Core Stabilization, Core Coordination

by Aline Newton, Certified Advanced Rolfer

ABSTRACT

This paper introduces the concepts involved in spinal stabilization from two perspectives: one, that of scientific research; and the other a theoretical and experiential framework for understanding movement based on the author's many years of study with Hubert Godard. The importance of spinal stabilization has been recognized for many centuries in diverse cultures. Modern research methods bring information available through electromyography. The mechanical and neurological aspects are described. Spinal stabilization involves a co-contraction of lumbar multifidus and transversus abdominis and seems to be an effective approach to resolving low back pain. The living movement perspective, based on the work of Godard—Rolfer, dancer, and movement educator—clarifies the involvement of the diaphragms in core stabilization, and suggests a dynamic approach to the concept of "core." Instead of a center of accumulation, it is conceived as a center of circulation.

The author is once again grateful and indebted to Hubert Godard for his capacity to respect and synthesize both the contributions of science and the wisdom of experience.

HISTORICAL PERSPECTIVE

In the past five years, the concept of spinal segmental stabilization has received considerable attention from research science.[1] Sometimes known as "core" stabilization, this approach puts a focus on the role of the abdominal muscles in rehabilitation and prevention of low back pain. Although it seems a recent discovery in the Western world, the importance of the basic movement of stabilizing has been recognized throughout history and in many cultures.

In the practice of yoga, students learn to apply "bandha" to seal the unified energy of inhalation and exhalation. These subtle movements often precede the practice of a specific pose or asana. The bandha "uddiyana" is described thus: "the belly above and below the navel should be pressed or drawn backwards toward the spine." And, more mysteriously: "uddiyana is so called because the great bird, Prana, tied to it, flies without being fatigued." The text is from 1915, but of course the pose itself dates back centuries (Figure 1 and Figure 2).

The bandha is described as having the potential to bring back youth and vigor, and the author assures us that "by practicing this for six months, one can undoubtedly conquer death."[2]

In the world of martial arts in the Chinese tradition, the lower "tantien" is found in this same area, about two inches below the navel. B.K. Frantzis describes it thus: "The tantien is the single most important gate with regard to physical health. Located in approximately the center of the body, all energy lines related to physical health and well-being connect here."[3] As with the bandha, the movement of drawing in this area of the belly to flatten the back is key in all the movements of Tai Chi.

The same idea is apparent in the work of Bess Mensendieck, who is considered to have been an influence on both Ida Rolf and Martha Graham, among others. For example, she describes "The Round Forward Trunk Bending Exercise" (Figure 3) in a text from 1937.

"Slowly draw in the abdomen by contracting the lowest section of the Abdominal muscle, starting at the lowest point of the region below the navel."[4]

More familiar to us today is the work of Joseph Pilates, Mensendieck's contemporary and compatriot. Pilates' expression for this area is the "powerhouse," also called "the girdle of strength."[5] [6]

Throughout the ages the movement that brings the navel towards the spine has been recognized as an essential underpinning of good coordination and health.

The modern investigation of this movement has come in response to a pathology, specifically the problem of low back pain. With the help of electromyography, a more precise description of what is involved in the movement is possible. The current understanding is that the movement of bringing the navel towards the spine involves a co-contraction of lumbar multifidus and of transversus abdominis, specifically the sub-umbilical portion (Figure 4; Figure 5).[7] [8]

The next section of this paper will examine the contribution of modern research to our understanding of this movement. Following that, in an attempt to broaden our perspective, we will turn to the world of movement as experienced.

