Lumbar pain and fin swimming.

- **Verni E**,
- **Prosperi L**,
- **Lucaccini C**,
- **Fedele L**,
- **Beluzzi R**,
- **Lubich T**.

II Division of Orthopedics and Traumatology, Istituto Ortopedico Rizzoli, Bologna, Italy.

BACKGROUND: It was hypothesised that fin swimming have unique physiopathologic features in particular concerning low back involvement. METHODS: Retrospective study. Setting: elite competitive fin swimmers. Participants: 17 males and 14 females aged from 16 to 23 years. Intervention: piroxicam, sport interruption for a week, proper warming-up and wearing suggestions during out-of-water exercises in the symptomatic group. Absence of intervention in the asymptomatic one. Measures: anthropometric measures (weight, height, legs length discrepancy), isokinetic measures (trunk flexor/extensor ratio) and conventional radiological investigation were taken for all subjects. RESULTS: Low back pain was present in 14 subjects during off season but only 7 referred discomfort in competitive season. 78.5% of symptomatic subjects showed radiological abnormalities while imaging changes were present in 52.9% of the asymptomatic group. Flexor/extensor ratio isokinetically evaluated was less than one in 6 athletes complaining back discomfort. Non steroid medication, physiotherapy, training and wearing cares was suggested. Authors report a pain free return to competition in 57% and a partial resolution in 28% of those symptomatic cases who were not used to training cares (in particular proper "out-of-water" warming up) and wearing precautions (complete wiping and suitable thermic clothing after swimming). CONCLUSIONS: In fin swimming low back pain can be related to the existence of environmental and intrinsic factors. In our series no significant difference in imaging changes was pointed out among asymptomatic or painful athletes. Therefore a cyclic load on the column, in absence of training precautions can make spine abnormalities (in particular schisis, facet derangement and pars lesion) symptomatic.

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Stiffness and neuromuscular reflex response of the human spine to posteroanterior manipulative thrusts in patients with low back pain.

- Colloca CJ,
- Keller TS.

Postdoctoral and Related Professional Education Department, Logan College of Chiropractic, St. Louis, MO, USA. cjcolloca@neuromechanical.com

BACKGROUND: Studies investigating posteroanterior (PA) forces in spinal stiffness assessment have shown relationships to spinal level, body type, and lumbar extensor muscle activity. Such measures may be important determinants in discriminating between patients who are asymptomatic and those who have low back pain. However, little objective evidence is available concerning variations in PA stiffness and their clinical significance. Moreover, although several studies have assessed only load input in relation to stiffness, a more complete assessment based on dynamic stiffness measurements (force/velocity) and concomitant neuromuscular response may offer more information concerning mechanical properties of the low back. OBJECTIVE: To determine the stiffness and neuromuscular characteristics of the symptomatic low back. STUDY DESIGN: This study is a prospective clinical study investigating the in vivo mechanical and muscular behavior of human lumbar spinal segments to high loading rate PA manipulative thrusts in research subjects with low back pain (LBP). METHODS: Twelve men and 10 women, aged 15 to 73 years (mean age of 42.8 +/- 17.5 years) underwent physical examination and completed outcome assessment instruments, including Visual Analog Scale, Oswestry Low Back Disability Index, and SF-36 health status questionnaires. Clinical categorization was made on the basis of symptom frequency and LBP history. A hand-held spinal manipulation device, equipped with a preload control frame and impedance head, was used to deliver high-rate (<0.1 millisecond) PA manipulative thrusts (190 N) to several common spinal landmarks, including the ilium, sacral base, and L5, L4, L2, T12, and T8 spinous and transverse processes. Surface, linear-enveloped, electromyographic (sEMG) recordings were obtained from electrodes (8 leads) located over the L3 and L5 paraspinal musculature to monitor the bilateral neuromuscular activity of the erector spinae group during the PA thrusts. Maximal-effort isometric trunk extensions were performed by the research subjects before and immediately after the testing protocol to normalize sEMG data. The accelerance or stiffness index (peak acceleration/peak force, kg-1) and composite sEMG neuromuscular reflex response were calculated for each of the thrusts. RESULTS: Posteroanterior stiffness obtained at the sacroiliac joints, transverse processes, or spinous processes was not different for subjects grouped according to LBP chronicity. However, in those with frequent or constant LBP symptoms, there was a significantly increased spinous process (SP) stiffness index (7.0 kg-1) (P <.05) in comparison with SP stiffness index (6.5 kg-1) of subjects with only occasional or

