertebral joint. Contrast medium was then injected into the costovertebral joint under fluoroscopic imaging. The quality, intensity, and distribution of the resultant pain produced from the injection of contrast medium into each costovertebral joint were recorded. **Results:** Of the 21 costovertebral joint injections attempted only 6 (29%)

were classified as being entirely intra-articular based on fluoroscopic examination of the location of the contrast medium. Of these 6 joints, 5 (two right T2 joints; one left T5 joint; two left T7 joints) of the injections produced a pain sensation distinctly different from that of needle placement. Average pain produced was 3.4/10 on a 0-10 verbal pain scale. Pain was described generally as a deep, dull ache, and pressure sensation, with one left T5 joint provoking pain described as a sharp, burning pressure. Pain produced from the right T2 produced pain in one volunteer extending from the right T2 costovertebral joint region up the right posterior neck to approximately the C6 level, and a local region of pain just lateral to the right T4 spinous process in the other volunteer. The pain patterns from the left T3 and left T5 joints were located superficial to the injected joint. **Conclusion/Clinical Relevance:** The diagnosis of the pathoanatomic structures involved in spinal pain has historically been problematic for the practitioner. Unlike zygapophyseal joint injections the technical difficulty of achieving isolated costovertebral joint injections is substantial. Nonetheless, this study provides preliminary data of the pain referral patterns of costovertebral joints. Replicating research to confirm this finding in symptomatic subjects is warranted. This information may be useful in guiding further research in differentiating musculoskeletal from non-musculoskeletal thoracic pain.