CORE STABILITY AND LOW BACK PAIN

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Abstract

Malfunction of trunk muscles acting as both prime movers and as stabilizers has been linked to increased incidence of low back pain (LBP) among adults. The term “core instability” has been used in the past to refer to the inability of the deep trunk muscles to act as stabilizers to the joints of the spine in both open and closed kinematic chain activities. Such instability (when measured appropriately) is correlated with increased incidence and severity of mechanical LBP. Interestingly enough, core instability also has been linked to lower extremity dysfunction and, more recently, to shoulder dysfunction.

This paper is linked to a presentation that focuses on defining and assessing core instability and distinguishing it from core strength. Research evidence that links core instability to dysfunction of the spine, lower limbs, and upper limbs will be presented. Finally, we will offer recommendations to ergonomists regarding effective methods for relieving the excess loads that core instability places on the joints of seated and standing workers with the primary goal of reducing LBP and associated workplace absences.

Keywords: Core stability, Instability, Low Back Pain

Introduction

Low back pain (LBP) has been identified as one of the most common causes of disability and workplace absences in United States. Chronic LBP results in reduced productivity, additional medical expenses, and total costs estimated at more than $100 billion dollars every year (Crow & Willis, 2009).

There are many mechanical and physiological causes of LBP. Chief among them is weakness and dysfunction of the trunk muscles and associated structures, clinically and popularly known as the “core muscles.” While rehabilitation specialists have long understood the crucial roles that these muscles play in maintaining healthy backs and spines, it has only been over the past several decades that fitness trends including yoga, Pilates, and Tai Chi have become so popular due to their focus on improving core muscle strength and stability (Akuthota, Ferreiro, Moore, & Fredericson, 2008).

The terms core “strength” and “stability” are often used interchangeably but actually refer to different sets of movements at the lumbar spine involving specific muscle groups. Core muscle strength refers to the capacity of the muscles to perform movements. Stability, however, requires resistance of excessive intervertebral motion at the lumbar spine. Strong abdominal and spinal core muscles are necessary to produce this resistance, but they must work effectively as a unit to achieve proper stability as a base for optimum back mobility during daily living activities.

This article will present the anatomy of the core muscles and the injuries associated with core instability. Tests for measuring core stability will be discussed together with recommendations for teaching workers proper exercises to improve core strength, reduce instability, and promote back health.

Anatomy

The core of the human body can best be described as “a muscular box with the abdominals in the front, paraspinals and gluteals in the back, the diaphragm as the roof, and the pelvic floor and hip girdle musculature as the bottom” (Akuthota, Ferreiro, Moore, & Fredericson, 2008:39). A total of 29 pairs of muscles work in tandem to move the thorax (flexion, extension, rotation, and lateral flexion) and stabilize the spine and pelvic girdle. Other components of the body’s core include the bones, ligaments, tendons, fascia, skin, and nerves of the thorax and abdomen.

The core muscles can be grouped together as either prime movers (rectus abdominis, the external and internal obliques, the erector spinae muscles, iliacus, psoas major, and quadratus lumborum) or stabilizers (the diaphragm, transversus abdominis, the transversospinalis muscles, and the pelvic floor muscles; Figure 1). The nerves that supply the prime movers originate from throughout the spine (the...
anterior and posterior rami of the cervical, thoracic, and lumbar spinal nerves (C4-L4) and in the lower back (the femoral nerves (L2-L4) to the iliacus, psoas major, and quadratus lumborum).

Figure 1. Lateral view of core muscles.

The muscles that stabilize the core attach to the rib cage, spine, and pelvis. The diaphragm is the most superior of the core stabilizers and separates the thoracic and abdominal cavities. It is the chief muscle of respiration. The diaphragm attaches to the inferior six ribs and the three superior lumbar vertebrae (Figure 2). It is innervated the by the two phrenic nerves (C2-4) that travel down both sides of the neck and pass laterally to the heart to enter the superior surface of the diaphragm’s two domes.

Figure 2. Location and attachments of the diaphragm.

The transversus abdominis lies inferior to the diaphragm and is the deepest of the three flat abdominal muscles. It fibers extend from the lower five ribs, thoracolumbar fascia, and iliac crests of the pelvis anteriorly to insert into the linea alba located at the midpoint of the abdomen (Figures 1 and 3). This muscle effectively surrounds and compresses the organs while also resisting lumbar movement to support the lower back. The transversus abdominis is innervated by the T6-L1 spinal nerves.

Figure 3. Posterior and anterior views of the core stabilizers and prime movers.

The transversospinalis muscle group lies deep to the thicker, more prominent erector spinae muscles (Figure 3) and occupies the space between the spinous and transverse processes of the vertebrae. Three small muscles comprise this group: semispinalis, multifidis, and rotatores. These muscles originate from the transverse processes and pass superomedially to the spinous process of the next superior vertebra. (The semispinalis capitis inserts onto the occipital at the back of the cranium.) Collectively, they extend the head and upper spine and rotate them contralaterally. Of note, the multifidis is thickest in the lumbar region and works to stabilize the vertebrae when local movements of the spinal column occur. These muscles are all innervated by the segmental nerves of the entire spine.

At the bottom of the body’s core, the pelvic floor muscles form a funnel-shaped sheet through which the urogenital structures pass. These muscles, the coccygeus and levator ani, span the space from the pubic bones to the ischia and the inferior surfaces of the sacrum and coccyx (Figure 4). They also attach to the walls of the prostate or vagina, the rectum, and the anal canal. Together, the pelvic floor muscles support the organs, maintain urinary and fecal continence, and resist increases in intra-abdominal pressure. They are innervated by branches of the fourth and fifth sacral spinal nerves and the coccygeal spinal nerves.

