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# ABSTRACTS OF ACC CONFERENCE PROCEEDINGS

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## Platform Presentations

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### Does Subluxation Actually Affect the Nervous System Preliminary Morphologic Evidence That It Does

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Since its inception, the chiropractic profession has hypothesized that abnormal spinal function has an effect on the nervous system. With recent introduction of a successful rat model of chronic vertebral hypomobility, it should be possible to test this hypothetical link between vertebral function and the nervous system. Synapses are thought to be primary sites of plastic changes in the nervous system, and morphologic changes to synapses are believed to be a part of this process. The purpose of this pilot study was to make a preliminary determination if chronic vertebral hypomobility at L4–L6 in the rat would affect synaptic density and/or morphology in the superficial dorsal horn of the L2 spinal cord level.

#### METHODS

Using an established rat model of chronic vertebral hypomobility, three contiguous lumbar segments (L4–L6) were fixed for 8 weeks with a specially engineered vertebral fixation device. Electron micrographs (final  $\times 25,000$ ) were obtained from the medial portion of the lateral one third of Rexed's laminae I and II on the right side of the caudal portion of the L2 spinal cord segment in two animals from the experimental (fixed) group and each of three control groups (no surgery, surgery but no devices implanted, and devices implanted but not fixed) (total tissue examined/group =  $4,000 \mu\text{m}^2$ ). Synapses were randomly selected using a stereological (Physical Disector) approach and were analyzed

for symmetry (symmetric versus asymmetric), curvature (straight, positive, or negative), type of postsynaptic profile (dendritic shaft, dendritic spine, or soma), and perforations. The synaptic density was also estimated.

#### RESULTS

There was an increased synaptic density and percentage of positively curved synapses in the dorsal horn of experimental animals as compared with controls. Also, experimental animals had a lower percentage of axospinous synapses, with a concomitant increase in the percentage of synapses on dendritic shafts. Even though there were low percentages of perforated synapses identified in this study, there were higher percentages of perforated synapses in the dorsal horns of experimental versus control animals. No differences in the symmetry of synapses was apparent between experimental and control animals.

#### DISCUSSION

These data show for the first time that there actually appears to be a relationship between abnormal vertebral function (chronic vertebral hypomobility) and morphologic changes in the nervous system (alterations of synaptic density and morphology in the dorsal horn of the spinal cord). The increased percentage of positively curved synapses, along with the increased number of synapses in the experimental animals, may indicate an increase in synaptic activity in the dorsal horn of animals with hypomobile vertebrae. The decreased percentage of axospinous synapses may indicate

a decrease in excitatory synaptic activity in the dorsal horn of the experimental animals as compared with controls. The biologic significance of these findings remains unknown.

## CONCLUSION

These preliminary data suggest that chronic vertebral hypomobility at L4–L6 in the rat affects synaptic density and morphology in the superficial dorsal horn of the L2 spinal cord level. Additional, more definitive studies are warranted,

and the biological significance of these findings should be investigated.

## ACKNOWLEDGMENTS

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# Location of Applied Forces During Side Posture Lumbar Manipulation Where Should Forces Be Applied to Produce Cavitation?

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The purpose of this study was to document applied forces by the manipulator to the lumbar spine, lower torso, and lower extremities on the subject during side posture lumbar manipulation. It was hypothesized that the location of the forces applied to the recipient of side posture lumbar manipulation influences the ability to achieve cavitation. Clinicians utilizing side posture lumbar manipulation claim to emphasize using their contact hand on the patient's spine to cause spinal joint cavitation.

## METHODS

This study was reviewed and approved by the Institutional Review Boards of Canadian Memorial Chiropractic College and University of Waterloo. Seven asymptomatic participants, ranging in age from 16 to 32 years, volunteered to act as subjects. Ten clinicians performed side posture lumbar manipulation. The range of clinical experience was 1–24 years. All asymptomatic subjects received side posture lumbar manipulation. The subjects were mounted with pressure mats covering their spine, posterior pelvis (PSIS and iliac crest), and upside lateral thigh. Accelerometers were secured to the subject's skin over the spinal column and each accelerometer detected vibration from the cavitation associated with side posture lumbar manipulation. The location and magnitude of applied force was noted at the time of peak force during side posture lumbar manipulation

and assumptions were made to estimate the lumbar axial moment.

## RESULTS

Subjects exposed to axial lumbar moments equal or in excess of 109.8 Nm invariably generated cavitation. Conversely, less than 82.8 Nm of lumbar axial moment failed to achieve cavitation among all subjects. Directing 25% or more of the total force to the lumbar spine, as opposed to more peripheral sites, invariably generated no cavitation. There was an inverse linear relationship between pelvis and thigh applied force only when cavitation was achieved, because those manipulators emphasized either thigh or pelvis force, not both. There was no relationship when cavitation did not occur.

## CONCLUSION

Successful generation of cavitation during side posture lumbar manipulation requires emphasizing forces to areas on a patient remote from the spine such as the pelvis and/or lateral thigh. This would produce a sufficient lumbar axial moment. Students learning side posture lumbar manipulation should be taught to utilize contact points on the posterior pelvis and/or lateral thigh if lumbar cavitation is a desired outcome of the manipulative procedure.



# A Single-Blind Study to Assess the Identifying Elements of Foot Hyperpronation and Their Role as a Causative Factor in Mechanical Low Back Pain

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Chiropractors frequently theorize compensatory kinematic relationships between distal joint structure and patient pain and function. One such relationship is that between foot biomechanics and low back pain. This study was developed to assess the percentage of navicular drop and the degree of calcaneal eversion in a recurrent mechanical low back pain cohort in comparison to a control arm cohort without low back pain. It was hypothesized that the percentage of navicular drop and the degrees of calcaneal eversion would be greater in the recurrent mechanical low back pain population.

## METHODS

This study was reviewed and approved by the Institutional Review Board of the European Institute of Health and Medical Sciences. This was a single-blind study of 6 months duration. Thirty volunteers diagnosed with mechanical low back pain or with a history of at least two episodes of mechanical low back pain were entered into the intervention group. Another cohort of 28 volunteers, reporting no history of low back pain, were recruited as a control arm. Inclusion criteria limited subjects to between the ages of 20 and 68 years. A blinded evaluator (a podiatrist) performed navicular measurements, calculated percentage navicular drop, and measured relaxed weightbearing calcaneal eversion.

## RESULTS

There were no statistically significant differences between the groups in the percentage of navicular drop, the initial

nonweightbearing height of the navicular, degree of calcaneal eversion, difference in navicular drop bilaterally, or difference in calcaneal eversion bilaterally. Calcaneal eversion was shown to have a significant and positive relationship to navicular drop. A fair to moderate relationship was determined in the left foot ( $r = 0.451$ ) and a moderate to good relationship was determined in the right foot ( $r = 0.626$ ). Power and effect size were low.

## DISCUSSION

Study limitations include the possibility of insufficient statistical power secondary to a weaker than expected effect size that may have influenced study outcomes. In order to enhance power, it is suggested that more stringent inclusion and exclusion criteria exclude control subjects with musculoskeletal pain to the lower limbs (a manifestation of the hyperpronated foot), focus on a chronic low back pain population with a history of a greater number of episodes, and increase the sample size.

## ACKNOWLEDGMENT

This study was originally completed as part of a Master's degree in the Programme of Chiropractic, European Institute of Health and Medical Sciences, University of Surrey, Guildford, Surrey, England. The authors wish to thank the University of Surrey for its help and support.



# Motor Learning and Drop Jump Techniques

## Effects of Orthotic Intervention on Neuromuscular Adaptations and Performance Gains

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Stretch shortening cycle (SSC) exercises, such as drop jumps, are known to improve the mechanical output of muscles. The primary neural factor contributing to the increased mechanical output of the muscle during SSC exercises is the stretch reflex response (SRR). An understanding of the plasticity of the SRR provides insights on the adaptive capacity of the neuromuscular system. However, there are limited data on training adaptations to SRR during SSC exercises. Adaptations of the SRR may be more evident during motor learning than following exercise training, because of the concept of task specificity and the contributions of movement coordination to skilled human performance. In addition, an optimal orthotic, which improves footwear comfort, may improve human performance by enhancing neuromuscular efficiency. Specifically, effective dampening of soft tissue vibration by orthotics may reduce muscle activity, minimize fatigue, and increase comfort perception. The potential consequences of undamped soft tissue vibrations are impairments to neuromuscular efficiency. The purpose of the study was to establish that motor learning occurred during SSC exercises and to determine the effects of orthotic intervention on neuromuscular adaptations and performance gains during motor learning.

### METHODS

This study was reviewed and approved by the Institutional Review Board of the New York Chiropractic College. The subjects were 10 physically active, young adults ( $24 \pm 1.5$  years;  $173 \pm 12$  cm;  $83 \pm 20$  kg; 6 males and 4 females). Subjects were randomly assigned to perform jumping exercises either with or without their orthotic intervention. The orthotic intervention was the flexible, custom-made orthotics by Foot Levelers, Inc. (Roanoke, VA). The subjects participated in a 5-day skill acquisition period and a skill retention session, 1 week later. All data were pooled to meet the first research goal. A single-factor repeated-measures analysis of variance model was used to analyze the electromyogram amplitudes of the SRR of the medial gastrocnemius, soleus, and vastus lateralis muscles and jump height.

### RESULTS

Two subjects did not show improvements in jump height performance during the 5-day skill acquisition period. These

two subjects were excluded from further statistical analyses because the objective of the research was to describe neuromuscular adaptations and performance gains during motor learning. Among the remaining eight subjects, there was a significant improvement in jump height performance of 17% that occurred during the 5-day skill acquisition period [ $F(5,35) = 3.6$ ;  $p < .05$ ]. The improvement in jump height performance was maintained 1 week later, to infer motor learning of the drop jump. There were no changes in the electromyogram amplitudes of the SRR of the gastrocnemius, soleus, and vastus lateralis muscles accompanying the increase in jump height performance ( $p > .05$ ). There is a sample size requirement of at least 10 subjects per group to detect significant differences between individuals jumping with or without their orthotic intervention at an adopted power of .80 and alpha level of .05.

### DISCUSSION

The increase in jump height performance met the first goal of the research design, which was to establish that motor learning occurred. Facilitation of the SSR did not contribute to increases in jump height performance. Learning-induced changes in the gain of the SSR may account for this finding. Although the current report emphasized the direct measurement of SRR using spike-triggered averaging techniques, electromyogram activities during the preactivation, eccentric, and concentric phases of the drop jump are also being collected in this research study. Thus, neuromuscular adaptations contributing to increases in jump height and changes in the gain of SSR will be addressed. Ten additional healthy young adults are being tested to determine the effects of an orthotic intervention on neuromuscular adaptations and performance gains during motor learning.

### ACKNOWLEDGMENT

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# The Use of Radiographic Imaging Protocols by Canadian Memorial Chiropractic College Interns

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A questionnaire was administered to the 4th-year interns at the Canadian Memorial Chiropractic College (CMCC) to determine whether they will follow published, evidence-based, imaging guidelines when choosing to radiograph their patients in accordance with the principles taught through the radiology program at CMCC, once these interns are in private practice.

## METHODS

Ten clinical scenarios, representing commonly presenting chiropractic patient complaints, were created and subjected to face and content validity assessment. Cases were purposely created in which radiographs would definitely be indicated and would definitely not be indicated. In addition, for some cases the decision to take radiographs was not straightforward, representing the “gray areas” in practice. After each scenario, interns were asked whether or not they would obtain radiographs of the patient. For those cases in which interns determined that they would take radiographs, they were asked to select the exact “views” that they would order. Questionnaires were sent or given to all 4th-year interns at CMCC. A “gold standard” was established by two radiology diplomates at CMCC who agreed on the answers together prior to the questionnaire being administered. Intern

answers were compared to the gold standard using percent agreement.

## RESULTS

Sixty-eight interns (44%) completed the questionnaire. Agreement between the interns and the gold standards for the question of whether or not they would obtain radiographs ranged from 63.2% to 100%, depending upon the case. The cases that demonstrated the highest percent agreement were further analyzed for whether or not the radiographic views ordered consisted of a complete diagnostic series as chosen by the gold standards. The percent agreement for the correct radiographic views chosen ranged from 32.6% to 48.4%.

## DISCUSSION

CMCC interns are generally aware of and would appropriately apply radiographic guidelines as outlined in the current literature and taught through the radiology program at CMCC when determining whether or not radiographs are indicated. However, the interns are inconsistent in choosing the correct views for the areas examined, and therefore this aspect of the curriculum needs more emphasis.



# Recruiting Underrepresented Minorities

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Admissions departments at chiropractic colleges across the United States are under continual pressure to recruit students. With changes in the health care industry, many of the schools are finding it challenging to maintain optimal enrollments. The underserved minority communities are potentially fertile recruiting grounds.

## METHODS

After receiving Institutional Review Board approval, the Directors of Admissions of all the U.S. chiropractic colleges were contacted to set up telephone interviews. Each respondent was asked “Do you have any recruitment program that

targets underserved populations?" The definition of underserved was left open for the respondent to define. A negative response terminated the interview. A positive response elicited two more questions: "Please describe your program," and "Do you feel it has been successful in recruiting students?"

## RESULTS

Sixteen of the 17 colleges were successfully polled. Nine of the schools reported "no program." Of these nine, two would be better described as "no, but." Both offered scholarships for minority students, placed ads in minority publications, and/or supported the American Black Chiropractic Association (ABCA) through attendance at their convention. Of the seven directors who replied in the affirmative, five were working with historically black colleges and universities. Three of the schools had student chapters of the ABCA and three schools reported that multicultural activities were part of campus life. Two mentioned diversity in faculty and staff. One school incorporates multicultural faculty to make calls to prospective students who have identified themselves. Three of the schools had identified minority recruiters, persons of color whose main focus is on recruiting minority students. One school had employed a retired African American chiropractor as a recruiter. The doctor had sought out the position at the profession's education conference. One school

reported an active program recruiting Hispanic students and one for Native Americans. Two of the directors reported that they believed their lack of success was due in large part to the lack of role models, both on the faculty and in the field.

## DISCUSSION

Prospective students' ethnicity is self-reported in the inquiry, or recruiting, stage. Applicants and students are voluntarily identified, so any report of findings will obviously be more indicative than accurate. The latest available (2003) Integrated Post Secondary Education Data System (IPEDS) data were used as a measure of success of the recruiting programs. For six of the seven schools that reported "no program," the percentage of students who were reported as minorities by the IPEDS definition ranged from 4.7% to 35.8%. One school was not included in the IPEDS report. For those schools with reported programs, the percentage of students who reported themselves in the IPEDS minority categories ranged from 8.4% to 26% of the student body. Programs to attract minority students can be created and infrastructure can be provided, but they are nearly useless without role models. Factors beyond the control of the Admissions office are often the most important determinants.



## Neuromuscular Contributions to Dynamic Posteroanterior Spinal Stiffness

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The purpose of this study was to investigate the effects of trunk muscle stimulation and mechanical stimulus on dynamic posteroanterior (PA) lumbar spine stiffness.

## METHODS

To investigate muscle stimulation, four needle EMG recording electrodes and two stimulating electrodes were placed into the multifidus muscles bilaterally at the levels of L3 and L4 in 10 adolescent Merino sheep. Constant voltage (4 V), electrical stimulations with varying pulse durations (2.5, 5, 10, and 20 Hz) were randomly administered. At rest and during muscle stimulation, a computer-controlled voice

coil actuator equipped with a load cell was used to deliver an oscillatory PA force directly to the L3 spinous process over a 2- to 20-Hz range (20-N preload to 200-N peak). In each trial, L3 displacement and EMG responses were recorded. The PA secant stiffness (force/displacement, kN/m) was determined and the effect of muscle excitation on the PA stiffness was assessed at each mechanical excitation frequency using a paired-observations *t*-test ( $p < .05$ ).

To investigate mechanical stimulus, the apparatus delivered a PA mechanical force to the L3 spinous process of 15 adolescent Merino sheep. PA forces (48 N peak, ~ 20% body weight) were randomly applied at periodic excitation frequencies of 2 Hz, 6 Hz, 12 Hz, and 2- to 20-Hz sweep. Force and displacement were recorded over a 13- to 22-second interval.

## RESULTS

During maximum muscle stimulation, the PA stiffness increased 3- to 9-fold and the increase was statistically significant ( $p < .05$ ) for 22 of the 28 mechanical stimulation frequencies. For submaximum muscle stimulations, the PA stiffness was significantly increased for 7/28 mechanical excitation frequencies (10-Hz stimulus), 6/28 mechanical excitation frequencies (5-Hz stimulus), and 1/28 mechanical excitation frequencies (2.5-Hz stimulus) when compared to rest.

During the application of mechanical stimulation, the in vivo posteroanterior stiffness of the ovine spine was frequency dependent and varied 3.7-fold over the 0.5- to 19.7-Hz mechanical excitation frequency range. Minimum and maximum PA stiffness values were  $3.86 \pm 0.38$  N/mm and  $14.1 \pm 9.95$  N/mm at 4.0 Hz and 19.7 Hz, respectively.

Stiffness values based on the swept-sine measurements were not significantly different from corresponding periodic oscillations (2, 6, and 10.6 Hz). The mean variance in the swept-sine PA dynamic stiffness assessment method was 15%, which was similar to the variance associated with the periodic oscillation method (10–16%).

