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Motor Control Problems in Patients With Spinal Pain: A New Direction for Therapeutic Exercise

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ABSTRACT
Recent research into muscle dysfunction in patients with low back pain has led to discoveries of impairments in deep muscles of the trunk and back. These muscles have a functional role in enhancing spinal segmental support and control. The muscle impairments are not those of strength but rather problems in motor control. These findings call for a different approach in therapeutic exercise, namely a motor learning exercise protocol. The specific exercise approach has an initial focus on retraining the cocontraction of the deep muscles (i.e., the transversus abdominis and lumbar multifidus). Initial clinical trials point to the effectiveness of the approach in patients with both acute and chronic low back pain in terms of reducing the neuromuscular impairment and in control of pain. (J Manipulative Physiol Ther 2000;23:115-7)

Key Indexing Terms: Low Back Pain; Motor Control; Exercise; Transversus Abdominis; Lumbar Multifidus

INTRODUCTION
The current era of evidence-based practices has made all health care practitioners reflect on current practices for the management of spinal pain. Many exercise programs for the patient with spinal pain have traditionally focused on strength, endurance, fitness, and functional capacity training. These general programs are appropriate in late stages of rehabilitation and are of value for the deconditioned patient with spinal pain. Many exercise programs for the patient with spinal pain have traditionally focused on strength, endurance, fitness, and functional capacity training. These general programs are appropriate in late stages of rehabilitation and are of value for the deconditioned patient with spinal pain. Nevertheless, it is our contention that they may not necessarily directly address the physical impairments in the neuromuscular system associated with the onset of low back pain, as well as those associated with persistent and recurrent spinal pain. Recent research suggests that a key impairment in the muscle system is one of motor control rather than one of only strength. It is reasoned that such impairments need to be addressed specifically before, or at least in conjunction with, more general exercise programs prescribed for patients with low back pain.

A different and specific type of exercise termed segmental stabilizing training has been developed that may more directly address some key physical impairments in the neuromuscular system. This exercise is based on research in biomechanics, neurophysiology, and research in physiotherapy. Segmental stabilizing training is aimed toward controlling pain and protecting and supporting the spinal segment from reinjury by re-establishing and enhancing muscle control to compensate for any loss of segmental stiffness caused by injury or degenerative change. The exercise approach is based on the specific function of particular trunk muscles for segmental support and control and proven impairment in these muscles in patients with low back pain.

Discussion
Panjabi's model to explain the development of spinal pain provides a reasonable explanation as to why, when the spinal segment is compromised, exercises designed to improve the functional supporting role of the muscle system may help increase spinal segmental stability. It centers around the concept of spinal stability. Spinal stability is accomplished by the interdependent function of 3 subsystems: the passive subsystem (osseoligamentous structures), the active subsystem (the spinal muscles), and the neural subsystem (the control of these muscles by the central and peripheral nervous systems). The systems are interdependent, and although their interaction is complex and to a large extent ill-defined in scientific studies, the model presents a clear link between the passive subsystem and the neuromuscular systems.

There has been growing interest in how the neuromuscular system supports and controls the spinal segment. Bergmark described 2 functional muscle systems linked to spinal stabilization as the local and global muscle systems. The muscles of the local system are deep and, anatomically, are closely related to the individual vertebrae. They are capable of increasing spinal segmental stiffness. Muscles of the global system are primarily the larger torque-producing muscles and are anatomically more remote from the joint but important for controlling spinal orientation and balancing external loads.

Research is now starting to reveal how the central nervous system prepares and modulates the muscle system to support the lumbar spine and its segments for functional activity and load. Support is growing for the functional differentiation...
between global and local muscles in relation to spinal control.9,10 More pertinent, links are now emerging between low back pain and motor control deficits in muscles of the local system, notably the transversus abdominis and lumbar multifidus. These muscles appear to lose their normal anticipatory function in patients with low back pain, exhibiting delays in activation and thus a loss of their normal preprogrammed function for support.7,8 In contrast to patients without low back pain, the transversus abdominis appears to be unable to function independently of the other abdominal muscles in patients with low back pain10 and demonstrates phasic activity rather than the tonic activity required for its supporting function. Lumbar multifidus has been shown to react by inhibition at a segmental level in acute episodes of low back pain.1,11

Spinal Segmental Stabilization Training

The specific therapeutic exercise program of spinal segmental stabilization training aims to address and reverse these problems in motor control in key muscles of the local system and restore normal synergistic function between the local and global muscle systems. The clinical evaluation and retraining methods for patients with low back pain are described in detail elsewhere.1 In brief, the program is a motor learning exercise protocol. The initial and pivotal focus is on retraining the cocontraction of the transversus abdominis and lumbar multifidus, muscles that form part of the local muscle system of the lumbo pelvic region. This initial focus still recognizes that both local and global muscle systems are required for spinal stabilization and support. In the clinical situation the motor skill aligned to a normal pattern of deep muscle activation is an action of drawing in the abdominal wall. When performed with a normal motor pattern, this action activates the deep transversus abdominis in cocontraction with the deep fascicles of lumbar multifidus. During the retraining process, these local muscles are activated cognitively, as independently as possible from the global muscles. Facilitation of the deep muscle motor pattern with relative independence from global muscle activity requires a high level of clinical skill. Teaching and training often proceeds with the aid of technical devices, such as surface electromyography, pressure biofeedback, and ultrasound imaging.1 The contraction is practiced repeatedly with the aim of restoring the muscles' automatic stabilization function. As this is achieved, training then focuses on the integration of activity of the local and global muscle systems.

Two directions of research are currently being followed in the process of investigating this exercise approach. The first direction is through clinical trials of the effectiveness of the approach on pain and function in patients with low back pain. The second is through investigating the effects of the exercise on the muscle impairments.

Two randomized, controlled, clinical trials have been conducted to date by O'Sullivan et al14,15 on patients with low back pain. The first trial included patients with low back pain with a radiologic diagnosis of spondylolisthesis or spondy-
is and the lumbar multifidus and the presence or not of timing deficits in transversus abdominis in automatic laboratory tests of motor control.\textsuperscript{20}

**CONCLUSION**

Although much is left to be learned, one factor is becoming clear from our clinical research and practice with patients with low back pain. There is considerable variability in the nature and degree of the motor control problems presenting in patients with low back pain. In the future, links may be found between certain variables in the patterns of motor control exhibited by patients with low back pain and the tendency for severity or persistence of the condition. In the short term, this variability between patients highlights the need for an individual problem-solving approach to the neuromuscular dysfunction in patients with low back pain in the clinical situation. A one-size-fits-all approach to the prescription of therapeutic exercise is not rationally based.

**REFERENCES**