Figure 1

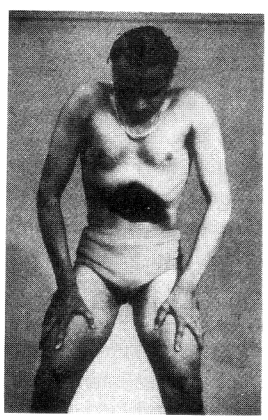


Figure 2

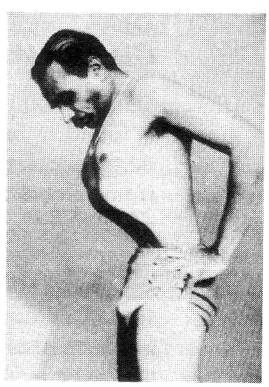
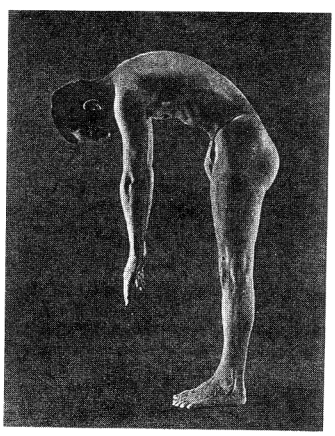


Figure 3



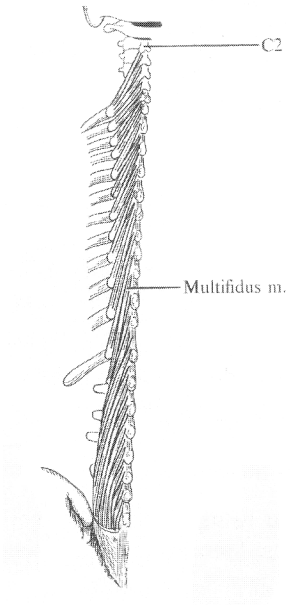


Figure 4

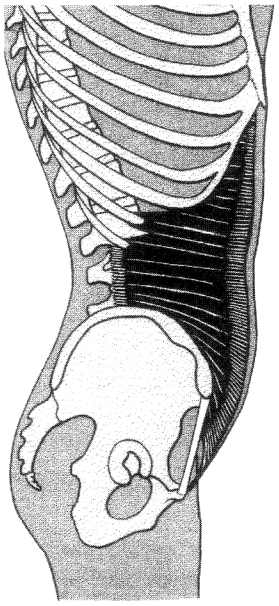


Figure 5

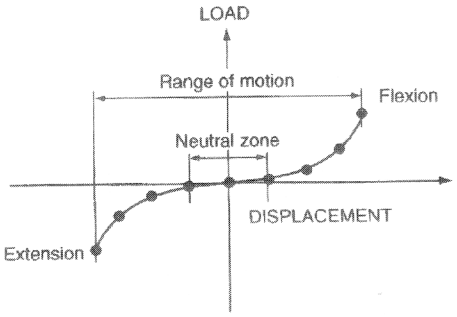


Figure 6

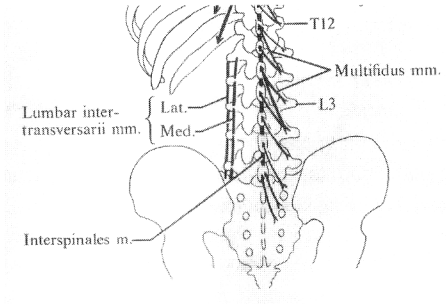


Figure 7

MECHANICS OF SPINAL STABILIZATION—WHAT IS STABILIZATION?

It is commonly accepted that what makes a back "bad" is some kind of instability or imbalance. Standard approaches to back rehabilitation usually involve mobilizing joints and strengthening muscles. Generally this has taken the form of passive manipulation for the joints combined with exercises to strengthen either abdominal muscles, as in sit-ups, or back extensors, as in the McKenzie system.

In 1992, a model proposed by Panjabi introduced a refinement in the understanding of stabilization. Instead of just looking at the joint in terms of bone and ligament, Panjabi argued that muscle involvement and neurological control would play key roles in joint stability.[9] The ligaments' main influence comes at the end range of the movement within the joint. In the mid-range of the joint, what Panjabi calls the neutral zone, the action of muscles would be necessary to maintain the joint's stability (Figure 6). Panjabi's model suggests that the three aspects—osseoligamentous, muscular and neurological—have to work together. However, to explore them here, we have to take them one at a time. We will take the mechanical aspect first, and then explore the role of the nervous system more deeply.