## DISCUSSION

Submaximal and maximal neuromuscular excitation causes PA spine stiffness to increase, which may be important biomechanical considerations in the pathomechanisms and diagnosis of low back pain. Dynamic stiffness assessments could be used to provide important information concerning the mechanical status of the normal and dysfunctional or pathologic spine.



## A Patient With Mobius Sequence and Daily Headaches Implications for Spinal Manipulation

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Mobius sequence is a very rare congenital disorder characterized by aplasia of the abducens (VI) and facial (VII) nerves, limb malformation, and orofacial malformations. These patients have a mask-like appearance due to their lack of facial expression and inability to abduct the eye from midline. They also have various craniofacial and limb malformations. There are no previous cases of the treatment of a patient with Mobius sequence in the chiropractic literature.

## CLINICAL FEATURES

A 32-year-old male musician was diagnosed with whiplash-associated disorder by his general practitioner following an automobile accident. He was prescribed physiotherapy and trigger point injections. After 3 years of treatment, he stopped care because of dissatisfaction. He presented to a chiropractic clinic 6 months later, with daily headaches, which had been increasing in severity and frequency, and sharp posterior neck pain. The headaches, described as “vice-like,” started mildly and increased in severity throughout the day. He reported using an average of eight extra-strength acetaminophen tablets per day to control his headaches. Visual inspection showed a mask-like facies and malformation of both hands and the left foot. The left hand had three partial digits, and the right hand had four partial digits. The left foot was truncated at midfoot and only vestiges

of the metatarsals were present. Vital signs were all within normal limits. Cervical range of motion revealed restricted movement and localized, sharp pain in the midcervical spine. Cervical compression reproduced the neck pain. Tenderness was noted during manual palpation of the posterior neck musculature. No motor or sensory disruption was noted. Deep tendon reflexes were intact bilaterally. Respiratory, abdominal, and cardiovascular systems were unrevealing. Cranial nerve exam revealed cranial nerves (CN) I, II, III, IV, and VIII–XIII were intact bilaterally. Upon testing the abducens nerve, lateral gaze was completely absent. Jaw jerk reflex was present when testing the trigeminal (CN V) nerve; however, dysesthesia was noted around the mouth. The patient stated that the dysesthesia started following surgery to elongate the mandible 13 years earlier. Testing of the facial nerve revealed only very slight movement of the corners of the mouth and no other facial movements. When asked about this condition, the patient stated that he had been previously diagnosed with Mobius syndrome. He rated his pain intensity as a 6.0/10 on a visual analog scale (VAS). The initial Neck Disability Index (NDI) score was 28, indicating severe disability. The initial Headache Disability Inventory (HDI) score was 68%.

## INTERVENTION AND OUTCOME

A working diagnosis of cervicogenic headache with cervical and thoracic joint dysfunction complicated by

Mobius sequence was made. Following informed consent, the patient underwent seven treatments consisting of diversified-type spinal manipulation and stretches for the suboccipital, trapezius, and levator scapulae muscles. The patient was instructed on self-care and stretching. After the first treatment, there was a transient increase in cervical stiffness and discomfort that abated within 24 hours. After the seventh and final treatment, the patient rated his pain 1.8/10 (VAS). The NDI immediately post-treatment was 19 (moderate disability). The HDI was 38%. At a 4-month follow-up, the patient rated his pain 3.0/10. The NDI was 21 (moderate disability) and the HDI was 34%. At this time the patient was taking two acetaminophen tablets per day as needed.

## CONCLUSION

This case documents the successful resolution of cervicogenic-type headache using primarily spinal manipulative therapy in a patient with Mobius sequence, a rare congenital disorder. This is the first report of any manual treatment in this rare population. Future case studies documenting the treatment of rare populations and future research with regard to these populations is needed.



## Mathematical Modeling of the So-called “Allis Test”

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In the chiropractic profession, the primary leg-checking procedures that are done include a variety of both supine and prone procedures. Another method that is occasionally used is described as the “Allis test.” The purpose of the present study was to perform mathematical modeling of this so-called Allis test, prior to undertaking a clinical investigation. Although the reliability of prone and supine leg-checking procedures is reasonably well known, and there are some studies on their validity, the authors are not aware of any investigations of the Allis protocol for determining leg-length inequality. In the search for information on the Allis test, it became apparent that the test as it is commonly performed (described in the methods section below) might be more appropriately called the Weber-Barstow test.

## METHODS

For the purpose of mathematical modeling, the authors assumed a left tibial length of 470 mm, a left femoral length of 460 mm, and the distance between the hip and foot of the supine patient to be 570 mm. These numbers are based on a typical tibiofemoral ratio of 1:1.26, and a knee angle of approximately 90°. Since under these assumptions the femur, tibia, and hip-foot distance creates a triangle of known dimensions, it was possible to use trigonometry to calculate the angles of the triangle. From these angles, it was then possible to compute, for given changes in the length of the right leg bones, changes in the height and y-axis position of the knee. The authors also explored the mathematical consequences of one hip being drawn up cephalad compared

with the other, while the feet are kept even at the foot of the table (thus increasing the hip-foot distance on one side).

## RESULTS

The knee altitude is diminished with either femoral or tibial length reduction. The knee is shifted cephalad when the femur is reduced in length. Shortening of the femur has an approximately 25% greater impact on knee y-axis location than tibial shortening, whereas tibial length reduction has an approximately 25% greater impact than femoral shortening on knee altitude.

## DISCUSSION

Irrespective of nomenclature, this modeling shows that the traditional interpretation of the test may be flawed. Although it may detect a leg-length inequality, the test does not appear to detect what some individuals have said. This study is limited by the fact that it is pure modeling, and it will take a clinical study to see if its predictions are borne out. The simple model we described may not be an entirely appropriate representation of a flesh and blood leg, with the complexity of its joint kinematics. Future studies may address the interexaminer and intraexaminer of this type of visual check, and compare the results against an accepted gold standard for a leg-length inequality, such as the scanogram X-ray.

There are significant discrepancies in the literature on the description of the Allis/Galleazzi test, which appears relevant only to infants, and is performed with the hip at 90°. The procedure that chiropractors commonly perform closely resembles what Magee calls the Weber-Barstow procedure. The modeling that the authors performed refutes what Magee

and others have said on the interpretation of the test. Either a short tibia or femur lowers the knee seen from the foot of the table, by similar amounts, and cannot discriminate between a leg-length inequality due to one or the other. In the side view, a short femur brings the knee cephalad, and a short tibia brings it caudad, by similar amounts.



## Chiropractic Consultation Requests in the Veterans Affairs Health Care System

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The purpose of this study was to review demographic characteristics of Veterans Administration (VA) chiropractic patients and determine the level of appropriateness of chiropractic consultation requests within a VA chiropractic clinic. Information regarding the volume of requests and wait times for appointments was obtained to provide insight into the demand for and access to VA chiropractic services.

### METHODS

A purposive sample of the first 100 chiropractic consultation requests received through the Computerized Patient Record System at the VA Medical Center was selected for data collection and analysis.

### RESULTS

The VA chiropractic patients in this study were primarily older males with chronic low back pain that had not responded to medical management and other treatment modalities. More than half of patients had some degree of service-connected disability. Consultation requests came largely from Primary Care and the majority of requests were for patients for whom chiropractic was clinically indicated and requested preconsultation diagnostic studies had been performed.

### DISCUSSION

This study represents an early investigation into the integration of chiropractic services within the VA Health Care System. Chiropractic clinical training for students and postgraduate education for VA doctors of chiropractic should emphasize management of chronic mechanical pain syndromes complicated by conditions specific to military experience and possible combat exposure. The chiropractic consultation request process can be adapted to the specific needs and resources of VA chiropractic clinics with appropriate access to chiropractic services enhanced by effective communication between chiropractors and referring provider types.

### CONCLUSION

The VA chiropractic patients in this study differed from traditional non-VA chiropractic patients with regards to age and gender. Commonalities in patient presentations within this veteran population should influence training for doctors of chiropractic entering the VA Health Care System. While the consultation requests were appropriate based on locally established criteria, timely access to chiropractic services in this part-time clinic became limited as demand quickly exceeded capacity. Additional health systems research is indicated to evaluate chiropractic implementation on a larger scale within the VA Health Care System.



# The Effect of Combining Spinal Manipulation With Exercise on Respiratory Function

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The cause of over 20% of all deaths in the world can be attributed to diseases of the respiratory system. Noncommunicable respiratory conditions are responsible for nearly one third of these deaths, with chronic obstructive pulmonary disease being blamed in over 70% of the cases. Spinal manipulation is infrequently included as a therapeutic technique in the management of the chronic respiratory patient. A reliable protocol that includes spinal manipulation as a part of the management approach for the chronic respiratory patient is required.

## METHODS

This study was reviewed and approved by the Macquarie University Ethics Review Committee. Twenty healthy volunteers between the ages of 18 and 40 were allocated into four groups of five subjects: group 1 (exercise only) received a predetermined treadmill exercise program; group 2 (spinal manipulation only) received spinal manipulations of the cervical and thoracic spines; group 3 (spinal manipulation and exercise) received spinal manipulations of the cervical and thoracic spines followed by the predetermined treadmill exercise program; and group 4 acted as the control group. Forced vital capacity (FVC), forced expiratory volume in 1 second (FEV-1), and forced expiration time (FET) measurements were taken for each subject before and after intervention. Each subject in groups 1, 2, and 3 undertook six exercise sessions and/or six spinal manipulation sessions over a 4-week period.

## RESULTS

Subjects who received only the exercise program showed a decrease in FVC readings of 0.305 liters (-7.57%). Subjects

who received only spinal manipulation showed an increase in FVC of 0.318 liters (+7.69%). Subjects who received both spinal manipulation and the exercise program showed an overall increase of 0.578 liters (+14.35%), which consisted of an increase of 0.327 liters (+8.12%) immediately after spinal manipulation followed by an additional increase of 0.251 liters (+6.23%) at the completion of the exercise program. Subjects in the control group showed an increase in their FVC of 0.045 liters (+1.52%).

## DISCUSSION

The increase in FVC across both groups of subjects who received spinal manipulation is consistent with previous studies. The decrease in FVC readings for subjects in the exercise only group may be explained by the effect of exercise-induced respiratory resistance. The results of the group who received both spinal manipulation and the exercise program appear to show a reversal of the exercise-induced respiratory resistance seen immediately after exercise. This has potential importance when designing future management programs for chronic obstructive pulmonary disease (COPD) subjects that include an exercise component because spinal manipulation prior to exercise may permit additional tolerance within the respiratory system to allow for the COPD subject to undertake a more extensive exercise program than was previously possible.

## CONCLUSION

This study showed the beneficial effect of spinal manipulation as well as the additional benefit of combining spinal manipulation with exercise on respiratory function.



# Categorizing the Severity of Neck Pain Establishment of Cut Points for Use in Clinical and Epidemiological Research

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Grading pain intensity scales into simple categories provides useful information for both clinicians and epidemiologists and methods to classify pain severity for numerical rating scales have been recommended. However, the establishment of cut points is still in its infancy and little is known as to whether cut points are affected by age or gender. The objectives of this study were to establish optimal cut points in pain severity in individuals with neck pain and to investigate whether the cut points were influenced by gender and age.

## METHODS

Data from the population-based Funen Neck and Chest Pain Study were used. Univariate and multivariate analyses of variance were performed to calculate optimal single and double cut points for three different pain intensity scores within the past 2 weeks relative to two neck disability scales (global assessment of neck pain and the Copenhagen Neck Functional Disability Scale).

## RESULTS

The two disability scales showed small differences in optimal cut points. Furthermore, cut points changed for

each of the three pain intensity scales. Only small gender differences in cut points were seen and no specific trend was noted in either single or double cut points in different age groups.

## CONCLUSION

This study has implications for understanding the impact of using different pain intensity scales and provides reference cut points in neck pain for use in future clinical and epidemiological research.

## ACKNOWLEDGMENTS

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# Mesothelioma Presenting With Neck and Shoulder Symptoms A Case Report

**R. Bruce Fox**, D.C., D.A.C.B.R., and **Philip A. Librone**, B.A., D.C., Life University

The purpose of this report is to discuss the case of a patient with malignant mesothelioma who presented with musculoskeletal symptomatology at a chiropractic office.

## CLINICAL FEATURES

A 46-year-old male, with a 3-month history of progressively worsening left-sided lower neck pain with extension

into the shoulder, sought treatment at a chiropractic clinic. Plain film cervical spine radiography revealed opacification of the left lung apex. This was followed by chest radiography which demonstrated extensive, lumpy, soft tissue thickening along the left lateral chest wall extending into the apex, with hazy opacification of the left lung and slight upper mediastinal deviation to the right.

## INTERVENTION AND OUTCOME

The patient was referred to a primary care medical physician for subsequent management including pulmonary consultation, chest CT, and biopsy.

## DISCUSSION

Malignant mesothelioma is a rare primary pleural malignancy with approximately 3,000 cases reported annually in the United States and has a strong association with asbestos exposure. This case illustrates the importance of including careful evaluation of the lung apices on cervical spine radiographs. Although primary pulmonary neoplasm would always be a first consideration for apical opacification in this age group, this case illustrates the importance of careful correlation of patient symptomatology, radiographic findings, and past patient history.



## The Effect of Axial Distraction With and Without Flexion and Extension on Nuclear Pressure and Stress Distribution in Lumbar Intervertebral Discs

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Mechanical failure of the intervertebral disc has been implicated as a primary cause of low back pain. Distraction manipulation (also termed flexion-distraction) is commonly used to treat discogenic lumbar conditions. The proposed biomechanical effect is reduction of nuclear pressure and anterior shifting of nuclear material. However, the effect of distraction manipulation on the distribution of stress within the disc is unknown. The goal of this study was to determine the effect of axial distraction (neutral), flexion-distraction, and extension-distraction on the distribution of intradiscal stress in lumbar discs as measured by stress profilometry.

## METHODS

Fifteen motion segments from nine fresh-frozen ( $-20^{\circ}\text{C}$ ) cadaveric lumbar spines were prepared in the standard manner. Specimens with severe osteoporosis, posttraumatic deformity, or pathological disease were excluded. Upper and lower vertebral bodies of each motion segment were mounted in circular acrylic fixtures using polymethylmethacrylate. Fixtures were attached to a custom testing device to apply pure bending moments and simultaneous axial compression or distraction. A high-pressure transducer (Model OrthoAR, Medical Measurements, Inc., Hackensack, NJ) measured nuclear pressure and estimated compressive stress perpendicular to the transducer membrane. It was passed through each disc in the midsagittal plane and extracted at 2 mm/s to

produce a “stress profile” for five loading conditions: 300-N compression (simulated nonweightbearing); 500-N compression (simulated relaxed standing); 90-N distraction (simulated axial distraction); 90-N distraction and 5-Nm extension (simulated extension-distraction); and 90-N distraction and 5-Nm flexion (simulated flexion-distraction). Disc degeneration was graded by two observers. Grades were collapsed into “low degeneration” (grades 1 [normal] and 2 [mild]) and “high degeneration” (grades 3 [moderate] and 4 [severe]) groups for analysis.

## RESULTS

Mean age of cadavers was 66.4 years (range, 40–82). The nine spines yielded 15 L1–L2 to L4–L5 motion segments (eight low-degeneration and seven high-degeneration discs). Disc levels were reasonably distributed. Neutral distraction yielded the lowest mean nuclear pressure ( $1.9 \pm 13.4$  kPa). Nuclear pressure became negative in four of eight low-degeneration discs but only in one of seven high-degeneration discs. Greater decreases in nuclear pressure (difference between 300-N compression and the distracted conditions) occurred in the low-degeneration group compared with the high-degeneration group and the magnitude of the difference was similar in low- and high-degeneration groups for all three distracted conditions. The stress (pressure) distribution patterns for flexion-distraction and extension-distraction were

similar in low-degeneration discs. Discs with high degeneration had markedly less stress (pressure) in the posterior annulus than in the nucleus and anterior annulus during flexion-distraction. Extension-distraction resulted in a more even distribution of stress but more in the posterior annulus and nucleus than in the anterior annulus.

## DISCUSSION

The only simulated condition associated with negative intradiscal pressures in this model was axial distraction. The

distribution of stress in discs with lower grades of degeneration was similar during flexion-distraction and extension-distraction. In contrast, discs with higher grades of degeneration distributed forces differently, possibly due to an inability to generate or sustain high nuclear pressure. In those discs, flexion-distraction produced a stress gradient that was lowest in the posterior annulus, while extension-distraction produced more stress in the posterior annulus than in the nucleus and anterior annulus.



## Short-Lasting Changes in Vertebral Position Alter Lumbar Paraspinal Muscle Spindle Sensitivity

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Elucidating the response pattern of paraspinal muscle spindles to biomechanical changes in the spine may be important for understanding neuromuscular control of the spine. Altered information about paraspinal muscle length and velocity might lead to aberrant posture and movement, alter spinal stability, and lead to injury and pain. In arm or limb muscles of humans and cats, a muscle's length history affects the resting discharge and sensitivity of its muscle spindles. The authors found similar thixotropic effects in lumbar paraspinal muscles where holding a vertebra in a static position for at least 2 seconds changed resting spindle discharge and its discharge to subsequent movement. The aim of this study was to investigate the effects of a static vertebral position less than 2 seconds in duration on static and dynamic responses of lumbar paraspinal muscle spindles.

