ORE TRAINING™ has gained popularity in recent years. Typical programs include a variety of abdominal training techniques, emphasizing isometrics with imposed loads through limb movement. Core training is used for rehabilitation and in most strength and conditioning programs. A consideration in addition to strength when designing core-training programs is core mobility.

Anatomically, the core is defined as the lumbopelvic–hip complex. When considered as a functional unit, the core must be not only stable but also mobile to accommodate ranges of motion required for sport. A primary purpose of the core during athletic movement is to transfer momentum. The core transfers momentum from the lower extremities through the pelvis and spine to the upper extremity. A key point momentum transfer during most athletic movements, such as overhead throwing and hitting, is between the pelvis and upper torso. Rotational movement between these segments allows for an exponential increase in rotational velocity from the pelvis to the upper torso. Energy is then passed to the upper extremities and ultimately to the hand for throwing or to the implement for hitting. This process of increasingly greater rotational velocities between body segments is known as kinetic linking. Welch et al. describe a kinetic link as

large base segments passing momentum to smaller adjacent segments. The basic principle is that a system of segments moving at a certain velocity has momentum. When a large base segment decelerates, the velocity of the remaining system increases as it assumes the momentum lost by the base segment. Overhead-pitching studies have shown increased throwing speed in those who maximize pelvic and upper torso rotation range of motion (ROM) and velocity. Maximizing kinetic-linking parameters is thought to greatly contribute to an athlete’s physical performance.

Kinetic linking can only be tested with motion analysis, but the functional relationship of the muscles and joints of the core can be tested clinically. This relationship is complex, with 29 muscles having attachments throughout the core. Isolated ROM and strength testing might not be adequate to identify the functional-movement needs of athletes. Isolated muscle tightness or joint ROM deficits might or might not contribute to changes in movement, because athletes commonly compensate for a given deficit. If asymmetrical movement patterns develop as a result of compensations from tightness, the compensatory movement is thought to be less efficient. This inefficiency can disrupt ideal kinetic linking during athletic movement. In addition, it has been suggested that joint proprioceptors are more active toward the end ranges of motion. Therefore, reduced mobility might be associated with a reduction in afferent input, which, over time, could affect functional-movement patterns.

Because of the complex integrated nature of the core and the importance of full-range symmetrical movement, a movement-based functional assessment and training approach is recommended. If stability and strength are prioritized before mobility training, an inefficient compensatory motor program might be reinforced and, with repetitions of training, become permanent. The goal of assessing and training the mobility of the core, before aggressive strength or stability training, is to normalize hip and upper torso
ROM to allow for maximum functional strength gains from rehabilitation- or performance-enhancement-oriented core-stability-training programs.

The purpose of Part 1 of this three-part series is to explain movement tests that athletic trainers can use clinically to assess the core from a functional-movement perspective. Part 2 will focus on functional-movement training for the core, and Part 3 will be dedicated to functional-movement and muscle testing related to athletic low back pain.

Two functional-movement tests, the deep squat and total rotation, are presented, as well as associated isolated tests that can be used if deficits are identified. Testing to identify abnormal movements that can contribute to or cause a given pathology was emphasized by Janda and popularized in physical therapy by Sarhmann. Based on the premise that compensatory movement is detrimental to normal function, Cook developed a functional-movement evaluation and training program to complement physical therapy intervention and a functional-movement screening program to be incorporated into athletic rehabilitation and conditioning. The tests presented here are derived from this original work.

**Deep Squat**

The deep squat is used to assess bilateral mobility of the hips, knees, and ankles, as well as the sagittal-plane movement between the pelvis and spine. The athlete places his or her feet shoulder-width apart and presses a dowel overhead, then descends into a squat position while keeping heels flat on the floor and trunk upright (Figure 1). Key observation points include heels flat, trunk upright, hips breaking parallel, and equal weight bearing in the frontal plane.

Suggested isolated testing if key criteria are not met includes ankle-mobility assessment (Figure 2) and prone hip-mobility testing (Figure 3). This test allows isolation of muscle lengths normally assessed during the Thomas test and is an effective position from which to manually treat identified tight muscles. Tightness in the iliopsoas, rectus femoris, or tensor fascia latae/iliotibial band tends to alter normal lumbopelvic movement, making the deep squat difficult.

**Total Rotation**

The total-rotation test assesses an athlete’s ability to disassociate pelvic and upper torso movement. The motion primarily comes from the hips rotating in opposite directions and the upper thoracic spine rotating. The athlete stands with feet shoulder-width apart, then naturally looks over one shoulder and rotates as far as possible without moving the feet. The test is repeated in the other direction (Figure 4). Key observation points include the following: Pelvis movement accounts for approximately 50% of total motion, upper torso can rotate through at least 90° (can see opposite anterior shoulder), and symmetry with movement left and right.

![Figure 1 Deep squat. (a) Key observations from the lateral view include heels flat, upright trunk, and breaking parallel. (b) From the anterior view, equal weight bearing without shifting left or right is appreciated.](image1)

![Figure 2 Assessing closed kinetic chain dorsiflexion for anterior impingement or posterior tightness that could limit range of motion. Excessive compensatory subtalar-joint pronation is also a consideration.](image2)