no LBP symptoms. Subjects with frequent or constant LBP symptoms also reported significantly greater scores on the visual analog scale (P =.001), Oswestry (P =.001), and perceived health status (P =.03) assessments. The average SP stiffness index was 6.6% greater (P <.05) and 19.1% greater (P <.001) than the average sacroiliac stiffness index and average transverse process stiffness index, respectively. CONCLUSIONS: This study is the first to assess erector spinae neuromuscular reflex responses simultaneously during spinal stiffness examination. This study demonstrated increased spinal stiffness index and positive neuromuscular reflex responses in subjects with frequent or constant LBP as compared with those reporting intermittent or no LBP.

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Active trunk extensor contributions to dynamic posteroanterior lumbar spinal stiffness.

- **Colloca CJ**,
- **Keller TS**.

Department of Kinesiology, Atizona State University, Tempe, AZ, USA.
DrC100@aol.com

BACKGROUND: Assessments of posteroanterior (PA) spinal stiffness using mobilization apparatuses have demonstrated an increase in PA spine stiffness during voluntary contraction of the lumbar extensor muscles; yet, little work has been done to this degree in symptomatic subjects. OBJECTIVE: To use a previously validated dynamic mechanical impedance procedure to quantify changes in PA dynamic spinal stiffness at rest and during lumbar isotonic extension tasks in patients with low back pain (LBP). METHODS: Thirteen patients with LBP underwent a dynamic spinal stiffness assessment in the prone-resting position and again during lumbar extensor efforts. Stiffness assessments were obtained using a handheld impulsive mechanical device equipped with an impedance head (load cell and accelerometer). PA manipulative thrusts (approximately 150 N, <5 milliseconds) were delivered to skin overlying the L3 left and right transverse processes (TPs) and to the L3 spinous process (SP) in a predefined order (left TP, SP, right TP) while patients were at rest and again during prone-lying lumbar isotonic extension tasks. Dynamic spinal stiffness characteristics were determined from force and acceleration measurements using the apparent mass (peak force/peak acceleration, kg). Apparent mass measurements for the resting and active lumbar isotonic task trials of each patient were compared using a 2-tailed, paired t test. RESULTS: A significant increase in the PA dynamic spinal stiffness was noted for thrusts over the SP (apparent mass [17.0%], P=.0004) during isotonic trunk extension tasks compared with prone resting, but no statistically significant changes in apparent mass were noted for the same measures over the TPs. CONCLUSIONS: These findings add support to the significance of the trunk musculature and spinal posture in providing increased spinal stability.

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Electromyographic reflex responses to mechanical force, manually assisted spinal manipulative therapy.

- Colloca CJ,
- Keller TS.

Postdoctoral & Related Professional Education Department, Logan College of Chiropractic, St Louis, Missouri, USA. cjcolloca@neuromechanical.com