## METHODS

All experiments were performed in anesthetized cats in accordance with the Guiding Principles in the Care and Use of Animals approved by the American Physiological Society. Single unit nerve activity from paraspinal muscle spindle afferents with receptive fields in the low back was recorded from the L6 dorsal root. Paraspinal muscle spindle discharge at an intermediate vertebral position (static test) and during ramp movement of vertebra from that intermediate position (dynamic test) were determined after having held (conditioned) the vertebra in one of three positions (hold-long, hold-short, or hold-intermediate) for 0, 0.5, 1.0, 1.5, and 2.0 seconds. The hold-short vertebral position unloaded and the hold-long vertebral position loaded the muscle spindles relative to the hold-intermediate vertebral position.

## RESULTS

Twelve paraspinal muscle spindle afferents were tested. All were located in either the multifidus or longissimus muscles innervated by the L6 segment spinal cord. For the static test, hold-long relative to hold-intermediate conditioning decreased mean instantaneous frequency of resting discharge by  $-8.8 \pm 15.9$ ,  $-13.9 \pm 4.6$ ,  $-18.9 \pm 9.8$ ,  $-23.7 \pm 12.4$ , and  $-26.8 \pm 14.2$  Hz for 0-, 0.5-, 1.0-, 1.5-, and 2.0-second conditioning durations, respectively. Hold-short conditioning increased the mean frequency by  $-0.9 \pm 14.3$ ,  $3.5 \pm 4.3$ ,  $3.8 \pm 5.4$ ,  $3.8 \pm 6.7$ , and  $4.3 \pm 6.8$  Hz for the same five conditioning durations, respectively. For the dynamic test, hold-long relative to hold-intermediate conditioning decreased the mean frequency by  $-1.1 \pm 0.8$ ,  $-2.5 \pm 2.3$ ,  $-4.4 \pm 3.1$ ,  $-5.6 \pm 3.6$ , and  $-7.3 \pm 4.5$  Hz for 0-, 0.5-, 1.0-, 1.5-, and 2.0-second conditioning durations, respectively. On the other hand, hold-short conditioning increased the mean frequency by  $1.0 \pm 1.1$ ,  $1.1 \pm 1.5$ ,  $1.1 \pm 1.7$ ,  $2.0 \pm 1.9$ , and  $0.9 \pm 1.9$  Hz for the same five conditioning durations, respectively.

## DISCUSSION

These results suggest that lumbar paraspinal muscle spindles can experience thixotropic effects when a vertebra is held in a static position for very short durations. Positions that lengthen the paraspinal muscles decrease and positions that shorten the muscles increase spindle responsiveness. However, the effects are most pronounced when the muscles

are lengthened. This effect begins within 1/4 second and appears to increase with durations up to 2 seconds. That spindle discharge to a given vertebral movement can depend upon the muscle's previous history would be expected to alter proprioceptive information arriving at the central nervous system. Whether this leads to proprioceptive errors or whether the central nervous system corrects for this instability is not known.

## ACKNOWLEDGMENTS

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## The Effects of Active Release Technique on Carpal Tunnel Patients A Pilot Study

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Carpal tunnel syndrome (CTS) is the most common nerve entrapment disorder affecting 1–3% of the general population. It has been estimated that direct medical costs associated with CTS in the United States will exceed \$1 billion a year, with associated costs approaching \$13 billion a year. In the Netherlands, 39% of neurologists prefer surgery over conservative care for the initial treatment of CTS. However, conservative care is still the preferred intervention for mild to moderate cases in the United States. The most common nonsurgical treatments for CTS include wrist splints, exercise, nonsteroidal anti-inflammatory drugs, ultrasound, manipulation, acupuncture, and myofascial release. The clinical utilization of myofascial therapies such as active release technique (ART) for CTS is common, although there is a lack of empirical evidence supporting such utilization. The purpose of this clinical pilot trial was to examine ART's effect on CTS patients using electromyography (EMG) and a valid self-administered outcome measure.

## METHODS

This study was reviewed and approved by the Institutional Review Board of the Logan College of Chiropractic. Five subjects (mean age 48 years) with physician-diagnosed CTS were included in the trial. Subjects completed the Boston Questionnaire and an EMG examination prior to the first treatment. The Boston Questionnaire is a valid and reliable measure of symptom severity and functional status in CTS patients. The EMG analysis utilized surface electrodes placed on the flexor carpi radialis and extensor digitorum muscle bellies. Subjects were instructed to perform two maximum isometric contractions in wrist flexion and wrist extension as well as three repetitive active wrist flexions and wrist extensions. The EMG analysis was performed

before and after the first treatment. Subjects were treated with active release technique using the median nerve protocol three times a week for 2 weeks. The Boston Questionnaire was re-administered following the final treatment. The mean scores for the initial and final symptom severity and functional status were calculated and compared using a paired samples *t*-test. An analysis of variance (ANOVA) was used to compare the mean contraction amplitudes of the flexor carpi radialis and extensor digitorum between the participants before and after the first active release treatment. An ANOVA was also used to compare mean contraction amplitudes for maximal flexion, maximal extension, repetitive flexion, and repetitive extension. The *a priori* alpha level was set at  $p < .05$ .

## RESULTS

There was statistically significant improvement in the mean symptom severity and functional status scores following the intervention (mean symptom severity preintervention,  $2.87 \pm 1.03$ , and postintervention,  $1.73 \pm 0.16$ ,  $p = .03$ ), (mean functional status preintervention,  $2.63 \pm 0.89$ , and postintervention,  $1.48 \pm 0.32$ ,  $p = .02$ ). There were no significant differences found in the EMG analyses.

## DISCUSSION

Our population of CTS participants showed significant improvements in both symptom severity and functional status following the 2-week treatment intervention. This improvement in the Boston Questionnaire scores is clinically relevant because of the questionnaire's responsiveness to clinical change. The EMG analyses showed no significant changes in

flexor carpi radialis or extensor digitorum contraction amplitudes following the single active release treatment. The limitations in this trial included the lack of control, the small sample size, and the absence of a follow-up measurement to determine whether symptom severity and functional status

improvements were maintained. The preliminary data from this clinical pilot trial suggest that active release technique may be an effective conservative management strategy for CTS patients. These results support the need for more quality clinical research in this area.



## Comparison of Active Release Technique and Proprioceptive Neuromuscular Facilitation for Improving Hamstring Flexibility A Randomized Controlled Trial

**James W. George, D.C., Rodger Tepe, Ph.D., Jason Clewis, Ryan House, Erik Schlobohm, and Clayton D. Skaggs, D.C.,** Logan College of Chiropractic

The hamstrings are commonly injured muscles in athletic activities. Over half (51%) of the therapy provided at the 1996 Olympic Games involved a hamstring injury. Most studies have concluded that inflexibility contributes to lower extremity injury. Techniques previously investigated for improving hamstring flexibility include static stretching, exercise, heat, massage, and proprioceptive neuromuscular facilitation (PNF). PNF is a common stretching technique and involves an alteration between maximal contractions, relaxation, and stretching, including the techniques of hold-relax and contract-relax. Active release technique (ART) is a manual therapy for treating soft tissue problems. Its procedures involve taking tissue from a shortened to lengthened position while using a manual contact to maintain tension along the tissue's fibers. The current evidence suggests that PNF significantly increases hamstring flexibility when compared with other interventions such as static and ballistic stretching. There are anecdotal reports and a pilot trial suggesting that ART can significantly improve hamstring flexibility. There are no comparative studies on hamstring flexibility using ART and PNF. The purpose of this randomized controlled trial was to compare the ability of ART and PNF to increase hamstring flexibility in an asymptomatic population as well as to determine whether the effects were maintained at a 10-day follow-up.

### METHODS

This study was reviewed and approved by the Institutional Review Board of the Logan College of Chiropractic. Thirty-four participants (25 males, 9 females), mean age 26.5 SD  $\pm$ 5.3, were recruited. The participants were randomly assigned to ART (13), PNF (11), or control (10) groups. Participants were seen two times a week for 2 weeks and at a 10-day follow-up. The ART group received treatment to the dorsal sacral ligament, hamstring origins, insertions, and muscle bellies. The PNF group received five cycles of

contract-relax stretching. The control group sat in a room with an investigator for 5 minutes. The active knee extension test was used to measure hamstring flexibility by a masked investigator. Measurements were taken before and after each encounter and at follow-up. A one-way analysis of variance (ANOVA) was used to compare the group means at treatment 1 (T1), following treatment 4 (T4), and at the 10-day follow-up (T10). A one-tailed paired samples *t*-test was used to compare the scores within the groups at T1, T4, and T10. A one-tailed independent samples *t*-test was used to compare the scores between the groups at T1, T4, and T10. The a priori alpha level was set at .05.

### RESULTS

The one-way ANOVA showed no significant differences between the group means at T1, T4, and T10. The ART group show statistically significant improvement at T4, while the PNF group showed statistically significant improvement at T4 and T10. There was no significant difference between the ART and PNF group means at T4; however, there was a significant difference between the groups at T10.

### DISCUSSION

ART and PNF failed to increase hamstring flexibility significantly compared with control at the end of the 2-week treatment period and 10-day follow-up. The lack of significant difference between the control and experimental groups might have been attributed to our asymptomatic population that lacked measured deficits in flexibility. At the 10-day follow-up, the PNF group had significantly greater flexibility compared with ART. This may indicate that ART's

effectiveness is dependent on mechanical deformations or tension within the musculoskeletal system not typically found in normal asymptomatic populations. It may also represent PNF's ability to impact contractile functions of the

muscle that may not contain mechanical pathologies such as connective tissue changes. The results of this study suggest the need for future comparative trials using symptomatic populations.



## Combined Use of Conventional Medical Strategies and Chiropractic Care for Chronic Low Back Pain in an F/A-18 Aviator

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The purpose of this report is to discuss an example of the integration of chiropractic care with medical treatments for the management of chronic low back pain in a United States Marine Corps F/A-18 aviator. No previous literature discussing the use of chiropractic care for jet pilots has been published.

### CLINICAL FEATURES

An aviator instructor had insidious severe acute low back pain without radiation or neurological deficit, resulting in 24 hours of hospitalization. Spinal degenerative disc disease was discovered on plain film and magnetic resonance imaging. Four months after the initial pain episode, it still took as long as 10 minutes for him to get out of bed because of stiffness and pain. He had discontinued his regular Marine Corps fitness training because of pain avoidance. He experienced severe pain after flying and getting out of the jet. He rated the severity of pain during the day at 1.5 cm on a 10-cm visual analog scale and 7.1 cm upon waking. His modified Roland Morris Disability Questionnaire score was 5 out of 24.

### INTERVENTION AND OUTCOME

When the pain began, he was prescribed naprosyn, diazepam, and hydrocodone/acetaminophen for pain control and

confined to quarters to rest. The hospital physiatrist provided a home TENS unit, gentle osteopathic manipulation, and some home exercises. His pain decreased with prone lumbar extension and hip adductor stretching. A physical therapist recommended back flexibility and core stability exercises, which provided further relief. Chiropractic care was begun approximately 4 months after the initial pain episode and included high- and low-velocity, low-amplitude spinal manipulation, soft-tissue therapy, home spinal exercise, and an individualized reconditioning program. After 15 chiropractic treatments, he had no pain on the visual analog scale and his Roland Morris Disability Questionnaire was rated 0. He was able to fly multiple training missions per week and exercise to Marine Corps standards.

### CONCLUSION

A course of care integrating flight medicine, chiropractic, physical therapy, and physiatry appeared to alleviate pain and restore function to this F/A-18 aviator with chronic low back pain. The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or the United States Government.



# Confidence, Study Habits, and Attitudes Toward Radiology Assessments

## A Comparison Study Between Students Involved in Two Different Curriculum Delivery Systems

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Much discussion is occurring in educational circles regarding various curriculum delivery systems: lectured-based, problem-based, and hybrids of the two styles, all of which are currently used in different chiropractic colleges. A new hybrid curriculum termed adult-based learning was introduced at a chiropractic college in October 2002 with the goal of enhanced integration of basic and clinical sciences. The advantages and effect of this type of approach are relatively unknown. The purpose of this study was to compare different trends in students enrolled in two different delivery systems: an adult-based (ABL) system modeled after the problem-based style and a traditional lecture-based learning (LBL) curriculum. Performance on a comprehensive radiology test, confidence in diagnostic abilities, study tools utilized, and attitudes toward radiology in general were assessed.

### METHODS

Multiple surveys were distributed before and after a comprehensive clinic radiology examination. Two groups of students took the same examination and answered the same voluntary surveys but were enrolled in two different curricula in two campuses of the same college. Confidence levels were assessed in both pretest and posttest surveys. Attitudes and study habits were surveyed before the test. Questions were answered using a 5-point Likert scale.

### RESULTS

Initially, both groups appeared similarly confident in their diagnostic abilities. They also expressed a relatively high interest in radiology and its importance in chiropractic practice. When asked about the importance of radiological diagnosis, the students who were enrolled in a problem-based approach indicated a significantly higher rate of importance. In postexamination surveys, both groups were less confident about their diagnostic abilities. This was specifically marked in the ABL students even though their scores were significantly higher on the examination. The problem-based group also reported utilizing more diverse resources to prepare for the test.

### DISCUSSION

Based on the results of this study, the ABL curriculum seems to offer the benefits of a problem-based learning curriculum without the perceptions of deficiency that have appeared in the literature. Positive attitudes about radiological diagnosis and daily practice seen in the ABL group provide evidence of the intended link between basic radiology and clinical diagnosis. Hybrid curricula have been proposed as an optimal delivery method and the ABL curriculum has demonstrated some of its advantages in this small-scale study.



# Force and Speed Characteristics of Double Transverse Posterior to Anterior Thoracic Adjustments by Different Chiropractors

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Chiropractors treat spinal conditions using manually applied forces to improve spinal function. Chiropractors apply quick dynamic loads as part of treatment. The objective of this study was to measure the three-dimensional characteristics of thrusts delivered to the thoracic spine by three different chiropractors.

### METHODS

A total of 36 thrusts (double transverse, posterior to anterior) were delivered by the three chiropractors to a mannequin of similar shape and texture to a human. A

three-dimensional force transducer was used between the doctor's hand contact points and the mannequin. A computer and Motion Monitor software (Innovative Sports Training, Chicago, IL) was used to collect data at a sampling rate of 1,000 samples per second. Each of the three doctors were asked to deliver two-hand contact double transverse thrusts to the upper thoracic, middle, and lower thoracic levels. The doctors were instructed to deliver four types of thrusts according to their judgment. These are (1) high-force, high-speed, (2) high-force, low-speed, (3) low-force, high-speed, and (4) low-force, low-speed thrusts. Doctors were not permitted to observe each other delivering thrusts. All the doctors and the technician collecting the data were blinded to the data. The data were exported to a text file and read into a MathCAD (version 11, Math Soft Inc., Waltham, MA). The data were reduced to important thrust characteristics using a custom-developed MathCAD software program. Biomechanical characteristics of the thrusts in terms of the duration, rate of loading, preload, and peak loads were extracted from the data for the three chiropractors. The data were analyzed descriptively using minimum, maximum, average, and standard deviation calculations and comparisons based on these values.

## RESULTS

The three clinicians had distinct thrust characteristics. Inferior to superior forces varied from  $-35$  N to  $99$  N at the thrusting hand while they varied from  $-73$  N to  $62$  N at the stabilizing hand. Lateral forces varied from  $-88$  N to  $50$  N at the thrusting hand while they varied from  $-52$  N to  $41$  N at the stabilizing hand. Peak loads in the posterior to anterior direction ranged from  $146$  to  $454$  N at the thrusting hand, and

from  $148$  to  $362$  N at the stabilizing hand. Durations of the thrust ranged from  $119$  to  $652$  milliseconds. Rates of loading have ranged from  $246$  to  $2,105$  N/s. The stabilizing hand peak forces were  $90\%$  of the thrusting hand peak forces. Low-force adjustment force magnitudes were  $70\%$  compared to high-force adjustment magnitudes. Duration and rate of loading for low-speed adjustments were  $50\%$  of the magnitudes for the high-speed adjustments.

## DISCUSSION

The thrusting hand forces observed were smaller compared with the literature values reported for a single-hand contact posterior to anterior thoracic adjustment. This is a first study reporting the hand contact forces at both hand contacts during double transverse adjustments by experienced clinicians. This study provides a system for quantifying the three-dimensional load characteristics of different doctors on a mannequin. Future studies should aim at the training of the clinicians at specific ranges and use of this information in clinical trials on patients to determine the optimal treatment parameters. Improved mannequin development could lead to development of a database for training of students in chiropractic colleges.

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## Pelvic Posture as Rotations and Translations in Three Dimensions From Three Two-Dimensional Digital Images Validation of a Computerized Analysis

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Pelvic posture is an important component of measuring dynamics in gait and running. However, no system exists to measure rotations and translations of the pelvis in three-dimensions (3-D) in standing static posture. The

purpose of this study was to determine the validity of the Biotonix PosturePrint Internet computer system (Montreal, Quebec, Canada) used to measure standing pelvic posture in 3-D.

