

Core: The Foundation of Movement

Why is the core important?

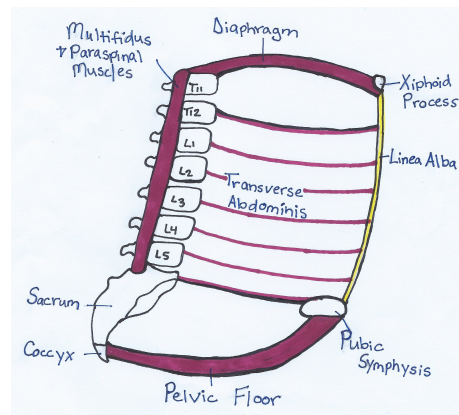
- offers stability to protect the spine
- offers foundation for the legs and arms to move
- improves amplitude through efficient force transfer.
- improves shaping which improves energy transfer and decreases stress risks.
- improves the SI/Pelvic torque conversion from spinal rotation to hip flexion extension

The importance of core stability for injury prevention in athletes has received some support from studies relating low core stability to incidence of injuries of the back (Cholewicki 2005) and lower extremities (Zazulak 2007; Leetun 2004).

What muscles make up the “core”?

- Diaphragm
- Transverse Abdominus
- Pelvic Floor
- Multifidus & Paraspinals
- Internal Obliques
- External Obliques

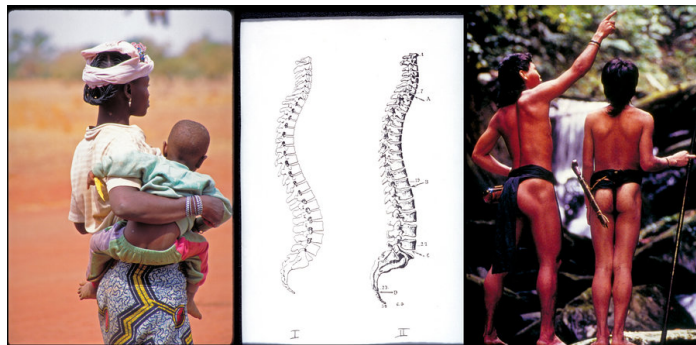
(Julie Weibe 2013, 2016)



Not included in this list is the Rectus Abdominus (6-pack muscle) because it does not attach to the lumbar spine or offer stability to the spine, which means the 6-pack muscle does nothing for shaping or transfer of forces. It looks pretty and supports the internal organs.

Neutral Spine

The spine has natural curves in it. The current traditional model shows an S curve when looking from a side view, with a forward curve at the neck, a backward curve at the mid-back/thoracic spine, a forward curve at the low back, and a backward curve at the sacrum/tail-bone. Though the S-curve is still the most widely accepted model, recent medical an-



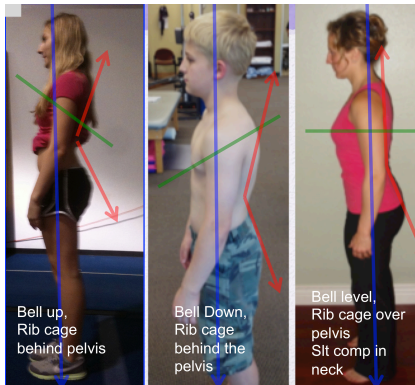
"Primal posture: Ubong tribesmen in Borneo (right) display the perfect J-shaped spines. A woman in Burkina Faso (left) holds her baby so that his spine stays straight. The center image shows the S-shaped spine drawn in a modern anatomy book (Fig. I) and the J-shaped spine (Fig. II) drawn in the 1897 anatomy book *Traite d'Anatomie Humaine*. Courtesy of Esther Gokhale and Ian Mackenzie/Nomads of the Dawn" (Doucleff 2015)

thropology research has proposed a “J-Spine” as ideal. A flatter mid-back/thoracic spine and a slightly less pronounced curve at the low back with well defined gluteals creates an appearance of a J rather than an S-curve in the spine. Writings, drawings and current posture of an indigenous tribe in central India exhibit a J-spine and essentially no one among this tribe has reported low back pain. This J-spine is found among several cultures with low incidence of back pain. It is believed that this J spine or alignment of the rib cage over the pelvis maybe correlated to decreased stresses on the lower back (Douceff 2015) (Little 2008).

Postural Alignment: Effects on the Diaphragm-Pelvic Floor-Transverse Abdominus Piston System

Rather than focusing on the shape of the spinal curves, Julie Weibe, PT looks at the rib cage as a “bell” and discusses the effects of the position of the “bell” over the pelvis on the core function. The position of the “bell” or thoracic cage affects the entire spinal alignment from the thoracic spine to the lumbar spine to the tilt of the pelvis (Harrison 2002) (Weibe 2013, 2016). Weibe goes on to describe, neutral pelvis and rib cage over the pelvis puts the core in mid range (Weibe 2013, 2016). Muscles are strongest at their midrange and weakest when they are long or short. For example,

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much easier to lift a heavy weight using the biceps with the elbow bent at 90 degrees. It is much harder when the elbow is either completely straight or completely bent. Claus 2009 looked at the transvers abdominus and multifidus with various sitting postures. They found that the transvers abdominus and multifidus were the LEAST active with the spine in flat back position (flat upper back and tail tucked/HOLLOW). They also found minimal activation military position (exaggerated “erect” posture creating increased low back curve, bell up) and in a slump posture (bell down). The transverse abdominus and multifidus were the MOST active when sitting in a position closer to spine neutral gentle lordosis in the low back and gentle curve in the mid back and neck (Claus 2009). Sapsford 2006 researched the pelvic floor muscles in sitting and found that as patients moved toward spine neutral they improved resting activation of the pelvic floor.

