



Core Stability

The core is where the most of the body's power is derived. It provides the foundation for all movements of the arms and legs. The core must be strong, have dynamic flexibility and function synergistically in its movements in order to achieve maximum performance. Motion of the human body is not isolated to one muscle or tissue moving in one specific direction. Rather, it is a complex event involving agonists and antagonist structures that work together to create changes in position and/or location, and to stabilize the body in all three directional planes. Regardless of what sport one plays, it is essential to have core strength and trunk stability to maximize performance and prevent injury.

What Makes Up the Core

The foundation of the core is much more than the abdominal muscles. It includes muscles deep within the torso, from the pelvis up to the neck and shoulders. The core includes the following structures:

- **Multifidus** – deep spinal muscles that run segmentally from the neck (C2) to the sacrum. They produce extension and, to a lesser degree, rotation and lateral flexion forces that provide stability to joints at individual levels of the spine.
- **Interspinales, Intertransversarii, Rotatores** – deep structures that attach directly to the spinal column. These are very important for rotatory motion and lateral stability.
- **External Obliques** – abdominal muscles that attaches at the lower ribs, pelvis, and abdominal fascia.
- **Internal Obliques** – abdominal muscles that attaches at the lower ribs, rectus sheath, pelvis and thoracolumbar fascia.
- **Transversus Abdominis** – abdominal muscles that attaches at the lower ribs, pelvis and thoracolumbar fascia, and rectus sheath.

These abdominal muscles work together to transmit a compressive force, and act to increase intra-abdominal pressure that stabilizes the lumbar spine. They also work individually to perform trunk rotation, while the internal and external obliques on the same side can work together, or synergistically, to laterally flex the spine.

- **Rectus abdominis**- abdominal muscle that attaches at the fifth through seventh ribs, the lower sternum and the front of the pubic bone. This muscle flexes the spine, compresses the internal organs of the abdomen and transmits forces laterally from the obliques. It is a common fallacy that the upper and lower rectus are isolated differently. Training the rectus can be done with one exercise.
- **Erector Spinae** – help to counterbalance all the forces involved in spinal flexion. They begin as the sacrospinalis tendon that attaches at the sacrum and ilium. This tendon then gives rise to different muscles that run up the spine and

obliquely to attach at lateral parts of the vertebrae and the ribs. In the cervical region, these muscles attach at the base of the skull.

- **Quadratus Lumborum** – attaches at the 12th rib and the upper 4 lumbar vertebrae and the pelvis. It stabilizes the lumbar spine in all planes of motion, stabilizes the 12th rib and the attachment of the diaphragm during respiration, and laterally flexes the trunk.
- **Latissimus Dorsi** – this is the largest spinal stabilizer. It attaches via the thoracolumbar fascia to the lumbar vertebrae, sacrum and pelvis, and runs upward to the humerus. It assists in lumbar extension and stabilization, and also performs pulling motions through the arms.
- **Thoracolumbar Fascia** – connects the latissimus dorsi, gluteal muscles, internal obliques and transverse abdominis, supplies tensile support to the lumbar spine, and is used for load transfer throughout the lumbar and thoracic regions.
- **Abdominal Fascia** – connects to the obliques and rectus abdominis, and to the pectoralis major. Fascial connections that cross the midline transmit forces to the muscles of the opposite side of the body.

Training the Core

The common myth is that training the core simply involves sit ups and back extensions. An efficient core routine consists of multiplanar movements - training in all planes of motion. As the body moves, the center of gravity changes, and forces exerted by, and on, the body's tissues are constantly changing. Dynamic stabilization must be included to increase proprioception and stability in the trunk, as well as in the rest of the body. This allows the parts of the body to react efficiently to external forces and stresses, such as gravity, changes in terrain, and carrying loads, as well as the internal forces exerted by other muscles.