## METHODS

In a university biomechanics laboratory, photographs of a mannequin pelvis were obtained in different postures on a stand in front of a digital camera. For each pelvic posture, three photographs were obtained (left lateral, right lateral, and anterior to posterior). The mannequin was positioned 2 feet from a calibrated wall grid, while the camera was at 33 inches in height and at 11 feet from and perpendicular to the wall grid. The mannequin pelvis was placed in 68 different single and combined postures (requiring 204 photographs) in 5 degrees of freedom: lateral translation, lateral flexion, axial rotation, flexion-extension, and anterior-posterior translation. The PosturePrint system requires 14 reflective markers to be placed on the subject (mannequin) during photography and 15 additional "click-on" markers via computer mouse before a set of three photographs is analyzed by the PosturePrint computer system over the Internet. The PosturePrint algorithm returns an analysis of the head, rib cage, and pelvis in 3-D as rotations (degrees) and translations (millimeters).

## RESULTS

Average absolute value errors were obtained by comparing the exact inputted posture to the PosturePrint's computed values. Mean and standard deviation of computational errors for sagittal displacements of the pelvis were: flexion-extension,  $0.5^\circ \pm 0.8^\circ$ ; and anterior-posterior translation,  $1.2 \text{ mm} \pm 0.6 \text{ mm}$ . For frontal view displacements, mean and standard deviation of computational errors were: axial rotation,  $1.3^\circ \pm 0.8^\circ$ ; lateral flexion,  $0.5^\circ \pm 0.3^\circ$ ; and lateral translation,  $0.9 \text{ mm} \pm 0.5 \text{ mm}$ .

## DISCUSSION

To those working within biomechanics and physical medicine settings, a practical notion is that static parameters

determine dynamics (structure determines function). This is also true when applied to neutral posture pelvic alignment and its effects on subsequent gait motion. In fact, pelvic posture is considered an important component in gait, leg-length inequality determination, dynamics in running, patient range of motion (ROM) assessment, and static analysis of patient posture. The pelvis is also an integral part of abnormal gait evaluations for pregnancy, gait in stroke victims, gait in hip osteoarthritis, gait in pain subjects, trunk flexibility, impact biomechanics, and biomechanics of hip surgery. Because pelvic posture is a clinically important parameter for patient health, an accurate means to assess pelvic posture is essential. An earlier study categorized pelvic postures as rotations and translations in 3-D, but no studies could be located providing these movements as rotations and translations in gait or in ROM studies. Although the validity and reliability of using radiographic procedures for assessing pelvic posture (i.e., pelvic obliquity) has been established, this method is costly and invasive, requires special expertise, and does not afford itself as a clinically simple patient screening tool. Further, as ionizing radiation is thought to pose potential risk to patients, use of digital pictures used within the comprehensive PosturePrint system allows a rapid and ionizing radiation-free means of data extraction to assess and/or monitor patient disease or treatment progression.

## CONCLUSION

The Biotonix PosturePrint system is accurate in measuring pelvic standing static postures in 5 degrees of freedom. Because this system allows for accurate pelvic postural measurement as rotations and translations, statistical research determining the correlation between pelvic postural displacements, back pain, function, and health status can be performed.



## Reduction of Deformity After Chiropractic Biophysics Mirror Image Care Incorporating the Noncommutative Properties of Finite Rotation Angles in Five Patients With Thoracolumbar Scoliosis

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Scoliosis involves large spinal rotation angles in three dimensions, as well as multiple postural displacements of

the thoracic and pelvic regions. Few conservative treatments have been reported to reduce this deformity. Given the

postural relationship to scoliosis and the fact that rotation angles are noncommutative, it may be possible to influence scoliosis positively by precisely controlling the order of postural movements that the patient performs during treatment. This report describes the reduction of deformity in five patients with thoracolumbar scoliosis by application of the noncommutative property of finite rotation angles under addition to the spine, in a unique application of chiropractic biophysics (CBP) mirror image treatment methods.

## METHODS

This study is a retrospective case series of five female patients with thoracolumbar scoliosis selected from a chiropractic clinic in Nevada. The cases include a 17-year-old, 19-year-old, 41-year-old, and 45-year-old presenting with chronic lower back pain, as well as a 35-year-old presenting with right-sided mid- and low back pain following a motor vehicle accident 8 months previously. Depending on the postural analysis of each subject, two mirror image postural stress X-rays were taken by altering the orders for the combination of either lateral translation and lateral flexion, or lateral translation and axial rotation. The goal was to determine which order of postural movements (first using lateral translation followed by lateral flexion or axial rotation, or lateral flexion or axial rotation first followed by lateral translation) showed the best reduction in scoliosis, as measured on the anterior to posterior (AP) lumbar view. Treatments of patient-specific mirror image exercises, adjustments, and traction were performed for various durations up to 108 treatments for one patient.

## RESULTS

At final re-examination of case 1, the AP thoracolumbar scoliosis measured a right thoracic translation of  $-6$  mm

(a 21-mm change) and a reduced angle of  $23^\circ$  from an initial  $47^\circ$ . The patient reported complete amelioration of her pain (NRS = 0). At final re-examination of case 2, the AP thoracolumbar scoliosis measured a right thoracic translation of 7 mm (a 13-mm improvement), an angle of  $11^\circ$  ( $3^\circ$  improvement), and right translation of T12-S1 of 8 mm (a 12-mm improvement). At final re-examination of case 3, it was found that the angle reduced to  $11^\circ$  ( $7^\circ$  improvement) and the lateral translation to  $-1$  mm (10-mm improvement). At final re-examination of case 4, the AP thoracolumbar scoliosis measured a right thoracic translation of  $-10$  mm (a 4-mm improvement) and an angle of  $-11^\circ$  ( $13^\circ$  improvement). Pain and disability measures were significantly improved. At final re-examination of case 5, the AP thoracolumbar scoliosis measured a right thoracic translation of  $+10$  mm (a 12-mm improvement) and an angle of  $+24^\circ$  ( $5^\circ$  improvement). Pain and disability measures showed steady improvement and were significantly improved at final follow-up.

## DISCUSSION

In a unique application, CBP mirror image methods resulted in significant reduction of scoliotic deformity in five cases with thoracolumbar scoliosis. The use of a postural translation to alter the orientation of the three-dimensional spinal rotation angles might seem contradictory until one realizes that the vertebral coupled movement is primarily lateral bending. The application of the noncommutative property of finite rotation angles under addition, as applied in these five cases, affords a more specific means to develop subject-specific, targeted structural rehabilitative procedures to stress the spine toward a more straightened configuration.



## Intraexaminer and Interexaminer Reliability and Comparison of Computer-Aided Methods of Thermal Pattern Analysis

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Thermal pattern analysis is used to assess the neurological component of the vertebral subluxation. Interpretation of thermal scans is often a subjective visual process. The present study investigates the reliability of three methods of using the more objective thermal pattern calculator software.

## METHODS

This study was reviewed and approved by the Institutional Review Board of the Sherman College of Straight

Chiropractic. Three independent examiners each compared two thermal scans from the same 30 subjects. Each examiner twice performed analysis by three different methods. Methods 1 and 2 involved vertically aligning scans for analysis. Method 1 also included the addition of usable data points at the top and bottom of the scans. Method 3 left the graphs in situ. The results were evaluated by intraclass correlation coefficients (ICC) and *t*-tests.

## RESULTS

Method 1 intraexaminer reliability ICC scores were acceptable (mean, 0.932; range, 0.859–0.987). Interexaminer ICC scores for this method demonstrated a mean of 0.876 (range, 0.798–0.926). *t*-Test intraexaminer alpha scores for method 1 revealed one significant difference for examiner A. Method 2 intraexaminer reliability ICC scores were acceptable (mean, 0.923; range, 0.790–0.981) and interexaminer reliability ICC scores for this method demonstrated a mean of 0.854 (range, 0.805–0.941). *t*-Test alpha scores revealed no significant intraexaminer differences for method 2. Method 3 intraexaminer reliability ICC scores were high (mean, 0.979; range, 0.936–1.0) and interexaminer reliability ICC scores for this method demonstrated a mean of 0.978 (range, 0.956–0.999). *t*-Test alpha scores did not reveal any significant intraexaminer differences for method 3.

The three methods were compared for each examiner. Comparisons of methods 1 and 2 resulted in ICC scores showing strong agreements (mean, 0.962; range, 0.870–0.991). *t*-Test alpha scores revealed no significant differences between these two methods for any of the examiners. Comparison of methods 1 and 3 resulted in lower ICC scores (mean, 0.639; range, 0.385–0.892). *t*-Test alpha scores revealed significant differences between these two methods in 44% of the thermal pattern calculator calculations. Comparisons of methods 2 and 3 also resulted in lower ICC scores (mean, 0.657, range, 0.437–0.891). *t*-Test alpha scores revealed significant differences between these two methods in 61% of the thermal pattern calculator calculations. ICC scores for comparisons of methods 1 and 2 were, on average, higher than any other method comparison.

## DISCUSSION

Intra- and interexaminer reliability is acceptable for thermal pattern calculator procedures. Vertically aligning the graphs increases inter- and intraexaminer agreement regarding percent similarity. Leaving the graphs in situ significantly lowers the percent similarity. Including extra data points made no significant difference in the percent of similarity.



# Stress and Confidence Status of Chiropractic Interns Student Perspectives

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Chiropractic College

Stress is widely understood to influence learning, performance, and self-confidence. It serves to motivate some students and yet overwhelms others. While it is naïve to believe that stress can be eliminated or controlled, concern for wellness and quality education directs attention to the influence of stress on health as well as its influence on learning. The influence of stress and self-confidence has been speculated by chiropractic faculty to impact learning as 3rd-year interns struggle with skill performance and observational testing. Little has been published regarding stress and confidence in chiropractic interns.

## BACKGROUND AND OBJECTIVES

It is widely reported that attending a graduate professional program is stressful, with academic performance inversely

related to perceived stress. Research has identified curricular sources of stress to include the complexity and volume of material, time availability, examinations, and the ambiguity of expectations. Sources of stress in medical students have been related to performance anxiety and evaluation methods. In graduate psychology students, the factors underlying stress included time constraints, feedback from specific faculty, financial constraints, and lack of faculty assistance; female students and 3rd-year students reported more stress. Other stressors have been associated with developmental demands of young adulthood, including intimate relationships, parental conflicts, and finances.

This study examined issues related to stress levels and clinical confidence in 7th- and 8th-quarter chiropractic interns. The specific aims were to examine interns' perceptions of stress and clinical confidence; the relationships between stress and confidence; and interns' perception of faculty/school actions which reduce stress and/or increase confidence.

## METHODS

The study was approved by the Institutional Review Board of Western States Chiropractic College. Students enrolled in 7th- and 8th-quarter courses were invited to participate. The qualitative instrument, constructed by the researchers, asked for ratings of current stress and confidence (0 = none to 10 = extreme). Five open-ended questions explored sources of stress, influences on confidence, and support that could be provided by the college/faculty. The tool required 15 minutes to complete.

## RESULTS

Participants self-identified their academic status, with 38 interns reported as 7th quarter and 48 as 8th quarter. When compared with 8th-quarter interns, 7th-quarter interns reported significantly higher stress ratings ( $t = 2.8, p = .07$ ) and lower confidence ratings ( $t = -1.9, p < .01$ ). Stress was inversely related to confidence, although significant only for 8th-quarter interns ( $r = 0.40, p = .004$ ). Two themes, time constraints and relationship factors, emerged as influential to perceptions of stress and confidence. The lack of time was implied throughout many comments. Personal relationships

as well relationships with faculty were identified sources of stress. However, additional interactions with clinical faculty were valued for instilling confidence.

## DISCUSSION

Many of the factors that influenced stress and confidence are areas that faculty can address through introspection and discussion, without major curricular revision. Awareness of student perceptions may help faculty to become effective coaches and mentors. The findings highlight the value of asking, sharing, and attending to student perspectives. The response rate and thoughtful responses conveyed that stress and confidence are important issues for the respondents. Chiropractic interns identified similar sources of stress as those reported for students in other graduate professional programs. As young adults, chiropractic interns may be at risk for similar psychological problems found in studies with medical interns, such as depression and substance abuse. The persistence of high stress and low confidence beyond the 7th quarter may be a salient marker of personal, academic, or clinical distress. Further research using triangulated methods is needed to probe the significance of the stress-confidence relationship found with 8th-quarter students.



## Musculoskeletal Injuries in Chiropractors

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Overexertion and repetitive motion injuries account for 32% of workplace injuries requiring days off work. These types of work-related injuries have been well documented in several health care professions. This study was undertaken to determine the prevalence and types of work-related injuries among a nationwide sample of chiropractors and to identify factors associated with these injuries.

## METHODS

A survey was developed to gather data on the injuries that occur in chiropractic practices. One thousand selected chiropractors were asked to record their three most serious injuries and give details on the type of injury, area of the body affected, activity being performed at the time, year of practice in which the injury had occurred, if the doctor had needed to take time off from work, and what they had changed as a result of the injury.

## RESULTS

A total of 422 responses were obtained (42.2%), which yielded 397 usable surveys. One hundred fifty-nine chiropractors (40.1%) reported experiencing a total of 252 injuries while working. There was no significant association between gender, age, height, weight, or practice volume and having been injured. Most injuries were classified as soft-tissue injuries and occurred while either performing (66.7%) or positioning (11.1%) a patient for manipulation. Body parts most commonly injured were the wrist/hand/finger (42.9%), shoulder (25.8%), and low back (24.6%). The most common areas being manipulated while being injured were the lumbosacral (37.1%) and thoracic spine (21.6%). Shoulder and low back injuries were significantly more likely to have been caused by adjustments of the lumbosacral spine with the patient in the side-lying position. Most commonly, injuries occurred in the 1st to 5th year of practice (37.3%). Of note, 5.4% of injuries reported occurred while still attending chiropractic college.

## DISCUSSION

A high prevalence of upper extremity injuries was reported by chiropractors in this study. These were most often related

to side-posture adjustments to the lumbar spine. Because most injuries occurred early on in the career and required a change in technique, efforts toward injury prevention should be geared toward chiropractic students.



## Reflex Effects of a Spinal Adjustment on Blood Pressure

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Most studies concerning the effect of a chiropractic spinal adjustment on blood pressure have shown either no significant effect of the adjustment or no conclusive relationship between the level of the spinal adjustment and the nature of the blood pressure changes. This paper presents the results of a pilot study that investigates the effect of a diversified spinal adjustment on blood pressure with respect to the region of the spine adjusted.

## METHODS

Participants that met the selection criteria of the study included 63 patients reporting to a private chiropractic practice in Auckland, New Zealand. Informed consent was obtained before the patients were included in the study and the study gained ethics approval from the New Zealand College of Chiropractic Ethics Committee. Blood pressure was manually recorded from both arms in the sitting position after patients were allowed 5 minutes of quiet relaxation. Patients were then examined for the presence of vertebral subluxations using motion and static palpatory findings and a coin was tossed to determine the allocation of the patient to the control or experimental group for that trial. In the experimental group, an adjustment was performed in each trial based on motion and static palpation findings and the trial was then allocated to a subgroup depending on the region of the spine that was adjusted. The control group received only gentle digital pressure at the site of suspected vertebral subluxation. The subgroup sizes ranged from 36 to 46 trials. Blood pressure was retaken at the end of each trial by the same chiropractor who performed the adjustment or digital pressure and the initial recording.

## RESULTS

The pre- and post-blood pressure recordings were compared using a two-tailed paired *t*-test. The experimental subgroups all showed statistically significant changes of systolic and diastolic blood pressure ( $p < .001$ ). The cervical and lumbosacral adjustment groups showed a decrease of both systolic and diastolic pressure, while the thoracic adjustment group showed an increase. In the control groups, the only statistically significant change following adjustment setup and gentle digital pressure was for the diastolic pressure of the cervical group, which showed a small decrease ( $p = .02$ ).

## DISCUSSION

The results of the present study support previous assertions that a sympathetic excitatory response may occur after adjustments to the thoracic spine and a sympathetic inhibitory response after adjustments to the lumbosacral and cervical spine. It is likely that considerable integration occurs at both spinal segmental and supraspinal levels of the neuraxis as a consequence of parallel processing of primary afferent inputs. Varying degrees of activation and inhibition of both segmental and supraspinal pathways may contribute to the different blood pressure responses depending on the region that was adjusted. Clinically, it is not known how important the results of this study are because blood pressure was not monitored long-term. Experimental design should be enhanced in future studies by using a blinded examiner, considering longer term follow-up, and using a digital oscillometric sphygmomanometer to record blood pressure.



# Description and Validity of an Algorithm to Estimate Three-Dimensional Rotations and Translations of the Head in Upright Posture From Three Two-Dimensional Digital Images

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This study was a computer analysis of three digital photographs of a mannequin head, placed in different combinations of rotations and translations in three dimensions, in a university biomechanics laboratory setting. The purpose of the study was to evaluate the validity of the new Biotonix PosturePrint computer analysis that claims to determine rotations and translations of the head in three-dimensions.

## BACKGROUND

Methods for measurement of head posture include the linear excursion measurement device, body photographs, the CROM device, and simple plumb line methods. Problematically, these methods are not able to measure postural rotations and translations in 6 degrees of freedom.

## METHODS

In a university biomechanics laboratory, photographs of a mannequin head were obtained by placing it in different postures on a stand in front of a digital camera. For each mannequin posture, three photographs were taken (left lateral, right lateral, and AP). The mannequin was positioned 2 feet from a calibrated wall grid, while the camera was at 33 inches in height and at 11 feet from and perpendicular to the wall grid. The mannequin head was placed in 125 different single and combined postures (requiring 375 photographs) in 5 degrees of freedom: lateral translation, lateral flexion, axial rotation, flexion-extension, and anterior-posterior translation. The PosturePrint system requires 14 reflective markers to be placed on the subject (mannequin) during photography and 15 additional "click-on" markers via computer mouse before a set of three photographs is analyzed by the PosturePrint computer system over the Internet. The PosturePrint algorithm returns an analysis of the head, rib cage, and pelvis in three dimensions as rotations (degrees) and translations (millimeters).