STUDY DESIGN: Surface electromyographic reflex responses associated with mechanical force, manually assisted (MFMA) spinal manipulative therapy were analyzed in this prospective clinical investigation of 20 consecutive patients with low back pain. OBJECTIVES: To characterize and determine the magnitude of electromyographic reflex responses in human paraspinal muscles during high loading rate mechanical force, manually assisted spinal manipulative therapy of the thoracolumbar spine and sacroiliac joints. SUMMARY OF BACKGROUND DATA: Spinal manipulative therapy has been investigated for its effectiveness in the treatment of patients with low back pain, but its physiologic mechanisms are not well understood. Noteworthy is the fact that spinal manipulative therapy has been demonstrated to produce consistent reflex responses in the back musculature; however, no study has examined the extent of reflex responses in patients with low back pain. METHODS: Twenty patients (10 male and 10 female, mean age 43.0 years) underwent standard physical examination on presentation to an outpatient chiropractic clinic. After repeated isometric trunk extension strength tests, short duration (<5 msec), localized posteroanterior manipulative thrusts were delivered to the sacroiliac joints, and L5, L4, L2, T12, and T8 spinous processes and transverse processes. Surface, linear-enveloped electromyographic (sEMG) recordings were obtained from electrodes located bilaterally over the L5 and L3 erector spinae musculature. Force-time and sEMG time histories were recorded simultaneously to quantify the association between spinal manipulative therapy mechanical and electromyographic response. A total of 1600 sEMG recordings were analyzed from 20 spinal manipulative therapy treatments, and comparisons were made between segmental level, segmental contact point (spinous vs. transverse processes), and magnitude of the reflex response (peak-peak [p-p] ratio and relative mean sEMG). Positive sEMG responses were defined as >2.5 p-p baseline sEMG output (>3.5% relative mean sEMG output). SEMG threshold was further assessed for correlation of patient self-reported pain and disability. RESULTS: Consistent, but relatively localized, reflex responses occurred in response to the localized, brief duration MFMA thrusts delivered to the thoracolumbar spine and SI joints. The time to peak tension (sEMG magnitude) ranged from 50 to 200 msec, and the reflex response times ranged from 2 to 4 msec, the latter consistent with intraspinal conduction times. Overall, the 20 treatments produced systematic and significantly different L5 and L3 sEMG responses, particularly for thrusts delivered to the lumbosacral spine.

Thrusts applied over the transverse processes produced more positive sEMG responses (25.4%) in comparison with thrusts applied over the spinous processes (20.6%). Left side thrusts and right side thrusts over the transverse processes elicited positive contralateral L5 and L3 sEMG responses. When the data were examined across both treatment level and electrode site (L5 or L3, L or R), 95% of patients showed positive sEMG response to MFMA thrusts. Patients with frequent to constant low back pain symptoms tended to have a more marked sEMG response in comparison with patients with occasional to intermittent low back pain. CONCLUSIONS: This is the first study demonstrating neuromuscular reflex responses associated with MFMA spinal manipulative therapy in patients with low back pain. Noteworthy was the finding that such mechanical stimulation of both the paraspinal musculature (transverse processes) and spinous processes produced consistent, generally localized sEMG responses. Identification of neuromuscular characteristics, together with a comprehensive assessment of patient clinical status, may provide for clarification of the significance of spinal manipulative therapy in eliciting putative conservative therapeutic benefits in patients with pain of musculoskeletal origin.

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Neuromechanical characterization of in vivo lumbar spinal manipulation. Part II. Neurophysiological response.

- Colloca CJ,
- Keller TS,
- Gunzburg R.

State of the Art Chiropractic Center, Pheonix, AZ, USA.

