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Editorial Staff

Preliminary morphological evidence that vertebral hypo-mobility induces synaptic plasticity in the spinal cord.

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Objective: A widely accepted theoretical model suggests that vertebral hypomobility can cause pain and abnormal spinal mechanics because of changes in sensory input from spinal and paraspinal tissues. The purpose of this pilot study was threefold: (1) to make a preliminary determination if chronic vertebral hypomobility at L4 through L6 in the rat would affect synaptic density and/or morphology in the superficial dorsal horn of the L2 spinal cord level; (2) to identify relevant outcome variables for future studies; and (3) to obtain preliminary data that would permit estimating an appropriate sample size for future studies.

Methods: Using an established rat model, we fixed three contiguous lumbar segments (L4-L6) for eight weeks with a specially engineered vertebral fixation device. Electron micrographs were obtained from 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). Synapses were randomly selected using a stereological approach and were analyzed for symmetry, curvature, type of postsynaptic profile, and perforations. The synaptic density was also estimated.

Results: There was increased synaptic density and percentage of positively curved synapses in the dorsal horn of experimental animals as compared with controls. Experimental animals had a lower percentage of axospinous synapses, with a concomitant increase in the percentage of synapses on dendritic shafts.

Conclusion: These preliminary data suggest for the first time that chronic vertebral hypomobility at L4 through L6 in the rat affects synaptic density and morphology in the superficial dorsal horn of the L2 spinal cord level. More definitive studies are warranted, and the biologic significance of these findings should be investigated.

Neck muscle endurance in nonspecific patients with neck pain and in patients after anterior cervical decompression and fusion.

Anneli Peolsson, PhD, PT, Görel Kjellman, PhD, PT

Objective: The purpose of this study was to investigate differences in ventral and dorsal neck muscle endurance (NME) among men and women with nonspecific neck pain (NP) or cervical disk disease

(who had anterior cervical decompression and fusion [ACDF]) and healthy controls (C). Another purpose was to investigate changes in NME after intervention.

Methods: Neck muscle endurance was measured in patients with NP (n = 78) and ACDF (n = 25) before and after the treatment period, and their results were compared to each other and to sex-specific reference values from controls (n = 116) at both the individual and group levels.

Results: Patients had significantly decreased ($P < .01$) NME compared with control subjects, except for ventral NME in female patients with NP before treatment and male patients with ACDF after treatment. Female patients with ACDF had lower ventral NME than female patients with NP ($P < .01$). Among the patients, 35% to 100% had NME disability, with most of them having a lower rate than the 95% confidence interval of controls. Female patients with NP and male patients with ACDF showed improvement ($P < .05$) after treatment. Flexion/extension ratio in patients with NP ($P = .36$), but not in patients with ACDF ($P < .0001$), returned to normal levels after treatment. There was a significant negative correlation ($P < .02$) between NME and Neck Disability Index in both patient groups, except for ventral NME in patients with NP before treatment.

Conclusion: Many patients had impairment in NME before and after treatment. This suggests that additional exercise of specific training for NME should be incorporated into the rehabilitation program, which may improve treatment outcome.

Cerebrospinal fluid pressure in the anesthetized rat.
Brian S. Budgell, PhD, Philip S. Bolton, PhD

Objective: The primary aims of this study were to determine the major frequencies and powers of oscillations in cerebrospinal fluid (CSF) pressure in the anesthetized rat, and to determine whether the CSF pressure oscillations correlated with the major oscillation frequencies in the cardiovascular and respiratory systems, as proposed by some chiropractic theories.

Methods: The cardiac and ventilatory cycles, and CSF pressure were simultaneously recorded during spontaneous and positive-pressure mechanical ventilation in the anesthetized rat. Power spectra were generated from the raw data to identify the major oscillation frequencies in cardiorespiratory and CSF data sets. Entrainment of CSF pressure with ventilation was tested by mechanically pacing the ventilation over a range of frequencies.

Results: The most powerful oscillation in CSF pressure was coincident with ventilatory chest movement during both spontaneous and mechanically paced ventilation. In 22 of 26 trials, there was also a very weak oscillation in CSF pressure that was entrained to heart rate. In addition, in 21 of 26 trials, it was possible to identify a low-frequency oscillation (<0.25 Hz) in CSF pressure that was coincident with a low-frequency oscillation in the power spectrum of the cardiac cycle.