## RESULTS

Average absolute value errors were obtained by comparing the exact inputted head postures to the PosturePrint's computed values. Mean and standard deviation of computational errors for sagittal displacements were flexion-extension =  $1.3^\circ \pm 0.6^\circ$  and anterior-posterior translation = 1.1 mm  $\pm 0.5$  mm, and for frontal view displacements they were axial rotation =  $1.1^\circ \pm 0.7^\circ$ , lateral flexion =  $0.6^\circ \pm 0.4^\circ$ , and lateral translation = 1.1 mm  $\pm 0.5$  mm.

## DISCUSSION

In previous postural studies, very few of the 12 movements of the head have been measured. Predominantly, forward and backward translations and flexion/extension of the head are measured as part of a postural analysis. Importantly, axial rotation is a degree of freedom of the head that is commonly measured for its range of motion and spinal coupling (vertebral displacement) pattern. To our knowledge, previous reports have presented neither a method to extract a value of axial rotation nor a value of other rotations and translations of a subject's head from photographs. Currently, upright posture evaluation is recommended as part of a comprehensive but focused spine-related physical examination of the cervical spine. Despite this, static postural displacements of the head on photographs has not been measured accurately in the AP view as a displacement within the range of motion. Our study provides a method of objective measurement of the rotational and translational degrees of freedom for the human head; therefore, improvement or worsening of a patient's condition can be reliably documented. The PosturePrint system is accurate in measuring head postures in 5 degrees of freedom. Because this system allows for accurate postural measurement as rotations and translations, statistical research determining the correlation between head postural displacements, neck pain, function, and health status can be performed. Furthermore, documentation as to the incidence/prevalence and magnitude of human head postural displacements can be obtained in both normal and pain populations.

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# National Public Health Week One Chiropractic College's Community Intervention to Promote Healthy Aging

**Julie Johnson, D.C., and Lisa Zaynab Killinger, D.C.,** Palmer College of Chiropractic

The American Public Health Association (APHA) sponsors the national observance of National Public Health Week (NPHW) each April. In 2005, the NPHW theme was Healthy Aging, and educational institutions, public health workers, health professionals, and health advocates were encouraged to sponsor, promote, and implement events focusing on health strategies for aging Americans. This NPHW project was designed at one chiropractic college to empower and educate the community's aging population by improving health care collaboration and providing relevant information regarding health, chiropractic, and quality of life issues in aging. The purpose of this paper is to present the steps taken to successfully plan and implement this project, details about the programs offered during the NPHW events, and results of this project in the community.

## METHODS

In April 2005, the authors' chiropractic college co-sponsored a series of community-based events in observance of NPHW. This activity required financial support from the institution's administration and faculty and staff resources to design and implement NPHW events. The authors championed this effort and organized a series of community-based educational programs in collaboration with numerous community partners, including a local visiting nurses association, a local radiology group, aging services organizations, health and legal professionals, and several age-related community businesses. NPHW partners were also surveyed as to their satisfaction regarding the collaboration and the events themselves.

## RESULTS

Topics addressed in the NPHW educational sessions included alternative healing, healthy eating, exercise and aging, health promotion and prevention, legal issues (such as

durable power of attorney and living wills), financial fitness (retirement planning), oral health and aging, and adult day care. In addition to the educational components of NPHW events, complimentary health screenings were offered through the local hospital and nursing associations, the chiropractic college, a radiology group, and a mental health center. Additionally, a mini-computer course was offered to assist elderly citizens in identifying evidence-based resources through the Internet.

Approximately 200 persons attended the NPHW programs. Subsequent to the events, a write-up about this chiropractic-sponsored public health educational program was featured on the NPHW Web site, and in the *Nation's Health* newspaper with a readership of over 60,000. These articles and events showed chiropractic in a favorable light, taking the lead in the public health effort in this community-based program. Responses to the participant and partner surveys will be summarized in this presentation.

## DISCUSSION

No large-scale, community-based NPHW events have been previously implemented by chiropractic colleges. This project offered an opportunity for our chiropractic college to experience a community partnership with a local hospital for the first time and it forged the establishment of numerous community partnerships that have led to additional opportunities for the enrichment of the citizens of the Quad City Area. It also provided an opportunity for our students to take part in a major community event and to learn about the health and wellness of an ever-growing aging population.

Although institutional resources can be a barrier to implementing such community-based programs, by identifying willing community partners, the costs and staffing burden can be reduced for the sponsoring chiropractic college. In this case, 26 organizations participated, offering time, expertise, staffing, financial resources, speakers, educational materials, and give-aways. Additionally, relevant governmental health organizations offered large quantities of free materials to

provide depth and breadth to the educational component of these community-based events. This observance was a unique opportunity for health care partnership in the local community. It benefited not only the aging in the community, but

also strengthened relationships between organizations serving the needs of the aging population. It is hoped that in future years, additional chiropractic colleges will sponsor NPHW events in their communities.



## The Effect of Line of Drive on Vertebral Acceleration

**Gregory N. Kawchuk**, B.Sc., D.C., M.Sc., Ph.D., University of Alberta, and **Stephen M. Perle**, D.C., M.S., University of Bridgeport

Chiropractors have professed that the line of drive should be matched to the plane of the target vertebra's facet joints. Although this approach has been taught and employed by chiropractors for decades, the authors are unaware of any data to support this rationale. This rationale has been challenged by a recent study that measured loads and displacements at the skin. Findings indicated that the skin-fascia interface is frictionless, implying that only normal forces are transmitted to the vertebra below. It was concluded that a manipulative thrust in any direction other than normal to the skin would result in a reduced force transmitted to the vertebra. This hypothesis was not confirmed by measuring the effect of non-normal forces on a vertebra directly. The purpose of this study was to determine the resulting acceleration response of a single vertebra to manipulative forces varying in their line of drive.

### METHODS

A porcine thoracic spine was mounted to bookend supports by stripping the pedicles, ribs, and all soft tissues from the terminal vertebrae to leave the remaining vertebrae suspended horizontally. A triaxial accelerometer was affixed to the middle vertebrae with the x-axis oriented superior/inferior, the y-axis medial/lateral, and the z-axis posterior/anterior. An Air Activator fitted with an in-series load cell was then used to apply 10 thrusts of increasing force to the skin over the spinous process of interest. Sampling rate was 50,000 Hz. From these data, a reference plot of input force versus resulting z-axis acceleration was created. Ten maximum force applications were then applied to the same spinous at 23.5°, 45°, -23.5°, and -45° in the x-axis. For each different line of drive application, the theoretical z-axis force was computed by multiplying the cosine of the angle by the recorded force. The experimental z-axis force was determined by taking the z-axis acceleration resulting from each angulated force application and then computing the z-axis input force from the reference plot.

### RESULTS

For the lines of drive of 23.5°, 45°, -23.5°, and -45°, the z-axis and x-axis vertebral accelerations were always less than those obtained from a line of drive of 0°. For lines of drive of 23.5°, 45°, -23.5°, and -45°, the mean percentage difference between the theoretical and experimental forces was -9%, -3%, -4%, and -6%, respectively.

### DISCUSSION

Errors of less than 10% between the theoretical and observed forces support the hypothesis under consideration. Additional support comes from the observation that as the angle of applied force increased from the vertical, the acceleration of the vertebra in the z- and x-axes never increased beyond acceleration values obtained at 0°. Therefore, at angles other than 0°, there is no continuation of force along the line of drive when a frictionless system is interposed between the point of force application and the vertebral target.

### CONCLUSION

When a frictionless tissue system underlies a point of force application, any change in the line of drive from one that is perpendicular to the skin results in a predictable decrease of force acting to accelerate the vertebra. The force lost in the z-axis is not recovered in the direction of the line of drive. In other words, when there is soft tissue between the point of contact and the target vertebra, line of drive in a manipulation greater than 0° is irrelevant to vertebral motion and serves only to decrease the force applied by the practitioner.



# Three-Dimensional Intersegmental Motion Validation of Mechanical Force Spinal Manipulation

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Spinal manipulation has been found to create demonstrable intersegmental spinal motions thought to be biomechanically related to its mechanisms. In device comparisons, significant differences in the force-time characteristics of spinal manipulative instruments have also been reported. Validation of these findings in spinal specimens, however, has not been conducted. The purpose of this study was to quantify and compare the three-dimensional intersegmental motions among three commonly used chiropractic adjusting instruments. The study was performed at the Institute for Medical and Veterinary Science, Adelaide, Australia.

## METHODS

Six adolescent Merino sheep were examined. In all animals, triaxial accelerometers were attached to intraosseous pins rigidly fixed to the L1 and L2 lumbar spinous processes under fluoroscopic guidance. Three hand-held mechanical force chiropractic adjusting instruments (Chiropractic Adjusting Tool [CAT], Activator Adjusting Instrument IV [Activator IV], and the Impulse Adjusting Instrument [Impulse]) were used to randomly apply posteroanterior spinal manipulative thrusts to the spinous process of T12. Three force settings (low, medium, and high) and a fourth setting (Activator IV only) were applied in a randomized repeated measures design. Acceleration responses in adjacent segments (L1, L2) were recorded at 25 kHz, and the three-dimensional intersegmental segmental (L1–L2) acceleration transfer at each force setting was computed and compared among devices using a repeated measures analysis of variance (ANOVA,  $\alpha = .05$ ).

## RESULTS

Intersegmental acceleration responses mirrored the peak force magnitude produced by each adjusting instrument.

For all devices, intersegmental accelerations were greatest for axial, followed by posteroanterior and medial-lateral measurement axes for the data examined. Compared to the mechanical (spring) adjusting instruments (CAT, Activator IV), the electromechanical Impulse Adjusting Instrument was found to produce the most linear increase in both force and intersegmental motion response. Intersegmental motions were similar when comparing the spring-loaded devices, Activator IV and CAT, for most force settings and axes examined. Significantly larger magnitude intersegmental motions were observed for Activator IV over CAT at the medium setting and setting 4 ( $p < .05$ ). Significantly larger magnitude posteroanterior and medial-lateral intersegmental motion responses were consistently observed for Impulse over Activator IV and CAT for nearly all medium- and high-force settings examined ( $p < .05$ ) measuring nearly 2- to 3-fold larger in some cases.

## CONCLUSION

Larger magnitude three-dimensional intersegmental motion responses were observed for spinal manipulative thrusts delivered with Impulse for nearly all force settings examined. Knowledge of the vertebral motion responses produced by hand-held chiropractic adjusting instruments assists in understanding biomechanical responses and supports the clinical rationale for patient treatment using instrument-based adjustments. Our results indicate that the force-time characteristics of impulsive-type adjusting instruments significantly affects spinal motion, and suggests that instruments can and should be tuned to provide optimal force delivery.



# Healthy People 2010 Chiropractic Clinical Teaching Faculty Knowledge, Perceptions, and Plans of Action

**Lisa Zaynab Killinger, D.C., and Julie Johnson, D.C.,** Palmer College of Chiropractic

In chiropractic education and practice, we have many opportunities to play an active role in promoting the Healthy People 2010 objectives. Through active participation in accomplishing the goals set forth in Healthy People 2010, chiropractic may better serve the health care needs of patients and the nation. Over the past 2 years, the National Board of Chiropractic Examiners has worked collaboratively with chiropractic teaching faculty and wellness and prevention experts to incorporate relevant components of the Healthy People 2010 document into the chiropractic board examinations.

## OBJECTIVES

In this project, the authors set out to assess the knowledge and perceptions of their chiropractic clinical teaching faculty regarding the Healthy People 2010 document and its goals. They also assessed which focus area of the Healthy People 2010 goals was most important in the minds of their chiropractic clinical teaching faculty and what action steps the faculty would propose for incorporating Healthy People 2010 into the chiropractic clinical teaching setting.

## METHODS

A review of the Healthy People 2010 document and related chiropractic literature was performed and utilized by the authors to identify several main Healthy People 2010 focus areas particularly relevant to chiropractic education and practice. A review of chiropractic and general health professions literature on health promotion, prevention, and aging-related Healthy People 2010 objectives was also performed to provide the necessary context for developing an appropriate educational intervention and assessment. Expert opinion of other chiropractic researchers related to the topic of Healthy People 2010 was also utilized in identifying focus areas and developing an educational intervention.

A PowerPoint presentation was subsequently developed to offer background information on Healthy People 2010 to chiropractic clinical teaching faculty. An assessment and “turn-in assignment” was built into this presentation to allow

the chiropractic clinical teaching faculty to express their perceptions and prior knowledge of Healthy People 2010 and to state which focus areas of Healthy People 2010 they felt were most important and practical for implementation in the chiropractic teaching clinic setting.

No identifying information was shared with the primary author, and the author did not participate in the educational intervention, so as not to bias the results of the assessment. The data, descriptive in nature, were reviewed and compiled by the authors.

## RESULTS

The literature search and expert opinion identified several main focus areas of the Healthy People 2010 that were particularly relevant to chiropractors in the clinical education setting. These included physical activity recommendations, overweight/obesity management, nutrition recommendations, injury prevention (especially in children and the elderly), and tobacco use cessation.

Thirty-three clinical faculty members attended the presentation, and all completed the assessment and offered written comments about the topic. Of the five priority areas in this project, most chiropractic clinicians who chose a specific topic selected physical activity as the most important and practical for implementation to incorporate in the chiropractic clinical teaching clinic setting. This is important to note, because physical activity may be the single most important lifestyle recommendation to help patients achieve better health.

## DISCUSSION

In this project the authors learned that most chiropractic clinical teaching faculty (at the institution surveyed) are not prepared to help implement the Healthy People 2010 goals because of a lack of familiarity with the Healthy People 2010 document. However, they also found that once the concepts of Healthy People 2010 were introduced to faculty, and examples of practical implementation steps given, most faculty members were willing to incorporate Healthy People 2010 into the clinical education setting.



# Developing a Spinal Health Promotion Initiative Use of an Expert Seed Panel and Electronic Delphi Consensus Process

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Slouched posture is linked to many spinal disorders and is becoming pandemic in technologically advanced countries. Individuals in technologically advanced countries are also becoming increasingly sedentary in terms of lifestyle, contributing to skyrocketing levels of obesity, which has been linked to spinal disorders. In response to these problems, experts in the field of health promotion and spinal rehabilitation decided to develop a spinal health promotion exercise module for the public. The objectives included developing a short set of simple, engaging, postural improvement and spinal health exercises and obtaining buy-in and acceptance from the profession's leaders, practitioners, and the public.

## METHODS

A consensus-based seed and Delphi panel process was utilized for exercise module development. Because of the impact of health habits on spinal disorders, lifestyle improvement recommendations also were incorporated as part of the spinal health initiative. A Delphi process expert was invited to help structure the module development process. A small group of health care practitioners with expertise in spinal health promotion and rehabilitation formed the seed panel to create a pilot exercise module. Seed panel members included individuals with diverse backgrounds and areas of expertise with strong international reputations lending credibility to the development process. Zoomerang electronic e-mail surveys were chosen to facilitate pilot exercise module development. Using a series of electronic surveys, the seed panel shaped a short engaging set of standing spinal exercises aimed at improving posture and enhancing core stabilization. The seed panel also named the spinal health program "Straighten Up America" through a voting process and developed a short set of accompanying healthy lifestyle recommendations. Simultaneous with the creation of the pilot module and lifestyle recommendations, a 90-member Delphi panel was assembled, including many of the presidents and clinic directors of the ACC colleges; researchers; international, national, and state chiropractic organization leaders; World Health Organization representatives; exercise physiologists; fitness experts; and

fitness champions. Utilizing Zoomerang electronic surveys, Delphi panelists voted on adoption of the individual slides of the module exercises and lifestyle recommendations. Slide adoption agreement level was set at 75%. In addition to adopting the exercises, the Delphi panelists provided very valuable feedback and refinements on the formatting and presentation of the program. The spinal exercise module was then presented to chiropractic college students and senior citizens for user feedback.

## RESULTS

The seed and Delphi panels created and refined a simple set of postural improvement and spinal health exercises that has been broadly embraced by leaders and practitioners of the chiropractic profession in the United States and abroad. The exercise module has been presented and embraced widely in venues across the chiropractic profession. The program is currently being reviewed by the U.S. Congress for appropriations funding as a national health initiative. Analysis of user feedback surveys from pilot class participants indicates that practicing the module regularly is useful for facilitating perceived levels of postural improvement and enhancing levels of spinal comfort.

## DISCUSSION AND LIMITATIONS

Project objectives have been met with a high degree of success. It would have been optimal to have a longer period of time to create the spinal exercise module and lifestyle recommendations. The Straighten Up America spinal exercise module and lifestyle recommendations are serving as simple enjoyable patient-active tools to facilitate improvement of posture and to promote habituation of positive spinal health behaviors. The vast majority of the state, national, and international chiropractic organizations and the profession's academic institutions are demonstrating enthusiastic support for the program.