OBJECTIVE: To simultaneously quantify vertebral motions and neuromuscular and spinal nerve root responses to mechanical force, manually assisted, short-lever spinal manipulative thrusts. METHODS: Four patients underwent lumbar laminarthrectomy to decompress the central spinal canal and neuroforamina, as clinically indicated. Prior to decompression, finely threaded, 1.8-mm diameter intraosseous pins were rigidly fixed to the lumbar spinous process (L1 or L3) using fluoroscopic guidance, and a high-frequency, low-noise, 10-g, triaxial accelerometer was mounted to the pin. Following decompression, 4 needle electromyographic (nEMG) electrodes were inserted into the multifidus musculature adjacent to the pin mount bilaterally, and 2 bipolar platinum electrodes were cradled around the left and right S1 spinal nerve roots. With the spine exposed, spinal manipulative thrusts were delivered internally to the lumbosacral spinous processes and facet joints and externally by contacting the skin overlying the respective spinal landmarks using 2 force settings (approximately 30 N, < 5 milliseconds (ms); approximately 150 N, < 5 ms) and 2 force vectors (posteroanterior and superior; posteroanterior and inferior). RESULTS: Spinal manipulative thrusts resulted in positive electromyographic (EMG) and compound action potential (CAP) responses that were typically characterized by a single voltage potential change lasting several milliseconds in duration. However, multiple EMG and CAP discharges were observed in numerous cases. The temporal relationship between the initiation of the mechanical thrust and the neurophysiologic response to internal and external spinal manipulative therapy (SMT) thrusts ranged from 2.4 to 18.1 ms and 2.4 to 28.6 ms for EMG and CAP responses, respectively. Neurophysiologic responses varied substantially between patients. CONCLUSIONS: Vertebral motions and resulting spinal nerve root and neuromuscular reflex responses appear to be temporally related to the applied force during SMT. These findings suggest that intersegmental motions produced by spinal manipulation may play a prominent role in eliciting physiologic responses.

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A rigid body model of the dynamic posteroanterior motion response of the human lumbar spine.

- Keller TS,
- Colloca CJ.

Department of Mechanical Engineering, University of Vermont, Burlington, VT 05405, USA.

BACKGROUND: Clinicians apply posteroanterior (PA) forces to the spine for both mobility assessment and certain spinal mobilization and manipulation treatments. Commonly applied forces include low-frequency sinusoidal oscillations (<2 Hz) as used in mobilization, single haversine thrusts (<0.5 seconds) as imparted in high-velocity, low-amplitude (HVLA) manipulation, or very rapid impulsive thrusts (<5 ms) such as those delivered in mechanical-force, manually-assisted (MFMA) manipulation. Little is known about the mechanics of these procedures. Reliable methods are sought to obtain an adequate understanding of the force-induced displacement response of the lumbar spine to PA forces. OBJECTIVE: The objective of this study was to investigate the kinematic response of the lumbar spine to static and dynamic PA forces. DESIGN: A 2-dimensional modal analysis was performed to predict the dynamic motion response of the lumbar spine. METHODS: A 5-degree-of-freedom, lumped equivalent model was developed to predict the PA motion of the lumbar spine. Lumbar vertebrae were modeled as masses, massless-spring, and dampers, and the resulting equations of motion were solved by using a modal analysis approach. The sensitivity of the model to variations in the spring stiffness and damping coefficients was examined, and the model validity was determined by comparing the results to oscillatory and impulsive force measurements of vertebral motion associated with spine mobilization and 2 forms of spinal manipulation. RESULTS: Model predictions, based on a damping ratio of 0.15 (moderate damping) and PA spring stiffness coefficient ranging from 25 to 60 kN/m, showed good agreement with in vivo human studies. Quasi-static and low-frequency (<2.0 Hz) forces at L3 produced L3 segmental and L3-L4 intersegmental displacements up to 8.1 mm and 3.0 mm, respectively. PA oscillatory motions were over 2.5-fold greater for oscillatory forces applied at the natural frequency. Impulsive forces produced much lower segmental displacements in comparison to static and oscillatory forces. Differences in intersegmental displacements resulting from impulsive, static, and oscillatory forces were much less remarkable. The latter suggests that intersegmental motions produced by spinal manipulation may play a prominent role in eliciting therapeutic responses. CONCLUSIONS: The simple analytical model presented in this study can be used to predict the static, cyclic, and impulsive force PA displacement response of the lumbar spine. The model provides data on lumbar segmental and intersegmental motion patterns that are otherwise difficult to obtain experimentally. Modeling of the PA motion response of the lumbar spine to PA forces assists in the understanding the biomechanics of

therapeutic PA forces applied to the lumbar spine and may ultimately be used to validate chiropractic technique procedures and minimize risk to patients receiving spinal manipulative therapy.

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