THE DEEP SUPPORT SYSTEM

Studies of a healthy knee joint have shown that in movement some muscles control and support the joint position, while others are engaged in moving the joint.[10] Although muscles may play different roles in different movements, through electromyography it has been possible to identify certain muscles as primarily performing a support function. For example, in the knee, the vastus medialis, which is usually considered an extensor, turns out primarily to control and support the patella during movement. [11]

The length of fibers of the stabilizers does not change very much over the course of a movement. Instead they remain consistently short to hold the joint in its neutral zone (before the end range where the ligaments get involved), to help it keep its integrity while it is handling load or doing larger motion.

GLOBAL AND LOCAL MUSCLES

Stabilization in this sense of deep support is found to be primarily the role of what Bergmark terms "local" muscles, as distinct from "global" muscles.[12] Local muscles are usually deeper and closer to the joint than the muscles involved in moving the joint, the global muscles. Local muscles also often attach directly to the joint capsules. [13] Global muscles are more superficial and tend to be larger. They are responsible for transferring and balancing external loads and for bigger movements. The local muscles' length changes very little and thereby does not have a big impact on the actual movement of the joint. The job of local muscles is primarily to stabilize the joint while the other muscles do the moving.

MULTIFIDUS AND TRANSVERSUS

Two muscles have been identified as primary stabilizers of the low back: lumbar multifidus and transversus abdominis. Because of their location and the direction of their fibers, these muscles control the lumbar and lumbo-sacral joints specifically, rather than acting on the relationship of thorax and pelvis (Figure 7).

"With reference to the trunk, McGill provided evidence that the deep fibres of the lumbar multifidus undergo only minimal changes in length throughout the range of motion. This is due to their proximity to the center of rotation of the lumbar joints and suggests that this specific component of the back muscles contributes minimally to the production of motion. In addition, due to the transverse orientation of the muscle fibres of the transversus abdominis, biomechanically, it cannot contribute to extension,

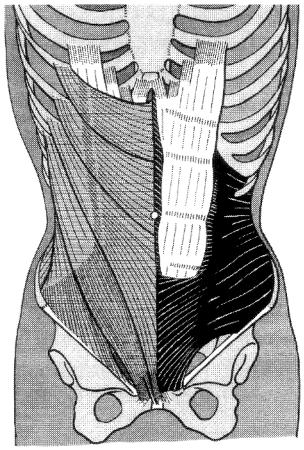


Figure 8

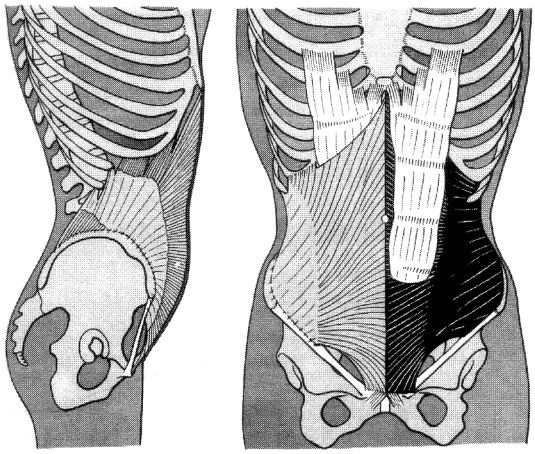


Figure 9

flexion or lateral flexion of the spine...