# Applying Generalizability Theory to High-Stakes Objectively Structured Competency Examinations in a Naturalistic Environment

**Douglas M. Lawson**, B.A., D.C., M.Sc., Ph.D., University of Calgary

Objectively structured competency examinations (OSCEs) are commonly used for licensure decisions and competency assessments. OSCEs have many sources of variance (candidates, raters, patients, and stations). Generalizability theory (G-theory) has been applied to OSCEs in artificial environments where raters are aware that their scores will be compared with others. Because of the high cost of using multiple raters, G-theory is generally applied as a “pilot project” with a small number of candidates, raters, and cases. The artificial environment (in comparison with high-stakes OSCEs) makes it difficult to generalize the results of the pilot project to the actual testing setting (a naturalistic environment). The purpose of this project was to determine if G-theory could be successfully applied to a high-stakes, licensure OSCE as part of its normal administrative procedures and whether the analysis could yield useful information with regard to sources of variance.

## METHODS

The anonymous data received from the Canadian Chiropractic Examining Board for its June 2005 clinical skills examination were analyzed with G-theory. Variance components were estimated with SPSS 11.5 as partially nested data. The data included 182 candidates, 43 raters, 40 standardized patient actors, and 18 individual cases. The examinations were administered twice per day for 2 days, with four parallel tracks of 10 stations each. Raters filled in checklists in each station using three ratings scales: 14–16 3-point rating scales (0 = not performed, 1 = performed but not correctly, 2 = performed correctly), a 5-point rating scale on professionalism, and a 10-point rating scale on overall technique. Both the professionalism scale and overall technique scale were anchored at the borderline pass and borderline fail levels.

## RESULTS

Both days of testing resulted in high measures of internal consistency (alpha day 1 = 0.86, day 2 = 0.91). Internal consistency measures for each individual station averaged alpha = 0.68 for day 1 and 0.74 for day 2. Generalizability coefficients for the day 1 stations averaged 0.63 and the generalizability coefficient for the day 1 examination was 0.65. Generalizability coefficients for the day 2 stations averaged 0.74 and the generalizability coefficient for the day 2 examination was 0.42. On day 1, the raters contributed 7% of the variance of candidate measures, and the standardized patients contributed 1%. On day 2, the raters contributed 8% of the variance of candidate measure, and the standardized patient measures could not be estimated.

## DISCUSSION

The application of G-theory in the naturalistic environment can contribute to the understanding of sources of variance and provide direction for the improvement of individual stations. D-Studies can be used to determine the effect on reliability of using multiple raters in a room. The size of the rater variance in a station may also indicate the need for increased training in that station or the need to make the scoring checklist more clear and definitive. G-theory, however, must be cautiously applied, and requires careful selection of the floating raters and vigorous training of the raters in each station.



# Applying Structural Equation Modeling to Canadian Chiropractic Examining Board Measures

**Douglas M. Lawson**, B.A., D.C., M.Sc., Ph.D., University of Calgary

Since 1962, the Canadian Chiropractic Examining Board (CCEB) has been evaluating chiropractors desiring to practice in Canada. The examinations currently include the

written examinations, the clinical skills examination, and a practitioner assessment examination. Structural equation modeling (SEM) combines models and methods from

econometrics, psychometrics, sociometrics, and multivariate statistics. SEM is a theory-rich approach to multivariate analysis and focuses on hypothesis testing of a structural theory as it applies to some phenomenon. The purpose of this research project was to determine whether SEM can be successfully applied to the CCEB measures to explore the inferential nature of the "causal" relationship between academic ability and success on the CCEB examinations, specifically the ability to make correct clinical decisions (diagnosis and management).

## METHODS

Data were supplied by the CCEB and consisted of anonymized data from 292 candidates for its March and June 2004 clinical skills examinations. There were six data variables provided by the CCEB: standardized scores for the basic science, applied science, clinical decision making, and objectively structured competency examinations. The last two variables were undergraduate grade point average and chiropractic college grade point average. As this was a time-series study (undergraduate grade point average to licensure examination data), a latent variable path analysis was the SEM method of choice. The theoretical model proposed that: 1) a latent trait called Academic Ability had a causal relationship to another latent trait called Professional Knowledge, and 2) that the latent trait Professional Knowledge had a causal relationship to a third and final latent trait called Clinical Reasoning Ability. The model to data fit was analyzed with EQS version 6.1 (B83).

## RESULTS

The comparative fit index (CFI) for the model to data fit was 0.98. All but one path coefficient were higher than 0.40. From Academic Ability to Professional Knowledge, the path coefficient was 0.84. From Professional Knowledge to Clinical Reasoning Ability, the path coefficient was 0.88. The path coefficients from the observed variables reveal that

the weakest path coefficient was between Applied Science and Clinical Reasoning Ability (0.24). The Clinical Decision Making variable had a much stronger path coefficient to Clinical Reasoning Ability (0.81).

## DISCUSSION

A CFI of 0.98 indicates that there was a strong fit of the data to the theoretical model. The strong path coefficients between latent variables infer that if chiropractors with strong Clinical Reasoning Ability are desired, then students should not move from the 2nd year of their education unless they have demonstrated a substantial grasp of underlying concepts. Further, in order for students to be able to achieve a large measure of the latent trait Professional Knowledge, they should enter the chiropractic education process with a large measure of the latent trait Academic Ability. The weak path coefficient from Applied Science to Clinical Reasoning Ability infers that the five-option short-format clinical vignette questions on the applied science examination are not as good a measure of the latent trait Clinical Reasoning Ability as is the 26-option long-format clinical vignettes from the clinical decision making examination.

## CONCLUSION

Structural equation modeling, in the form of a latent variable path analysis, can be successfully applied to data from the Canadian Chiropractic Examining Board. There is acceptable model to data fit, and inferences can be made from the data. These inferences include the need to recruit students with strong academic abilities, the need to hold back students who have not achieved a high level of understanding of the first 2 years of work at chiropractic college, and that the extended-matching, long-format questions are a better estimate of clinical reasoning ability than five-option short-format questions or the objectively structured competency examination.



# Predictors of Performance of Students From the Canadian Memorial Chiropractic College on the Licensure Examinations of the Canadian Chiropractic Examining Board

**Douglas M. Lawson**, B.A., D.C., M.Sc., Ph.D., University of Calgary, and **Hettie Till**, M.Sc., M.Med.Ed., D.Ed., Canadian Memorial Chiropractic College

There is very little evidence that the admission interview is able to predict success in a chiropractic program and

personal statements are also somewhat meaningless, especially if applicants can mail them in. Only undergraduate

grade point average (UGPA) and the MCAT have been shown to be predictors of success in medical school. Regardless, members of interview committees stoutly defend the process on the basis that they are measuring something else (e.g., “the fire in a candidate’s belly”). Evidence does exist, however, that personality traits such as conscientiousness may predict performance in medical school. The purpose of this study was to determine if variables from the admissions process at the Canadian Memorial Chiropractic College (CMCC) and/or CMCC examinations predict the performance of students on the licensure examinations from the Canadian Chiropractic Examining Board (CCEB).

## METHODS

After ethics approval from both CMCC and CCEB, data from one cohort of students were used, including preregistration information and all results from CMCC as well as CCEB exams. An independent researcher combined the data by student name and then anonymized the data and destroyed the linking information. Variables from CMCC included in the analysis were admission interviews, UGPA, chiropractic college grade point average (CGPA) for 4 years, 3rd-year objectively structured competency examination (OSCE) theory, 3rd-year OSCE practical, and 4th-year mid-term and final exams. The CCEB supplied outcome measures of basic science, applied science, clinical decision making, and clinical skills examinations. Gender, ethnicity, and UGPA (converted to a University of Calgary 4-point scale) were also considered. For each outcome variable, a backward stepwise multiple linear regression was performed.

## RESULTS

After nine iterations, 40% of the variance in the basic science examination ( $R^2 = 0.405$ ) was explained by the independent variables (predictors) of 3rd-year OSCE practical

and 2nd-year CGPA (in order of importance). After seven iterations, 45% of the variance in the applied science examination ( $R^2 = 0.448$ ) was explained by the 4th-year final exam, and CGPA for years 4, 2, and 3. After nine iterations, 24% of the variance in the clinical decision making examination ( $R^2 = 0.239$ ) was explained by CGPA of years 4, 1, 2, and 3. After nine iterations, 16% of the variance in the clinical skills examinations ( $R^2 = 0.160$ ) was explained by the 3rd-year OSCE theory and CGPA for year 2.

## DISCUSSION

This study is limited by its small sample size. Data over a number of years should be combined for a more effective study. In addition, multiple regression does not take into effect the timeline, and with a larger study a latent variable path analysis might be more meaningful and reveal the impact of UGPA and year 2 CGPA on the other variables. The admission interview was not a predictor of success on any of the outcome variables. The CGPA from year 2 was a predictor for all outcome variables. This infers that the knowledge and skills gained in years 1 and 2 are critical in the educational process of chiropractic students and that later success hinges on a student’s ability to perform well in the first 2 years.

## CONCLUSION

The admissions interview is not a predictor of success on the outcome measures of the CCEB. Student CGPA in year 2 is critical to success on CCEB licensure examinations. This information infers that students should only continue in their education after they have demonstrated a mastery level at the end of year 2. This is the first group project where data from CMCC were combined with CCEB outcome measures. It appears that the cooperation was successful and should continue.



# Measurement of In Vivo Lumbar Intervertebral Disc Pressure During Spinal Manipulation

## A Feasibility Study

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HVLA spinal manipulation is commonly used in the treatment of low back disorders. However, little is known of its biomechanical effects on the lumbar intervertebral disc. The purpose of this study was to measure lumbar intervertebral disc pressure in vivo before, during, and after high-velocity, low-amplitude (HVLA) spinal manipulation.

### METHODS

This study was reviewed and approved by the Institutional Review Board of the Palmer Center for Chiropractic Research. A pressure transducer was inserted into the nucleus pulposus of one normal-appearing lumbar disc (L3–L4) in an asymptomatic adult volunteer. Pressures were recorded during several body positions and maneuvers, then during the application of HVLA spinal manipulation, and finally during a repetition of the preintervention body positions.

### RESULTS

Baseline pressures in the prone and side-lying positions measured 110 kPa and 150 kPa, respectively. Pressure in

the manipulative position prior to thrust measured 500 kPa. During the manipulative thrust, the pressure rose to a peak of 890 kPa over 250 ms. Immediately following the thrust, pressures in the prone and side-lying positions measured 150 and 165 kPa, respectively.

### CONCLUSION

The peak pressures measured during the manipulation positioning and thrust were similar to pressures previously measured for sitting unsupported and sitting flexed, respectively. Measuring lumbar intervertebral disc pressure in vivo during HVLA spinal manipulation is technically possible and may lead to a better understanding of this treatment method.

### ACKNOWLEDGMENT

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# Quantifying Osteoarthritic Changes of the Zygapophysial Joints From X-Rays

## A Reliability Study

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Degeneration of the zygapophysial (Z) joints has been associated with back pain. In addition, the Z joints are

also structures significantly affected by spinal manipulation. Z joint degeneration can be evaluated on standard

radiographs if the appropriate views are used. At the present time, no 5-point scale for grading the severity of Z joint degeneration has been found to be reliable. A reliable grading scale could be implemented in future studies by examining the mechanism of action of the chiropractic adjustment and by comparing these studies with animal studies assessing spinal degeneration with induced hypomobility. The purpose of this study was to evaluate the reliability of a 5-point scale for grading degenerative changes of the lumbar zygapophysial joints from standard radiographs.

## METHODS

A modified protocol for Kellgren's classification of degenerative changes of the Z joints was evaluated for reliability in the lumbar spine. Seventy-nine individual Z joints were independently graded by two primary examiners on two separate occasions separated by 3 weeks. A third examiner (a radiologist) was also used as an expert for interrater reliability comparisons between measurements made in sessions 1 and 2 for both primary examiners. Percent agreement and weighted Kappa scores (KW) were calculated to determine interrater and intrarater reliability.

## RESULTS

Interrater agreement between examiner 1 and 2 was  $KW = 0.60$  with 49.4% perfect agreement (39 levels) and 40.5% one grade difference (32 levels), for a total of 89.9% agreement within one grade. Intrarater agreement was lower than interrater agreement. Examiner 1 ( $KW = 0.42$ ) demonstrated 39.2% perfect agreement (31 levels) and 40.5% agreement with one grade difference (32 levels), resulting in 79.7% agreement within one grade. Examiner 2

( $KW = 0.54$ ) demonstrated 33.75% perfect agreement (27 levels) and 52.5% agreement with one grade of difference (42 levels), for a total of 86.25% agreement within one grade.

Interrater reliability was also evaluated and compared for both grading sessions of examiners 1 and 2 with examiner 3. In session 1, agreement was  $KW = 0.37$ , with 61.9% agreement within one grade (27.8% perfect agreement) for examiner 1 and examiner 3, and  $KW = 0.39$  with 69.5% agreement within one grade (16.4% perfect agreement) for examiner 2 and examiner 3. Session 2 revealed  $KW = 0.57$ , with 94.9% agreement within one grade (perfect agreement 32.9%) for examiner 1 and examiner 3, and  $KW = 0.68$  with 94.9% agreement within one grade (50.6% perfect agreement) for examiner 2 and examiner 3. The average KW for session 2 was 0.63, which is a substantial strength of agreement.

## CONCLUSION

The modified Kellgren 5-point grading system used in this study provides acceptable intra- and interrater reliability when observers are adequately trained. The modified Kellgren grading system may be a useful method for future investigations assessing the relative degeneration of the Z joints in research subjects and may also be useful in assessing Z joint degeneration in back pain patients.

## ACKNOWLEDGMENTS

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## Social Communication Skills of Chiropractors Implications for Professional Practice

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Social communication skills are essential in the health professions. Effective communication can facilitate patient-centered exchange of ideas, opinions, options, and decisions regarding management, enabling full participation of patients in the process of healing. This exploratory study focuses on

social communication skills of practicing chiropractors. The goal of this research is to evaluate potential associations between contextual variables of professional practice and chiropractor's skills of social communication, the response variable.

## METHODS

The study sample represents volunteers from a population of Doctors of Chiropractic who currently participate in a practice-based research program. Participating chiropractors ( $n = 72$ ) agreed to complete a survey detailing provider-based variables of social communication (using Reggio's six-dimension social skills inventory [SSI] instrument), gender, age, and number of years in clinical practice. Practice-based variables were collected from a survey completed by the chiropractors' office staff and included measures of the size of the community, group vs. solo practice, and practice volume. Following the formulation of descriptive statistics, Pearson's correlation and regression analysis were applied to assess for significant associations between the response variable of doctor communication and the predictor and control variables obtained from the survey instruments.

## RESULTS

The weekly volume of patients to the practice emerged as a salient explanatory factor of overall social communication

skills, and as a factor individually for dimensions of social expressivity and social control. The practice arrangement (solo vs. group) proved important in terms of respondent emotional control dimension of communication. Similarly, the solo vs. group practice variable was associated with higher levels of emotional sensitivity. However, this association was mediated by the chiropractor's gender, with men reporting lower levels of emotional sensitivity than women.

## DISCUSSION

Results suggest that selected characteristics of clinical practice may be associated with the clinician's social skills of communication. The findings of this research suggested associations between dimensions of social communication skills, practice characteristics, practice arrangements, and gender that may inform the efforts of educators as they endeavor to better prepare health professionals for practice in a wide spectrum of settings.



# Clinical Assessment and Rehabilitation of a Stroke Patient

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New York Chiropractic College

The purpose of this study was to determine the efficacy of 6 weeks of chiropractic treatment for a 59-year-old male, poststroke patient with hemiparesis of 18 months duration.

## CLINICAL FEATURES

A 59-year-old male suffered a stroke on 1/13/04. The patient presented to the clinic on 7/11/05 for rehabilitation and restoration of motor function, strength, and proprioception. Cervical radiographs, a consultation with a psychoneurologist, and an MRI were obtained.

## INTERVENTION AND OUTCOME ASSESSMENTS

The treatment protocol consisted of full-spine diversified chiropractic manipulative therapy and electrical stimulation (Russian therapy). The functional rehabilitation consisted

of proprioceptive neuromuscular facilitation (PNF) patterns, modified Rhomberg's position, treadmill, and a maze setup to assess neural task systems. The patient received clinician-supervised chiropractic treatment along with functional rehabilitation four to five times per week for 6 weeks along with home exercises. Chiropractic treatment included singular applications of judicious cervical spine adjustments in lateral flexion of the middle cervical spine, the thoracic spine, the lower extremities (femoral-acetabular, ankle mortise joints, and metatarsal interphalangeal joints bilaterally), and the upper extremity (radial-ulnar, midcarpal, and metacarpophalangeal joints bilaterally). Baseline and postintervention assessments included tandem walk, heel/toe walk, modified Rhomberg's position, grip strength with a dynamometer, dexterity proprioception, can stacking, and PNF patterns.

## RESULTS

Objective improvements were seen in tandem walk and heel/toe walk. Video analysis revealed the patient's inability to initiate and terminate movements at baseline, and marked

improvement after treatment. Modified Rhomberg's position was sustained for longer duration. Grip strength of the right hand measured 5 pounds of pressure baseline and improved to 13 pounds of pressure after treatment. Dexterity proprioception was improved after treatment, demonstrated on video analysis. PNF patterns improved after treatment, with decreased apraxia, increased strength, and improved rebound ability.