Spine neutral or bell/rib cage hanging directly over the pelvis achieves the optimal relationship between the diaphragm and pelvic floor and optimal “core” recruitment.

Respiratory Affects on the Piston System

Hodges, Sapsford, Pengel 2007 found that inhalation produces an increase in internal pressure as the diaphragm, pelvic floor, and transverse abdominus lengthen or become elastically loaded. This increase in intra-abdominal pressure creates central stability during the inhalation phase. During exhalation the diaphragm, pelvic floor, and transverse abdominus recoil or reflexively contract, creating central stability during the exhalation phase (Hodge, Sapsford, Pengel 2007).

If the diaphragm and pelvic floor are seen as two trampolines they will drop slightly on inhalation and then on exhalation they rebound back up. The transverse abdominus or “waist” expands on inhalation and recoil/contract on exhalation (Talas 2011).

Bottom line, central stability comes down to the breath. The transverse abdominus works in response to the diaphragm and internal pressure changes (Hodges 2000). The pelvic floor pre-engages prior to transverse abdominus, matching the demands placed upon it (Sapsford & Hodges 2001).

Pre-Activation of the Piston System Before Movement

EMG studies found that prior to the activation of the deltoid to raise the arm or the hip with a straight leg raise, the transverse abdominus and diaphragm pre-engage predictably in a uniform way no matter the direction of movement (Hodges 1997 TA, Hodges 1997 Dia) (Sjodhal 2009). The same was found prior to elbow movement but not with hand or digit movement. Hodges (1997) also found that the diaphragm will pre-engage no matter what phase of respiration it is in. Luginbuehl (2013) found that the pelvic floor activates before the heel strike in running. The system not only pre-engages but it will perform to match the demands placed on the system. For example, you don't need the same amount of pelvic floor, diaphragm and transverse abdominus activation to lift a bottle of water as you do to lift a heavy box of books.

Summary of the Piston System

The core piston system is anticipatory and dynamic, dependent on optimal rib cage over pelvis spinal alignment. It should automatically turn on before movement of the extremities (arms or legs) to create an anchor for organized movement. Breathing is strongly correlated to the health of the piston system. The sequence of the muscles firing depends on the direction of movement to counterbalance the forces and responds to the demands of function/gymnastics. The muscles work and interact/react to each other. IT IS A SYSTEM! (Wiebe 2016)

The System is:

- Pre-loading/Anticipatory
- Dynamic
- Coordinated

Traditional Ab Training

When doing traditional forms of “ab” work, we are training the transverse abdominus and the pelvic floor to hold a firm isometric contraction which does not allow for “waist” or abdominal expansion or proper rib cage expansion. This stifles central stability by not allowing the dynamic Diaphragm-pelvic Floor-Transverse Abdominus Piston System to function the way it should (Wiebe 2016). Traditional forms of “ab” work in the gymnastics world are typically done in a “hollow” or “bell down” position which turns off the piston system (transverse abdominus, multifidus, and pelvic floor). This repeated training in a “hollow” diminishes central stability and contributes to pelvic floor dysfunction. Over time as the level of gymnastics competition increases, and forces increase and lead to urinary leakage with tumbling. Fifty percent of the 2011 artistic national team had urinary leakage with tumbling (USA Gymnastics 2012). Seventy percent of high level trampolinists had urinary leakage (USA Gymnastics 2012). Many male and female gymnasts have trained themselves at rest to keep a consistent tone in the transverse abdominus and pelvic floor, holding in their stomach for aesthetic looks, never truly having waist excursion with breathing. The old school use of “belly bands” or tapping athletes on their bellies and telling them to tighten up contributes to continued dysfunction. These old paradigms perpetuate the pelvic floor dysfunction and set up our athletes for central INSTABILITY. Central instability or dysfunction of the Pelvic Floor- Diaphragm-Transverse Abdominus System can lead to urinary leakage, pain with insertion of tampons (or painful sex when later sexually active), constipation, and very commonly hip and back pain due to the pelvic floor muscle connections to the sacrum and hips (seen in both males and females). This lack of central stability can lead to injury anywhere distal from the chain: TMJ, neck, shoulder, elbow, wrist, hip, knee, and ankle injuries. These are just the symptoms of a dysfunctional center or foundation (Wiebe 2016).

The #1 cause of MOST gymnastic injuries stems from imbalances and/or poor timing in the core piston system.