Dynamic stability is best achieved through training in functionally practical positions that mimic activities or movements in one's particular sport, or in life as a whole. With this in mind, one can conclude that most core training that is done while sitting or lying down and limiting pelvic movement has little functional value.

Medicine balls, balance boards and stability balls are great tools for core training and should be integrated into every program. Core exercises should include strengthening, as well as challenges such as standing one-legged and/or two-legged on stable and unstable surfaces, reacting to external forces such as a partner's light push or the catching and throwing of a medicine ball, and moving the joints of the body through all planes of motion.

The goal of functional core training is to develop in the core a system of efficient automatic responses to work as a stable base from which to generate optimal force and motion.

Postural Distortion And Biomechanical Dysfunction

Consider how the chronic shortening of just one muscle, which happens to be a core muscle, can impede performance and cause imbalances that lead to injuries.

The rectus abdominis is a good example of an over worked muscle. As this muscle is overworked, the other core muscles are often ignored. Crunches, leg raises and exercises using abdominal machines all work only in the sagittal plane, therefore limiting “benefit” to muscles that produce hip and trunk flexion. (Note that repetitive trunk flexion places increased injury-causing stress on the intervertebral discs of the lumbar spine). It is imperative to train the core in a multi-planar fashion, especially the transverse plane, in order to create stabilization in the trunk, and in effect more optimal posture, strength and motion in the entire body. The following is a common example of the result of overworking the rectus abdominis.

A tight rectus abdominis, when creating tension, or pull, on its upper and lower attachments, including the anterior pelvis, anterior ribs and inferior sternum, produces a flexion force in the trunk. This has consequences beyond the immediate structures affected.

These consequences include a chain of effects that begin with shortening and tightening of the pectoral muscles. These muscles will exert an inferior tension on the clavicle, superior ribs, and the anterior scapula and will assist in internally rotating the humerus.

The force of gravity also contributes to the internal rotation of the glenohumeral, or shoulder joint, as the trunk flexes forward. Internal rotation of the humerus tensions and lengthens the external rotators of the shoulder which in combination with the tension exerted on the anterior scapula by the pecs, will bring the scapula into protraction, lengthening and weakening the middle and lower trapezius, and rhomboid muscles. (Note that a tight latissimus dorsi can also be a primary contributor to internal rotation of the humerus.) The internally rotated humerus and protracted scapula will place the rotator cuff muscles at a biomechanical disadvantage in dynamically stabilizing the glenohumeral joint. The cuff will not function effectively, increasing the risk of injury.

The reaction of the cervical spine is two-fold. The lower segments of the cervical spine follow the forward and downward movement of the trunk, and they themselves flex, causing lengthening and weakening of the deep cervical flexor muscles. (This can also stress the outer layer of the intervertebral discs, which over time, may lead to injury.)

Naturally, if the lower cervical spine flexes forward, the head will follow, and if this force is not countered, gravity will cause the head to fall forward. In order to prevent this from happening, tension will develop in the cervical extensors, including the upper trapezius, splenius, semispinalis, spinalis and sub-occipital groups, which attach to the base of the skull. The upper cervical segments including the base of the skull are extended, shortening the sub-occipital muscles. This extension will allow the skull to remain somewhat level as it rests on the atlas, or the uppermost cervical vertebra.

The over-working of the upper trapezius muscle and lengthening and weakening of the middle and lower trapezius and the rhomboids will also contribute to early elevation of the scapula with shoulder motion. This will worsen the position of the glenohumeral joint and will further stress the rotator cuff.

This example has been limited to the rectus abdominis. It is important to understand that single muscles are rarely the isolated culprits in postural distortions and biomechanical dysfunction. (An exception would be an acute specific muscle injury that has not healed correctly and has caused compensatory overloading in other areas.) Because muscles act synergistically and as agonists and antagonists, there is usually more than one contributor. There are also connections between muscles through tough fascial connective tissue, which help to transmit forces between tissues. These cases of dysfunction can be rooted in other parts of the body, as the musculoskeletal system functions as a whole.