Conclusion: This study suggests oscillations in CSF pressure in the anesthetized rat are entrained to and driven by ventilation. The arterial pulse pressure makes little contribution to oscillations in CSF pressure in the immobile, anesthetized rat. This study provides normative, quantitative data on which to develop studies concerning the effects of vertebral movements and spinal posture on CSF dynamics.

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Objective: The aim of this study was to determine the difference in muscular and postural demands of performing manual therapy using a massage chair and a massage table.

Methods: Twelve female senior massage therapy students performed two 10-minute regional back massages on a fully clothed client using both a massage chair and massage table. The root mean square was used to determine the mean activation from the electromyographic signal collected from eight upper extremity muscles. Integrated electromyography was used to compare activation between the 14 massage techniques used. Eight electromagnetic motion capture sensors were attached: the head, trunk, and upper arm, forearm, and hand bilaterally to track segment kinematics and determine total time spent in different postures.

Results: There was higher activation in lumbar erector spinae when using the table and anterior deltoid when using the chair. The anterior deltoid showed a significant condition \times period interaction for mean muscle activation for six of the 14 massage techniques. The therapists spent significantly more time in mild trunk flexion when using the massage table and significantly more time in severe radial deviation and mild shoulder flexion when using the massage chair.

Conclusion: The chair and table were more demanding of the anterior deltoid and lumbar erector spinae, respectively. Therapists adopted trunk and wrist postures that would increase the risk of upper extremity injury while using either the massage chair or table.

Effect of age and sex on heart rate variability in healthy subjects.

John Zhang, MD, PhD

Objective: The study aimed to investigate the effect of age and sex on the heart rate variability (HRV) analysis and to explore the normal range of HRV in different age and sex groups for potential health care applications.

Method: Baseline HRV, age, and sex data were collected from 470 subjects without cardiovascular conditions. Short-term HRV was recorded using Biocom Active ECG units (Biocom, Seattle, Wash.). Subjects were divided by age into 10-year intervals and by sex for HRV analysis.

Results: Total power, representing the overall autonomic activity, decreased consistently from the age groups 10+ to 80+ years ($P < .001$). Both the low frequency (sympathetic activity) and high frequency (parasympathetic activity) declined ($P < .05$) as age increased. Sex had a significant effect on heart rate, R-R interval, high frequency, normalized low frequency, normalized high frequency, and low frequency-high frequency ratio. Sex did not seem to affect the SD of the normal-to-normal heartbeats and total power ($P > .05$) despite the significant heart rate changes ($P < .05$).

Conclusion: This study demonstrated that age had a greater impact on HRV than sex. The older age group had consistently lower HRV than younger people. The values generated in this study may be useful in health care settings to determine abnormal ranges of HRV under different clinical and experimental conditions.

Manual application of controlled forces to thoracic and lumbar spine with a device: rated comfort for the receiver's back and the applier's hands.

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Purpose: High volumes of manual therapy work can lead to overuse hand and wrist injuries. This study evaluated hand and back comfort in asymptomatic volunteers during spinal mobilization carried out with an instrumented manual therapy tool.

Methods: This crossover design study examined 36 asymptomatic physiotherapy students, tested in pairs. One participant assumed the role of the simulated therapist and the other the simulated patient, before reversing roles. Posteroanterior mobilization conditions formed by using two spinal segments (thoracic/lumbar), two force application methods (hands/device), and three grades of mobilization were applied in a random order. After each combination, both participants in each pair rated hand or back comfort, respectively, on a 100-mm visual analogue scale. Data were analyzed by analysis of variance.

Results: Rated back comfort was greater for hands than for the device and decreased with greater applied force. When the original hard rubber device tip was changed to one of soft molded rubber, both back and hand comfort improved significantly. Although tool mobilization was still rated as significantly less comfortable than mobilization with hands only, this difference was approximately half the discomfort experienced as the grade of mobilization increased from grade I to grade III. For hand comfort when using the softer device tip, the method of force application was no longer a significant determinant of comfort.

Conclusion: The mobilizing tool with a molded rubber tip was acceptably comfortable in use with asymptomatic backs and hands. Further research is indicated in manual therapy settings with therapists who have experienced hand pain.

A single-blind pilot study to determine risk and association between navicular drop, calcaneal eversion, and low back pain.