"Thus the transversus abdominis and lumbar multifidus, like the vastus medialis obliquus of the knee, have primary roles that do not include the production of motion."[14]

The responsibility of these deep support muscles—transversus abdominis and lumbar multifidus—is not to move the spine, but to stabilize it so that other muscles can move the trunk without compromising the integrity of the joints. For the lumbar spine, transversus and lumbar multifidus are examples of local muscles, while rectus abdominis and the external obliques are examples of global muscles (Figure 8). Engagement of rectus abdominis or the external obliques is likely to pull the chest and pelvis together. The direction of transversus fibers, in contrast, is parallel to the vertebrae. Transversus thus will be able to act very precisely on each vertebra, one at a time.

The co-contraction of the transversus, in particular the sub-umbilical portion, and lumbar multifidus muscles on each side of the spine will be able to increase the stiffness of the lumbar segments without interfering with trunk movement. The result of their contraction does not interfere with rotation, mobility of the trunk in general, or with the freedom of motion of the limbs. In fact, it hardly moves the spine at all: it actually holds it in place. Co-contraction at the level of deep, local, muscles can create support without restricting bigger movement. In dance, yoga and martial arts, it is important because it allows the mover to be strong in the belly and still free above.

NEUROLOGICAL COMPONENT

The effectiveness of a support muscle depends on a neurological component as well as a mechanical one. The muscle must be strong enough to do its job of stabilizing, and also it must act at the proper time. In Panjabi's model (see above), knee problems or back pain and instability were associated with too *large* a neutral zone, in other words, the stabilizer muscles took *too long* to begin to fire. When the deep support system doesn't do its job, the ligaments are at risk. Several studies have shown that a contraction of transversus abdominis normally will *precede* the contraction of muscles producing movement of either arm or leg by around 110ms. A healthy body automatically uses transversus to stabilize the spine before initiating any movement of the limbs themselves. In patients with a history of back pain, the contraction of transversus abdominis was delayed from 50-450ms.[15] The pathology seems to be more a result of inadequate stabilizer function than a problem in the global muscles. For the stabilizer muscles, good functioning depends on more than strength: it depends on coordination, on nervous system control. Timing is essential: To maintain a joint's integrity they must be able to fire before the main muscles of action. Stabilization is pre-movement.[16]

THE ROLE OF LUMBAR MULTIFIDUS AND TRANSVERSUS IN LOW BACK PAIN REHABILITATION

Carolyn Richardson and her colleagues in Australia investigated the role of these muscles in back pain and healthy patients.[17] In Richardson's experiment, the researchers found that only 10% of those with a history of low back pain could activate the transversus abdominis, compared with 82% of the non-low-back-pain subjects. They found that patients who performed exercises that specifically targeted the transversus abdominis over the course of ten weeks experienced a significant decrease in pain and an increase in functional ability compared to the control group, which received conventional treatments such as swimming, workouts and sit-ups. At the 30-month follow-up, the improvement had been maintained.

As for the multifidus, it was found that in patients with back pain, the size of the muscle was reduced at the segment and on the side of the pain. The studies found that when the size of the lumbar multifidus had been increased through specific exercises, there was a significantly lower incidence of recurrence of low back pain episodes.

Richardson's research supports the idea that the back pain results more from inadequate function of the stabilizer muscles than deficiency in the global muscles. One implication of this is that many stabilization programs are not specific enough. Sit-ups and lumbar extension exercises most often do not differentiate between global and local muscle involvement. Even programs calling themselves "core stabilization" may not make this distinction. This is problematic because too much development of global muscles was found actually to interfere with the action of the local stabilizer system.

Richardson's study also confirms the importance of the neurological component. She reports:

"The motor skill which was practiced with high repetition changed the size of the inhibited levels of the multifidus in acute back pain patients quite quickly, in some patients within a week. With this time frame, it can be surmised that the exercise effect was not related to muscle hypertrophy, but perhaps to neurally related events in the muscle which reestablished its size as well as its control of the associated lumbar segments."[18]

An important part of rehabilitation is to reestablish the appropriate sequence of firing of the muscles: local stabilizers first, global muscles after. The exercises that Richardson used in the back pain experiment have a component of kinesthetic education, learning to feel the subtle sensation of the pre-