In addition to the core muscles, the thoracolumbar fascia contributes to lumbar stabilization by increasing the stiffness of the spine.
Together, the muscles and fascia control the curves of the spine so that it may respond efficiently to the forces of gravity and withstand compressive forces without buckling.

![Diagram of the pelvic floor muscles](image)

Figure 4. Location and attachments of the pelvic floor muscles in women.

**The Core**

Sufficient core stability relies heavily on co-activation of the deep (local) and global trunk musculature when performing tasks such as the activities of daily living, work, and athletics (Kibler, Press & Sciascia, 2006). In all settings, core stability is defined as “the ability to control the position and motion of the trunk over the pelvis to allow optimum production, transfer, and control of force and motion to the terminal segment” (Kibler et al, 2006:189). These motions include active movement as well as resistance to the mechanical forces that affect the spinal column. As such, core stability is the foundation for virtually every form of movement in the extremities, controlling forces at the distal segments of the kinetic chain.

The deep (local) core muscles are slow-twitch in nature and are activated in endurance activities. These muscles may be selectively weakened, poorly recruited, and inhibited at low levels of resistance (Faries & Greenwood 2007). Conversely, global core muscles are fast-twitch and become active in activities that require power. Balance between the local and global muscles (stabilizers and prime movers, respectively) is necessary for overall function of the core and good back health.

In addition to optimal function and capacity of the core muscles, neuromuscular control is also an important factor to consider as an element of core stability. As noted by Akuthota, Ferreiro, Moore, & Fredericson, (2008:39), “stability of the spine is not only dependent on muscular strength, but also proper sensory input that alerts the central nervous system about interaction between the body and the environment.” Given the multiple origins from the neck to the sacrum and coccyx of the nerves that supply the core stabilizers, even minor trauma or faulty posture leading to degenerative changes can compromise the complex system that supports the spine and reduces the potential for LBP.

**Injuries Associated With Core Instability**

Core instability has been cited as a contributing factor, if not direct cause, of numerous injuries affecting the entire body. For instance, exploring the relationship between core instability and LBP Lehman (2006) demonstrated the importance of spinal stability in preventing low back injuries in golfers. The results of this study indicated the importance of endurance training of the core muscles, rather than strength training, to enhance their ability to resist motion of the lumbar vertebrae and maintain support of the entire spinal column. Similarly, for rehabilitation of mechanical LBP numerous researchers have compared the results of a core stabilization program with more traditional physical therapy strengthening programs in patients with chronic LBP. Subjects that participated in the core stabilization program made significant improvements compared to the subjects in the control group who received traditional therapy (Muthukrishnan, Shenoy, Jaspal, Nellikunja, & Fernandes, 2010).

In addition to LBP, core instability has been linked to certain upper and lower extremity injuries. For example, one study reported up to 100% sensitivity and 72% specificity for predicting ligament injury in the knees of female athletes when core instability was detected (Zazulak, Hewett, Reeves, Goldberg, & Cholewicki, 2007). Similarly, Radwan et al. (2014) established a relationship between core instability and shoulder dysfunction in collegiate athletes. The athletes with shoulder dysfunction also exhibited core instability manifested as significant deficiency in the neuromuscular activation that was assessed using the single leg balance test. Specifically, athletes who presented shoulder dysfunction had a significant reduction in their ability to stand on one leg for extended periods, in addition to other clinical (but not statistical) reduction in their core stabilizers’ ability to maintain prolonged contraction on a modified lateral plank test.
Measures of Core Stability

Accurately determining the level of an individual’s core stability is crucial for providing him or her with the most effective programs for either maintenance or improvement. A number of physical tests are used to assess how effectively deep core muscles are activated (and by extension the degree of stability) when tested. Tests are either static, like the Sorenson test depicted in Figure 5 or planks, or dynamic including the double leg straight lowering test (Figure 6). Both of these tests are easy to administer and require minimal equipment, making them cost effective.

![Figure 5. Sorenson test evaluating deep back extensors.](image)

In addition to tests that measure core stability, neuromuscular function must be assessed as well. The single leg balance (SLB) test (also called the unipedal stance test) is used to measure an individual’s postural stability as an indicator of neuromuscular balance. Performed with the eyes open and arms on the hips, the participant stands unassisted on one leg and is timed (in seconds) from when one foot is raised off of the floor to when it touches the ground again or an arm leaves the hips. This test is also easy to administer, requires no equipment, and effectively screens for balance impairments.

Core Stability Training

Core stability training involves similar strategies to those utilized in the assessment process. An endurance-type training that focuses on the deep core muscles while moving the body in both open and closed kinematic chains, this training is suitable for adults and more elderly individuals. Core stability programs should include the use of balance pads and Swiss balls and should be performed at low to moderate intensity levels without the use of strength machines. Exercises should target the frontal, posterior, rotational, and lateral core muscle groups. Adapting such program for at least nine consecutive weeks has been shown to significantly increase core stability, muscle strength, dynamic and postural control, and the spinal mobility of older adults (Granacher, Lacroix, Muehlbauer, Roettger, & Gollhofer, 2013).

Conclusion

Core instability is correlated with dysfunction of the lower back and the upper and lower extremities. One can easily visualize the “core stability” concept in the body as the muscles and associated anatomical structures form a stable base upon which the thorax and the extremities move and function. Without a stable base the extent of unnecessary movements, lack of control, and risk of injuries is magnified, especially in the lower back.

Seated and standing workers should be encouraged to improve and maintain the strength of their abdominal and back muscles that move the thorax and pelvis through regular exercise programs. They must also, however, include endurance training and specific static exercises to enhance their core stability. Simple, inexpensive physical tests can be used to accurately assess the core strength and stability of workers to minimize the risks of LBP and reduce workplace absences.

References


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**Biographical Sketches**

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