## DISCUSSION

Brain reorganization after stroke and determining whether specific rehabilitative techniques can stimulate brain plasticity, thereby improving motor function and decreasing

disability, are active areas of scientific research. The restorative processes occurring in the brain after stroke are still not fully understood. This case study may open the door to further research into the influence of chiropractic care on the central nervous system, and ultimately allow chiropractic to emerge as an integral component in the treatment of the hemiparetic stroke patient. Improvement in overall function of this poststroke patient was achieved through full-spine chiropractic treatment and functional rehabilitation. The importance of a thorough neurological workup with appropriate referral cannot be overemphasized, as well as a comprehensive physical examination. It is feasible to treat poststroke patients with hemiparesis conservatively with chiropractic full-spine adjusting to improve overall function of strength and motor capabilities. The long-term effects of treatment were not assessed.



## Success in Chiropractic Practice Phase II A Practitioner-Based Survey

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This study developed and performed preliminary tests on a 57-item survey instrument to operationalize outcome (dependent) and potential antecedent (independent) variables capturing the complex notion of "success" in chiropractic practice. Following up on an earlier study that used an open-ended survey format to explore potential variables, this study developed an instrument with face validity for four outcome and 15 antecedent variables, then tested it on a sample of alumni of a chiropractic college.

## METHODS

The four outcome variables were income, patient volume, patient retention, and low job stress. The antecedent variables studied were the ability to analyze the spine well, the ability to smoothly run practice operations, the chiropractor being sincere to patients, the chiropractor's ability to correct subluxations, the ability to educate patients capably, having an effective fee system, having a family emphasis in practice, the chiropractor having an advanced knowledge set, the chiropractor having a "good" personality, being able to satisfy patients, the chiropractor being "on purpose," getting symptomatic results, the chiropractor having good "sales" skills, having a service ethic, and having an effective staff. Descriptive statistics were generated. In addition, reliability of the instrument was explored by calculating Cronbach's alpha for each variable. Pearson's correlations coefficients were calculated to explore potential causality and to rule out multicollinearity.

In addition, 12 hypotheses were developed using the variables. The hypotheses are testable empirically, using the instrument as developed and employing either multiple regression or structural equation modeling to understand more explicitly the sources and outcomes of success in practice. The hypotheses are as follows:

Hypotheses 1–3: There is a statistically significant positive relationship between each of the three business acumen variables (level of satisfaction with educational preparation to have smooth clinic operations, an effective staff, and an effective fee system) and financial success.

Hypothesis 4: There is a statistically significant positive relationship between the level of satisfaction with the educational experience to prepare the respondent to communicate well with patients and patient volume.

Hypothesis 5: There is a statistically significant positive relationship between the level of perception of a doctor having a good personality and patient retention.

Hypotheses 6–8: There is a statistically significant positive relationship between the level of satisfaction with the educational experience to prepare the respondent in knowledge (hypothesis 6), clinical skills (hypothesis 7), and getting good symptomatic results (hypothesis 8) and practice volume.

Hypotheses 9 and 10: There is a statistically significant positive relationship between the level of commitment to chiropractic (hypothesis 9) and having a service ethic in practice (hypothesis 10) and patient volume.

Hypothesis 11: There is a statistically significant negative relationship between the level of stress in practice and being successful financially.

Hypothesis 12: There is a statistically significant positive relationship between the level of clinical skills and getting good symptomatic results in practice.

## RESULTS

There were 600 surveys distributed, and 239 completed surveys were received. Completed surveys were analyzed for basic statistical characteristics.

## DISCUSSION

This study has extended earlier work in moving toward a valid and reliable, generalizable survey instrument to measure the degree of success in chiropractic practice, and to identify potential antecedent variables. The results are of interest to chiropractic educators and others whose interest lies in equipping practitioners with sufficient skills to succeed in practice.



# Radiographic Variability of the Intercrestal Line

Linda Mullin, D.C., Life University

Palpation is a fundamental part of chiropractic practice, commonly used to identify specific vertebral levels in the spine. The top of the iliac crests is a landmark generally used to locate the spinous process of L4 or the interspinous space of L4/L5. Although palpation is widely used, studies have shown only minimal concordance and it has been suggested that misidentification of the exact segmental level may be a primary source of interexaminer error in reliability studies on motion palpation. The purpose of this study is to document the radiographic variability of the intercrestal line to the lumbar spine in order to evaluate its use as a reliable landmark.

## METHODS

Four hundred and one full-spine (14 × 36) anterior to posterior (AP) and lateral radiographs were reviewed following a prospective approval by Life University's Institutional Review Board committee. The iliac crests were identified on the AP radiograph and marked with a line drawn across the film connecting the right and left crest at the superior most margins (intercrestal line). Other findings recorded including the presence of sacralization, lumbarization, spondylolisthesis, or scoliosis in the lumbar spine.

## RESULTS

In this study, 46.6% of the population sample was found to have L4 spinous process on the intercrestal line, while in

21.7% the interspinous space of L4/L5 was located between the crests. Analysis by gender showed that 66.5% of males had L4 identified on the intercrestal line, while only 32.9% of females did. The authors found that although 30.3% of the subjects had an observable lumbar scoliosis, only 2% had a Cobb angle over 10°. Spondylolisthesis was found in 5.7% of the subjects with twice the occurrence in females (69.6%) over males (30.4%). The majority of subjects (90.3%) had five lumbar vertebrae, while 3.2% had only four lumbar vertebrae and 6.5% had six vertebrae.

## DISCUSSION

In this study, almost one third of the subjects had some structure other than L4 or the interspinous space of L4/L5 identified on the intercrestal line. This demonstrates that the chiropractor cannot reliably identify a particular lumbar segment by palpation using the point between the iliac crests alone.

## CONCLUSION

The intercrestal line is not a reliable or specific landmark for identifying the spinous process of L4 or the interspinous space of L4/L5.



# Head Repositioning Errors in Normal Student Volunteers

## A Possible Tool to Assess the Neuromuscular System of the Neck

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A challenge for practitioners using spinal manipulation is identifying when an intervention is required. This study was undertaken to determine whether a proprioceptive test could be applied to the neck as a global measure of neuromuscular function. The goal was to determine whether repositioning errors could be induced based on the thixotropic properties of muscle spindles. Specifically, this study attempts to address the question of whether the mechanical history of cervical paraspinal muscles affects an asymptomatic individual's ability to reposition his/her cervical spine.

### METHODS

This study was reviewed and approved by the Institutional Review Board of the Palmer College of Chiropractic. Participants were volunteers from the student population of a chiropractic college and were screened for incidence of cervical abnormalities. An electrogoniometer was used to measure head position, with a laser pointer used to relocate neutral head position between protocols. A force transducer measured the force of a maximum voluntary contraction with the neck extended 20° or left laterally flexed 25°. Each test began with location of neutral head position with participants' eyes closed. The experimental protocol consisted of a deconditioning sequence of five head nods, followed by one of three conditioning sequences: a "No Hold" conditioning sequence where participants immediately repositioned their heads to neutral; a "Passive Hold" conditioning sequence where participants extended or laterally flexed their necks and maintained that position for 10 seconds; an "Active Hold" conditioning sequence which was identical to Passive Hold and in addition participants contracted their neck muscles for 10 seconds to at least 70% maximum voluntary contraction. Following each conditioning sequence, participants resumed their perceived neutral target position. The difference between the initial and final head orientation was calculated in three orthogonal planes and used as a measure of proprioceptive error. An analysis of variance was used to account for variation between participants and to detect differences in proprioceptive error among the three conditioning sequences. Post-hoc tests (alpha level .05) were used for pairwise comparisons.

### RESULTS

Forty-eight students participated (36 males and 12 females, aged  $28.2 \pm 4.8$  years). During the 20° neck extension test, No Hold and Passive Hold conditioning sequences, evoked AP flexion overshoots of the neutral target position were not statistically different from each other. By contrast, the Active Hold conditioning sequence evoked undershoot of the target position that was significantly different by 2.1° when compared with the other conditioning sequences. During the 25° lateral flexion test, the three conditioning sequences produced no differences in repositioning to the neutral target within the same plane as the test.

### DISCUSSION

The main goal of this project was to investigate a proprioceptive task as an evaluative tool in the cervical spine. The authors found a statistically significant difference in repositioning error in AP flexion during the extension task after isometric muscle contraction for 10 seconds, suggesting that the recent history of cervical paraspinal muscle contraction can influence the ability of participants to reposition their heads to a predetermined target. The condition of muscle shortening by resting the head in an extended position for 10 seconds did not show a different repositioning error from control. Since the examiners were able to elicit a repositioning error in these normal, healthy student volunteers, it raises the question of whether patients with neck pain or signs of vertebral subluxation might show different repositioning errors in terms of magnitude or direction. Patients with vertebral fixation or relative segmental inflexibility might be more prone to the effects of muscle thixotropy and show repositioning errors in response to both the Passive Hold and Active Hold conditions. The next step will be to assess repositioning errors in a population showing clinical signs of joint dysfunction in the neck.



# Using Technology to Engage Faculty in Developing Assessment Outcomes

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Regional and professional accrediting agencies across the country are mandating assessment of student learning with renewed vigor. Demands are increasing on chiropractic colleges to develop more sophisticated means of assessing student accomplishment. Toward this end, a Learning Outcomes Council (LOC) was formed at Palmer College of Chiropractic, charged with creating a meaningful, manageable, and sustainable assessment plan that encompasses student, course, and program level. The 16-member Council is comprised of faculty from the basic and clinical sciences, clinics, and academic support, together with several academic and clinic administrators. Broad-based faculty involvement in assessment planning was an initial goal, with two specific aims: developing program-level outcomes and writing course-level outcomes. This paper focuses on the development of course-level outcomes, the electronic means used to assist faculty in the process of writing such outcomes, and the level of achievement in meeting the goals of the project.

## METHODS

The initial goals in developing the assessment program were that all stakeholders were trained, had adequate reference materials relevant to assessment, and shared a common vernacular. It was acknowledged that members of the LOC needed training first in order to support their peers in the development of the assessment program. The LOC formed a study group, reading two books on program assessment with discussion at meetings. An expert presenter gave a faculty in-service to the entire teaching faculty. The LOC fashioned a process to assist faculty in writing course-level outcomes and established a timeline for compliance over several stages. In stage 1, the LOC members wrote and critically reviewed outcomes for courses taught by its membership. A construct rubric was developed to provide critical feedback on the construction of outcomes. In stage 2, LOC teams met with discipline-based departments to introduce the process and the rubric. Packets of resources were provided with instructions for outcomes composition, the rubric, and

lists of suggested terms to describe outcomes (e.g., Bloom's Taxonomy). In stage 3, faculty wrote and submitted their course outcomes. Stages 4 and 5 were for peer review, with revision and submission of final outcomes. A custom-developed Web-based data entry system was used to collect learning outcomes. The Web form contained fields for course designation and instructor, course description and goals, and up to 30 outcomes grouped into learning domains.

## RESULTS

All lead instructors submitted a draft of learning outcomes on time, with 85 sets collected. The LOC found the rubric to be a useful tool to evaluate learning outcomes. Faculty seemed to have the most difficulty with using measurable verbs to describe their outcomes. There was confusion about the domains of learning, or which outcomes represent attitudes, knowledge, or skills. Some faculty also seemed unable to express deeper levels of learning that should occur in higher level courses.

## DISCUSSION

The authors' experience with the development of the LOC and an assessment plan has shown success, particularly in the collection of learning outcomes for every course in the curriculum. The Web-based entry system was useful and well received. The rubric that was developed proved useful both as a training and evaluation tool. The LOC members themselves seem well trained in outcome construction, but the general faculty lags behind. There is a lack of understanding at the basic level of outcome construction, and classification according to domain and level of knowledge. In the near future, the LOC will work to finish stages 4 and 5 of the plan. The LOC needs to find a better method for helping faculty hone their learning outcomes development skills.



# Academic Suspension: Productive or Punitive?

Kevin W. Paustian, D.C., Palmer College of Chiropractic

Institutions of higher learning have policies related to academic performance and progress. Classifications that define student success range from good academic standing to academic warning, probation, suspension, management, and dismissal. The definition and criteria to reach individual taxonomy varies by institution. In July 1997, significant changes were made to the Palmer College of Chiropractic institutional policy relating to academic progress. The decision was to mandate students serve a one-term suspension prior to being eligible for academic dismissal. The intent of this action was to allow a student the time to address and resolve impediments to their academic progress. The purpose of this study was to evaluate the rate of student attrition that occurred prior to and after the implementation of the suspension mandate. This analysis may shed light on whether serving a term of suspension impacts retention of at-risk students.

## METHOD

An exploratory data analysis was conducted on student academic records comparing the attrition rate prior to the policy change (1989–1996) to that under the new policy (1997–2003).

## RESULTS

During the period from 1989 to 1996, 101 of 746 students (13.5%) who meet the criteria for Warning/Probation were dismissed or failed to return after a term of academic suspension. By comparison, during 1997–2003 after the imposed term of suspension, 103 of 559 (18.4%) students were dismissed or discontinued.

## DISCUSSION

Mandating academic suspension may not deter many students from continuing their academic struggles. Over the 14-year test period, one third of suspended students failed to return from the term of suspension. The data suggest that mandating a term of suspension may not be an effective academic strategy for retention of at-risk students. It may suggest that the time a student spends under suspension is more punitive than productive.



# The Development of a Clinical Education Track Within a College of Chiropractic

Michael Pryor, M.B.A., D.C., Karen Numeroff, D.C., and Matthew McCoy, D.C., Life University

The Clinical Education Track (CET) is a curricular track within the main chiropractic educational curriculum that was designed in response to current and past programmatic assessments. These assessments revealed issues related to integration of clinical training from the classroom to the clinic. Teaching chiropractic students the clinical reasoning, physical examination, and case management skills necessary to function effectively as primary health care clinicians is the primary goal of this integrated curriculum. The CET instructional methodology is based on developing independent learners and thinkers utilizing a facilitative instructional method integrating evidence-based practices.

## METHODS

A faculty task force was established to review current curriculum structure and instructional strategies. A literature review, focus group discussions with faculty, and collaboration with an educational consultant were completed. Based on this process, a structure and instructional strategies were developed for the CET. Instructional methods were pilot tested in several courses in the already existing clinical rounds program. The input of faculty and students involved in piloted methods provided invaluable feedback in our efforts to develop the overall structure of the CET curriculum.

## RESULTS

The basic framework of the CET has been designed to include courses from the 6th through 13th quarters with each course building and expanding upon one another. The instructional strategies include case-based learning, team-based learning, and small group skills labs in order to encourage active learning, critical thinking, and a collaborative approach to learning. The courses that make up the CET have been designed to incorporate instructional methods that are complementary to their learning goals and objectives. Team-based learning (TBL) is the primary model incorporated, whereas small group labs are utilized to hone clinical skills and the traditional instructor-led lecture is used to introduce key concepts.

## DISCUSSION

The structure of the clinical education track is designed to incorporate an active learning approach and to integrate student development of communication skills, physical exam skills, and clinical decision-making skills. Frequent evaluation of the learning strategies and effect on the

learners and instructors will guide possible revisions and improvements. Evaluation strategies include the collection of data from those affected by and those participating in the curriculum. Learner evaluations are used as a measure of achievement of course objectives and are a part of the curriculum evaluation. Student and faculty surveys are administered toward the end of each quarter in order to measure the participants' perceptions. Personnel from the Office of Institutional Research conducted focus group discussions with the participants in the initial course implementation and these continue each quarter until their completion of the program. Outcome data from the 8th- and 11th-quarter objectively structured clinical examinations, 13th-quarter cognitive assessment class, and National Board of Chiropractic Examiners Parts II, III, and IV will provide feedback to the curriculum design, as will surveys of the clinic faculty regarding perceptions of intern's preparedness for the clinic experience. The Clinical Education Track at Life University College of Chiropractic is driven by a vision of educational and clinical excellence. The goal of the program is the integration of didactic learning and clinical experience. Faculty instructors facilitate learning through interactive and innovative instructional strategies designed to enhance the student's diagnostic, analytical, and case management skills.



# A Case Study of Back Pain and Renal Cell Carcinoma

**Robert Rectenwald, D.C., B.C.A.O., and M.B.K. Mathew, B.S., M.S.,** Life University

Renal cell carcinoma accounts for 3% of adult malignancy and 95% of neoplasms arising from the kidney. One third of the patients have metastatic disease at the time of presentation and are asymptomatic with the diagnosis made incidentally from a radiological study obtained for other reasons. Typically, skeletal metastases are purely lytic. This study chronicles the management, outcome, and final diagnosis.

## CLINICAL FEATURES

A 69-year-old male began experiencing middle back pain after twisting while working and presented for chiropractic care 2 weeks later. He also had a 10-year history of low back pain and a 2-month history of weakness at the knee. Plain film radiography was assessed as negative for pathology by a medical radiologist and a chiropractic radiologist.

## INTERVENTION AND OUTCOME

After 6 days of care utilizing atlas orthogonal adjusting, the outcome assessment revealed significant improvement in

the pain, but a regression in strength of the right quadriceps and peroneus muscles. The patient was referred for an MRI study, which revealed a mass on the kidney and large erosive bone lesion of the L4 vertebrae. The diagnosis of renal cell carcinoma was later confirmed.

