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Spinal Instability and Pain: Is There a Connection?

By Craig Liebenson, DC

A new study examined the theory that antagonistic trunk muscle coactivation is necessary to provide mechanical stability to the lumbar spine around a neutral posture. The authors found that antagonistic muscle coactivation increased in response to increased axial load on the spine. EMG measurements were gathered from three flexors -- external oblique; internal oblique; and rectus abdominous; and three extensors -- multifidus; lumbar erector spinae; and thoracic erector spinae.

The subjects were asked to perform slow trunk flexion and extension movements in a semi-seated position with hip motion restricted, but trunk motion free. Weights were then added to the torso. One conclusion was that "increased levels of muscle coactivation may constitute an objective indicator of the dysfunction in the passive stabilizing system of the lumbar spine."

Cholewicki J, Panjabi MM, Khachatryan A. Stabilizing function of the trunk flexor-extensor muscles around a neutral spine posture. Spine 1997;19:2207-2212.

Other recent studies have looked at various aspects of motor control and evaluated their correlation with pain and injury.

Reaction Time

When comparing back pain patients to asymptomatic subjects, the back pain patients had a slower reaction time, decreased peak output, increased after discharges when irregular load is handled. This study had particularly strong methodology because treatment was given and the reactions improved. Then sitting was shown to disturb these variables and a brief walking break to improve them again.

Wilder DG, Aleksiev AR, Magnusson ML, Poper MH et al. Muscular response to sudden load. Spine 1996;21(22):2628-2639.

Delayed activation of transverse abdominous during arm movements distinguishes lower back pain patients from normals.

Hodges PW, Richardson CA. Inefficient muscular stabilization of the lumbar spine associated with low back pain. Spine 1996;21:2640-2650.

Coordination

Loss of control of center of rotation during isoinertial resisted trunk movements in the sagittal plane occurred in low back pain patients, but not in normals. Increase in rotation and side bending and decrease in sagittal motion occurred.

Paarnianpour M, Nordin M, Kahanovitz N, Frank V. The triaxial coupling of torque generation of trunk muscles during isometric exertions and the effect of fatiguing isoinertial movements on the motor output and movement patterns. Spine 1988;13:982-992.

Spinal loading forces were increased during a fatiguing isometric trunk extension effort without a loss of torque output. Torque output remained constant because as the erector spinae fatigued, substitution by secondary extensors such as the internal oblique and latissimus dorsi muscles occurred.

Sparto PJ, Paarnianpour M, Massa WS, Granata KP, Reinsel TE, Simon S. Neuromuscular trunk performance and spinal loading during a fatiguing isometric trunk extension with varying torque requirements. Spine 1997;10:145-156.

Overactivity of antagonist back muscles during the ipsilateral swing phase of gait and decreased agonist peak muscle activity during double stance phase differentiated back pain patients from asymptomatics.

Arendt-Nielson L, Graven-Nielson T, Svarrer H, Svensson P. The influence of low back pain on muscle activity and coordination during gait. Pain 1995;64:231-240.

Increased ratio of rectus abdominous to transverse abdominous/oblique abdominals is correlated with lower back pain.

- Control subjects were able to preferentially activate internal oblique and transverse abdominous muscles without significant rectus abdominous activation.
- Low back pain patients could not do this.

- Performance of trunk curl fast instead of slow correlated with greater ratio of rectus abdominous to transverse abdominous/oblique abdominals.

O'Sullivan P, Twomey L, Allison G, et al. Altered patterns of abdominal muscle activation in patients with chronic low back pain. Aust J Physio 1997;43:91-98.

Altered muscle activation ratios of synergist spinal muscles during a variety of motor tasks differentiated from injured and uninjured individuals. Underactivity of agonists and overactivity of synergists was able to discriminate pain patients with 88% accuracy.

Edgerton VR, Wolf SL, Levendowski DJ, Roy RR. Theoretical basis for patterning EMG amplitudes to assess muscle dysfunction. Med Sci Sp Exer 1996;28:744-751.

Endurance

Decreased endurance of the trunk extensors has not only been shown to correlate with pain, but to predict recurrences and first time onset in healthy individuals. This evidence is extremely strong because it is prospective and thus the findings are not merely correlated by association, but by etiology.

Biering-Sorensen F. Physical measurements as risk indicators for low-back trouble over a one-year period. Spine 1984;9:106-119.
Luuto S, Heliovaara M, Hurri H, Alaranta H. Static back endurance and the risk of low-back pain. Clin Biomech 1995;10:323-324.
Vink P, van de Velde EA, Verbout AJ. A functional subdivision of the lumbar extensor musculature. Electromyogr Clin Neurophysiol 1988;28:517-25.

Atrophy

The multifidus in the low back has been shown to be atrophied in patients with acute low back pain, those recovered from acute low back pain, and those having surgery for nerve root compression. The acute patients' atrophy was unilateral to the pain and at the same segmental level as palpable joint dysfunction. Recovery from acute pain did not automatically result in restoration of the normal girth of the muscle. However, spinal stabilization exercises successfully did rebuild the muscle's size.

Hides JA, Richardson CA, Jull GA. Multifidus muscle recovery is not automatic after resolution of acute,

first-episode of low back pain. Spine 1996;21(23):2763-2769.
Hides JA, Stokes MJ, Saide M, Jull GA, Cooper DH. Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back pain. Spine 1993;19(2):165-172.

According to Edgerton et al., "The nervous system apparently can detect a reduced capacity to generate force from a specific muscle or group of muscles and compensate by recruiting more motoneurons. This compensation can be made by recruiting motor units from an uninjured area of the muscle or from other muscles capable of performing the same tasks ..."

According to Korr, "The brain thinks in terms of whole motions, not individual muscles."

Korr I. The spinal cord as organizer of disease processes. J Am Osteopath Assoc 1976:76;35.

For Your Practice:

- Inspect posture for poor stability (i.e., forward drawn posture);
- Inspect gait for poor stability (i.e., hyperpronation);
- Palpate joints for dysfunction (i.e., restricted mobility);
- Inspect movement patterns for incoordination (i.e., poor scapulo-humeral rhythm);
- Palpate muscles for hyperactivity (i.e., trigger points);
- Advise patients about good posture (i.e., sit and lift with neutral spine);
- Mobilize joints and soft tissues to improve mobility;
- Exercise patients' balance and reaction time with propriosensory training;
- Exercise patients with emphasis on co-activation of agonists and antagonists and maintenance of neutral spine posture (i.e., neutral lumbar spine during trunk curls, neutral head/neck posture during pull downs).

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