Not only will these faulty positions and compensatory biomechanics cause an athlete to move inefficiently. Over time they may lead to degenerative processes in the soft tissues and joints that will lead to further injury and impairment.

The neurological system also adapts to these changes, applying muscle memory, as it controls the musculature. Training this system is essential in developing healthy neurological pathways and muscle firing patterns. This is achieved through the methods mentioned above – using medicine balls, balance boards and stability balls and challenging the neuromuscular system.

Any of the muscles mentioned above may be the source of dysfunctional patterns, but it will most likely be a combination of them that will be the cause. It is important to follow the entire kinetic chain when assessing and treating these conditions.

Cycling¹

Most cyclists focus on their hamstrings, quadriceps and gluteal muscles, and forget about the importance of core stability.

Consider how many hours the cyclist spends bent over in a flexed position on the aero bars, with no rotational or side bending motions. A strong core is needed to counter-balance these forces.

With a focus on the core, a cyclist can generate more power and can sustain a higher level of intensity for longer periods.

A stronger core also means less stress on the primary muscle movers and a delay in the build up of lactic acid.

Even minor changes such as brake position can affect core stability¹.

If the brake handle position is too low, the cyclist is forced to reach too far forward with their forearms.

- This reaching position forces the cyclist to raise their head forcing the pelvic girdle posterior. This position can cause a restriction in several key muscles in the core, thus reducing performance.
- The ideal position for the forearms is to have the elbows bent and the forearms flattened out. In this position, the cyclist head drops into a more comfortable aerodynamic position, and the pelvis tilts forward. In this position, the cyclist is able to use all the core muscles with improved efficiency.

Running

Now consider how a shortened *rectus abdominis* affects a tri-athletes performance during running. Although opinions about the 'ideal running form' vary greatly, most authorities will agree that the less energy that is expended, the more effective and efficient the running style will be.

Common running recommendations¹

(Runners World Online)

- Run upright. Your back should be straight, roughly at a 90-degree angle to the ground.
- Look straight ahead. Your eyes should be focused straight down the road on a point moving about 10 meters in front of you. This helps to keep you in a straight line.
- Swing your arms naturally. The angle at the elbow between your upper and lower arms should be about 90 degrees. Your hands should be loosely cupped, about belly level.

How a shortened rectus abdominis affects your running¹

- A shortened rectus abdominis will pull the runners posture forward. This causes a braking action that reduces running economy.
- As the rectus is shortened, it pulls the chest forward allowing gravity to pull the head down. In order to look straight ahead as instructed, the athlete wastes a considerable amount of force in trying to overcome the contracted rectus abdominis.
- As the shoulders move forward, a shortened rectus abdominis causes the arms to rotate internally. This makes keeping your arms relaxed at the recommended 90-degree angle much more difficult, reducing running economy.

When performing a biomechanical analysis, it is very common to see numerous imbalances of which the athlete is completely unaware. By video taping an athlete during activity the practitioner can show and explain what is happening then correct it.

When analyzing a runner, some of the most common biomechanical faults looked for are:

- Over-pronation (rolling in as arches collapse) in the feet – this can cause a series of biomechanical imbalances from the foot up to the cervical spine.

- Excessive hip adduction – due to tight hip adductors and can cause increased load in the lateral tissues such as the iliotibial band, tensor fascia lata and gluteus medius.
- Lack of trunk rotation - due to restrictions in trunk rotators or shoulder extensors. This can cause overload in the hip musculature, spinal joints, and other trunk rotators.
- Lack of hip extension – caused by tight hip flexors restricting extension, and weak gluteal muscles. This causes the extensors and rotators of the lumbar spine to become overloaded in order to compensate for the lack of hip extension.
- Lack of shoulder extension – caused by restrictions in anterior shoulder muscles or poor trunk rotation.

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