## DISCUSSION

Progressive muscle weakness is one of the "red flag" signs in a back pain case. Consideration must be given to the possibility of an underlying condition of higher morbidity. Advanced imaging is necessary to detect occult disease processes such as renal cell carcinoma. With back pain and neurological signs, metastatic disease must be considered as a possibility. The chiropractor's role as primary care clinician includes the process of clinical reasoning and referral when the clinical picture becomes unclear and red flag signs arise.



# The Double Crush Syndrome Hypothesis Implications for Chiropractic

**Brent S. Russell, D.C.**, Life University

This review of the literature presents an overview of the double crush syndrome hypothesis, including findings from surgical reports, arguments both pro and con, alternative models of cervical spine–carpal tunnel relationships, and implications for the chiropractic profession. It is hoped that this paper may serve as a source of information for practitioners and students who wish to better understand this controversial issue and to advance chiropractic theoretical concepts in this area.

## METHODS

Peer-reviewed journal articles on double crush syndrome were found through PubMed, MANTIS, and the Index to Chiropractic Literature, using the search terms “double crush syndrome,” “double crush carpal tunnel,” and “chiropractic carpal tunnel syndrome.” Many other related papers were found through cross-reference and fortunate happenstance. Many of the articles that were included have also been quoted by a number of other sources, while some less popular papers offer ideas or perspectives not found elsewhere. Other papers were omitted because of redundancy, obscurity, and/or age. Many articles describing animal experiments were not used because doing so would have added little of clinical import, and those have been reviewed extensively by other authors. Papers used fell into several categories: experimental attempts to create double crush syndromes in animals; case series, case reports, and retrospective records reviews of carpal tunnel syndrome patients; double crush syndrome literature reviews with pertinent commentary; and alternative proposals to the original hypothesis. All information was chosen to present the pros and cons of double crush

syndrome to chiropractic practitioners, students, and educators.

## DATA SYNTHESIS

Many studies support that two or more sites of nerve compression cause a greater degree of dysfunction than a single site, but it is not clear that additional sites magnify the effects of compression. It appears that a significant percentage of carpal tunnel syndrome patients also have cervical spine problems, but the nature of the relationship between the anatomical regions has not been definitively explained. The original double crush syndrome hypothesis, based on a theorized interference with axoplasmic flow, is probably not valid for sensory disturbances in carpal tunnel syndrome. For these reasons, the double crush syndrome hypothesis has remained controversial and a number of alternative explanations are presented.

## DISCUSSION

Many authors of papers about double crush syndrome have suggested that patients may have more than a single problem at a time, and that examination and treatment should be directed toward multiple sites. This thinking might allow a greater role for chiropractic. However, the chiropractic profession needs to further develop theoretical models to relate cervical dysfunction to carpal tunnel syndrome, and would do well to look beyond axoplasmic flow and incorporate some of the alternatives to the original double crush syndrome hypothesis.



## What Constitutes a Case? Developing a Definition of a Patient Case in a Chiropractic Educational Program

**Marc P. Schneider, D.C., Matthew McCoy, D.C., Karen Numeroff, D.C., and Marni Capes, D.C.**, Life University

Beginning with the 2001 *Standards* of the Council on Chiropractic Education (CCE), the Doctor of Chiropractic Program (DCP) must ensure that each student is exposed to

a prescribed number of cases of varying levels of complexity that are common to practicing chiropractors. Since 2001, the number of cases has increased and will continue to do so

until 2011. However, the CCE *Standards* do not provide any specific features that define a case. The purpose of this paper is to review one institution's approach to interpreting the *Standards* and to apply that interpretation to a set of criteria to be utilized in defining and developing teaching cases for a chiropractic educational program.

## METHODS

A work group was formed of four faculty involved in the presentation of cases in the didactic and clinical setting. One member of the work group served as facilitator. The participants reviewed the literature on the topic of case-based teaching. In addition, the participants were asked to review their respective areas for evidence of instructors and classes that used cases for teaching purposes. These cases were then reviewed by the work group. The *Standards* were also reviewed and a working outline, criteria, and definition of a case were constructed. This draft was distributed to all faculty within the college of chiropractic for review and comment.

## RESULTS

The work group developed a working model/definition of a case as well as classifications of cases into simple, moderate, and complex. The College of Chiropractic adopted these guidelines for use in clinical education.

## DISCUSSION

Various individuals and departments within the College of Chiropractic had previously incorporated several means to

deal with the requirements outlined in the *Standards* that deal with patient cases. The clinics had developed Clinical Rounds Classes in the 9th, 10th, and 12th quarters to expose students to cases of various types and complexity. The Clinical Sciences, Chiropractic Sciences, and Technique and Analysis Divisions have developed and utilized case presentations to help expose students to common conditions. However, there was not a common set of criteria that defined a case and its level of complexity. Further, the *Standards* did not define the parameters of a case. To maintain a focused approach to the students' education and document student exposure both quantitatively and qualitatively, the authors adopted a common definition of a case and criteria for classifying the complexity of each case.

The CCE *Standards* require exposure to different case types with varying levels of complexity. Previously, the College of Chiropractic was unable to guarantee that each student would be able to deliver direct patient care to a person that would fit into each case type and category of complexity. Adopting these definitions and criteria would help develop a uniform presentation to the students. It would be expected that students who have been exposed to an increased variety of cases varying in complexity would be more successful in Parts III and IV of the National Board of Chiropractic Examiners (NBCE).

Difficulties associated with the adoption of this definition and criteria include aligning the faculty to understand the importance of conformity and application of the criteria to each case and investing the significant effort that is required in the development of a complete case. The Division chairs must show support for the proposal and emphasize to the faculty the importance for developing and documenting the cases.



## Low Back Endurance Strength in Postpartum Women A Pilot Study

**Clayton D. Skaggs**, D.C., Logan College of Chiropractic and Washington University School of Medicine, **Debbie Ducar**, D.C., **Mark Hawkins**, and **Kevin Christie**, Logan College of Chiropractic

Low back pain during pregnancy is the primary predictor and highest risk factor for the development of chronic low back pain among women. Although preliminary studies have identified provocative tests correlative to pregnancy-related pain, little has been determined that will help guide the

clinician to reduce or treat low back pain accompanying pregnancy. Low back muscle endurance has been clearly linked to patients suffering with chronic low back pain and to its recurrence. No tests exist for evaluating low back strength or function in pregnancy.

## METHODS

This study was reviewed and approved by the Institutional Review Board of Logan College of Chiropractic. Eight asymptomatic women were recruited from two private obstetric practices. They performed endurance holding tests for spinal extension, flexion, and side bridge holding.

## RESULTS

The subjects showed no inability to perform the tests and reported no pain during or following the tests. When compared with data on healthy, nonpregnant females, all of the tests had significantly lower times ( $p < .001$ ).

## DISCUSSION

All of the postpartum women tested in our study were capable of completing the low back endurance tests. This suggests that these quantifiable and reliable tests are feasible for the postpartum population and can be used in future clinical trials to assess function and low back stability. The endurance tests in the current study could provide valuable quantitative and objective assessments to support current self-report evaluations. The results of this pilot can be expanded to evaluate more thoroughly the mechanisms responsible for low back pain in pregnancy.

## CONCLUSION

This pilot study demonstrated the feasibility of using specific low back endurance tests to evaluate postpartum women.



# The New Index to Chiropractic Literature (ICL) A Tool for Evidence-Based Practitioners and Lifelong Learners in Chiropractic

**Anne Taylor-Vaisey**, M.L.S., Canadian Memorial Chiropractic College, and **Phyllis J. Harvey**, M.Ln., Palmer College of Chiropractic

The purpose of this paper is to describe and demonstrate an upgrade to an existing bibliographic database that: (1) helps chiropractors locate the literature published in chiropractic journals in English, particularly the literature relevant to the needs of evidence-based health care (EBHC) practitioners; and (2) provides access for all users to additional high-quality Internet resources pertaining to chiropractic in particular and health care in general.

## BACKGROUND

The EBHC movement now includes chiropractic and requires the learning of necessary skills, including how to form answerable questions, acquire and appraise evidence, apply this evidence to patient problems, and evaluate outcomes. Finding clinical evidence requires good searching skills, but well constructed databases also contribute to success in this process. The average field practitioner needs a database that brings together in one place the peer-reviewed chiropractic literature, available at no cost. To that end, the Chiropractic Library Consortium (CLIBCON) has produced the Index to Chiropractic Literature (ICL) since 1980, first in print and now on the Internet (<http://www.chiroindex.org>).

The 2004/2005 upgrade has augmented ICL's value as a tool for EBHC practitioners and others.

## METHODS

In 2003 a grant from the Association of Chiropractic Colleges (ACC) allowed CLIBCON to upgrade ICL, which included conversion of the database from Microsoft Access to My SQL, conversion of the Web site from HTML to PHP, complete overhaul of the Web site, and fine-tuning of the new search and editing features. After implementation and thorough testing by CLIBCON members and selected students, faculty, field practitioners, and journal editors, a test version was launched in March 2005 and presented to the chiropractic college presidents at the 2005 ACC-RAC in Las Vegas.

## RESULTS

The public ICL was launched formally in May 2005. The editors have solicited feedback, have responded to

all comments, and continue to work with the programmers to correct problems. Further enhancements are planned.

## DISCUSSION

The Index to Chiropractic Literature fully indexes peer-reviewed chiropractic journals in English, and also includes selections from non-peer-reviewed chiropractic journals. Most of the journals are indexed in other indexing and abstracting services, but ICL consolidates them at no cost, thus providing a high-quality product to all stakeholders. The librarians who produce ICL are highly aware

of the importance of the EBHC movement in chiropractic and the need to provide access to high levels of evidence, such as randomized controlled trials. Identifying relevant publication types and peer review status is therefore a priority, as is the ongoing development of CLIBCON's controlled vocabulary, CHIROSH (chiropractic subject headings). Users can limit results to peer review status and to various publication types, enhancements that facilitate retrieval of high-quality studies. ICL's Web site offers further services, such as the "Further Resources" page that leads users to high-quality free databases and Web sites; the "Journals Indexed" page that offers complete bibliographic information for chiropractic journals in English; and links to abstracts, free full text or DOIs (digital object identifiers) where available.



## Feedback on Students' Learning Following an Objectively Structured Clinical Examination-Style Evaluation

**Gene S. Tobias**, Ph.D., D.C., and **Emile Z. Goubran**, M.D., Ph.D., Los Angeles College of Chiropractic, Southern California University of Health Sciences

The medical education literature generally indicates that providing feedback to students on their performance, especially during assessment of clinical skills like history taking and physical exam, is valuable and can motivate students to improve performance. In addition, the objectively structured clinical examination (OSCE) has been promoted as a valued learning experience in clinical education. The authors designed a method to provide feedback to students, through a Web site, from an OSCE-style evaluation—Integrated Competency Exam (ICE)—and surveyed student satisfaction with this outcome. The results showed a high level of students' satisfaction with ICE as a useful educational experience and appreciation of the feedback process via the Web site.

## METHODS

Eighty-eight students participated in an OSCE at the end of the 1st year of chiropractic education (ICE I). ICE I consisted of six clinical performance stations—history, physical exam, neuromusculoskeletal exam, palpation, soft tissue procedures, and radiology—using standardized patients. There was also a written exam in multiple-choice format on six basic science disciplines: general anatomy, functional anatomy and biomechanics, biochemistry and nutrition, neuroscience, physiology, and general pathology and immunology. Each checklist item and each written exam question was attributed to at least one clinical competency (e.g., history taking, physical exam, radiological exam, etc.). Students at the

end of the exam received a score sheet, showing their responses/performance points in each item pertaining to each clinical and basic science station. This score sheet is used by the students to check their responses against the learning objectives and competencies posted on a Web site. A survey at the end of the ICE I, based on a 5-point Likert scale, was used to assess the students' satisfaction with the exam process and suitability for assessment of their knowledge and clinical skills.

## RESULTS

The results of the survey indicate that the level of agreement of the students regarding the helpfulness of course information and orientation provided at the Web site was at 87%. Level of agreement of students that the knowledge and skills tested were appropriate to their level of education at time of exam was 80%, and their satisfaction with the overall ICE I as a valuable educational experience was 89%.

## DISCUSSION

The OSCE-style evaluation of students at the end of the 1st year of chiropractic education (ICE I) was originally designed to use a combination of clinical performance stations with standardized patients and written basic

science exams to assess students' skills and knowledge and their ability to integrate the two. With the current iteration of this evaluation, it is possible to assign items from the individual performance station checklists and written exams to specific clinical competencies. Each student's outcome for each item can be exported to a Web site to provide feedback and to project the level of clinical competence. The student surveys indicate satisfaction with the feedback in the Web site, exam process, and suitability for assessment of their knowledge and clinical skills. The global outcomes of ICE I may be used for additional purposes, including providing evidence of students' learning, demonstrating integration of basic science knowledge with clinical

skills performance, and providing outcome measures for future curricular design.

## CONCLUSION

These results showed a high level of students' satisfaction with ICE as a useful educational experience and appreciation of the feedback process via the Web site. The global outcomes of ICE I may be used to provide evidence of students' learning and to improve on future curriculum design.



## Effect of Exercise and Custom-Made Flexible Orthotics on Blood Pressure and Heart Rate Variability

**John Zhang**, M.D., Ph.D., Logan College of Chiropractic, and **William M. Austin**, D.C., Foot Levelers, Inc.

The hypothesis for the study was that exercise and custom-made orthotics have a positive impact on the heart rate variability (HRV) and blood pressure (BP). The null hypothesis was that exercise and custom-made flexible orthotics would not induce positive changes in HRV and BP during the study period.

### METHODS

This study was reviewed and approved by the Institutional Review Board of Logan College of Chiropractic. All subjects were randomized into control and experimental groups by a randomization table. Both groups had the same exercise program and only the experimental group wore custom-made flexible orthotics. The exercise effects were compared before and after the training. Each subject must be a Ping-Pong club member for the last 5 years and be an active member in the club. The subject must also play no less than twice a week or no less than 6 hours a week. Heart rate variability was measured using Biocom's Heart Rhythm Scanner for HRV data collection. Blood pressure was determined by using Biopac blood pressure measurement equipment. Foot Leveler's custom-made flexible orthotics were factory-fitted to tennis shoes for the study. The study lasted 5 months with one data collection per month except for

the 4th month. The baseline HRV and BP were recorded before the warm-up period. When one player had played with two other players in a nonstop fashion, the data were collected again immediately after the second game. No rest was allowed for this data collection in order to detect the peak heart rate and blood pressure changes. The third data collection of HRV and BP was at the end of the playing period.

### RESULTS

Thirteen Ping-Pong players (10 males, 6 in the experimental group, 3 dropped out) were recruited from a local sports club. They agreed to participate in the study without compensation. The average age of the participants was  $44 \pm 16$  years. The blood pressure in the experimental group was significantly decreased after the 5-month study period. Significant blood pressure decrease was observed in the experimental group before, during, and after each exercise session. The blood pressure did not change significantly in each exercise session in the control group. The heart rate was significantly increased immediately after exercise and remained at higher level after the 20-minute rest at the end of each day's exercise session. The average resting heart rate (baseline HR before each data collection) decreased from  $69.7 \pm 1.708$

to  $66.8 \pm 4.480$  ( $p < .05$ ) in the experimental group, but increased from  $69.7 \pm 1.708$  to  $90.7 \pm 2.808$  ( $p > .05$ ) in the control group. The total power reflecting the total autonomic activity was significantly decreased immediately after exercise and after the 20-minute rest period at the end of the exercise session in both the control and experimental groups.

## CONCLUSION

This study demonstrated the potential benefit of combining exercise with orthotics to improve cardiovascular health in recreational athletes.



## Age and Gender on Heart Rate Variability in Normal Subjects

**John Zhang**, M.D., Ph.D., and **Dennis Enix**, D.C., Logan College of Chiropractic

The chiropractic profession has become increasingly aware of the value of heart rate variability (HRV) analysis with increased research activities in recent years. Some research evidence has suggested that autonomic nervous system activities may be affected by the chiropractic adjustment in normal and diseased conditions. There is a growing need for a clearly defined normal range of HRV in different age and gender groups to make HRV a useful clinical assessment tool in chiropractic and other health care professions.

## METHODS

This study was reviewed and approved by the Institutional Review Board of Logan College of Chiropractic. Baseline HRV, age, and gender data were collected from 470 subjects. Subjects were divided by age into 10-year intervals and by gender for analysis of HRV data.

## RESULTS

Total power, representing the overall autonomic activity, was decreased consistently from ages 10+ to 80+ groups. Subjects in the 10+ age group had much higher total power (1,627) compared with 284 in the 80+ age group. Total power was lower from 10+ to the 20+ age group and stayed fairly flat from the 20–50+ age groups. The other age groups

presented themselves in descending order. The HRV total power of the 60+ age group showed another marked drop before continuing a gradual decline to the 80+ age group. Both the sympathetic activity and parasympathetic activity declined as age increased.

## DISCUSSION

The effect of age on HRV demonstrates the most striking differences. The reason for this large drop at two critical ages was not clear. It was postulated that the significant decrease in HRV resulted from the transition from postpubertal growth spurt to adulthood and the overall decline in physical activities and possibly health in the 60+ age group. Further study may include neonates to extend the range of the age groups. It has been previously reported that increasing postnatal age was accompanied by a statistically significant elevation of HRV parameters.

## CONCLUSION

Age was the most significant factor affecting the HRV in this study. Gender did not seem to affect the resting HRV significantly. Further studies will compare this normal range of HRV with that in patients with a variety of illnesses and physical conditions.