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Objective: Syndromes causing mechanical low back pain (MLBP) continue to plague the U.S. health care system. One hypothesis is that flatfeet are a risk factor for MLBP. This pilot study evaluated whether subjects with flatter feet are at greater risk for MLBP than subjects without flatter feet.

Methods: Fifty-eight subjects (16-70 years old) were allocated to a group diagnosed with two or more episodes of MLBP or with no history of MLBP. A blind assessor measured navicular drop (ND) using navicular height (NH) and calcaneal eversion (CE). Based on a range of reported data, flatfoot was defined as a possible risk factor for MLBP with ND greater than 3, 8, and/or 10 mm, and/or greater than 6° CE.

Results: According to χ^2 analysis, risk of MLBP appeared similar between groups ($P > .05$). There was no significant difference ($P > .05$) between continuous variables (t tests, Pearson r and r^2) with one exception, correlation of increasing CE with increasing ND ($P = .0001$). Power was generally low (<0.80). Likelihood ratios and Fisher exact tests supported the χ^2 analysis.

Conclusion: In this study, flatfeet did not appear to be a risk factor in subjects with MLBP. However, small sample size, low power, broader age range, low prevalence of flatfeet (>10 mm ND), and lesser back pain severity make these data tentative. Further research is needed.

Interexaminer reliability and accuracy of posterior superior iliac spine and iliac crest palpation for spinal-level estimations.

Hye Won Kim, MD, PhD, Young Jin Ko, MD, PhD, Won Ihl Rhee, MD, PhD, et al.

Objective: The purpose of this study was to compare the posterior superior iliac spine (PSIS) and the iliac crest as accurate anatomical landmarks for identifying spinal level.

Methods: This study was conducted in two stages. First, four examiners examined 60 patients and blindly identified iliac crest and PSIS levels, and the interexaminer reliability of PSIS and iliac crest palpation were then analyzed. Second, four examiners attached a radio opaque marker at presumed PSIS and iliac crest levels in 72 patients, and posteroanterior lumbar radiographs were then taken. Four examiners then confirmed PSIS and iliac crest levels after radiographically identifying the marker levels and checked the spinal level at which the spinous process or interspace was crossed by drawing a horizontal line drawn between radio opaque markers.

Results: The interexaminer reliability of palpation was significantly greater for PSIS level than for the iliac crest ($P < .05$). Spinal levels of estimated PSISs identified by palpation ranged from the L5-S1 interspace to the S2 spinous process, and the spinal levels of estimated iliac crest ranged from the L2-3 interspace to the L5 spinous process.

Conclusion: Although PSIS palpation showed statistically higher interexaminer reliability than iliac crest level, clinicians should be cautious when applying this method as a measurement tool because estimated spinal level by palpation can be influenced inadvertently by examiner skill and anatomical variations.

Coupling behavior of the thoracic spine: a systematic review of the literature.

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Objective: The knowledge of three-dimensional spine coupling characteristics is important for treating patients with spinal pain. The purpose of this study was to examine the coupling directional pattern of the thoracic spine by systematic review. This review could help determine the use of coupling knowledge for manual therapy treatment.

Methods: A systematic review of studies examining *in vivo* and *in vitro* thoracic spine coupled motion was conducted using PubMed and Cumulative Index to Nursing and Allied Health Literature searches (1960-2006), as well as a separate hand-search. Study abstracts were independently reviewed and selected by two investigators based on face validity. The reliability between investigators was established using the Kappa (K) coefficient. A third investigator resolved any inclusion disagreement. Full studies were then evaluated for compliance with inclusion criteria. Coupling patterns from accepted studies were then qualitatively compared.

Results: Of the 56 citations originally identified in the searches, the first two investigators reached consensus on 41 citations and required further assistance by the third investigator on 15 citations. The

reliability between investigators was rated fair ($K = 0.38$). Twenty-one citations were deemed acceptable for further review. Of 21 citations, eight met the inclusion criteria and were fully reviewed. No consistent coupling pattern was observed across the eight studies, where they exhibited ipsilateral, contralateral, or mixed coupling behaviors.

Conclusion: Differences in study design, measurement method, and tissue preparation may have contributed to differences between studies. More quality, in vivo investigations are needed to evaluate thoracic coupling in symptomatic subjects in both a flexed and extended position.

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