# Pelvic Stability & Your Core

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## Introduction

A primary function of the pelvis is to transfer the loads generated by body weight and gravity during standing, walking, sitting and other functional tasks. How well this load is managed dictates how efficient function will be. The word 'stability' is often used to describe effective load transfer and requires optimal function of three systems: the passive (form closure), active (force closure) and control (motor control) (Panjabi 1992). Collectively these systems produce approximation of the joint surfaces (Snijders & Vleeming 1993a,b). The amount of approximation required is variable and difficult to quantify since it depends on an individual's structure (form closure) and the forces they need to control (force closure). The following definition of joint stability comes from the European guidelines on the diagnosis and treatment of pelvic girdle pain (Vleeming et al 2004).

## Definition of Joint Stability

> *"The effective accommodation of the joints to each specific load demand through an adequately tailored joint compression, as a function of gravity, coordinated muscle and ligament forces, to produce effective joint reaction forces under changing conditions. Optimal stability is achieved when the balance between performance (the level of stability) and effort is optimized to economize the use of energy. Non-optimal joint stability implicates altered laxity/stiffness values leading to increased joint translations resulting in a new joint position and/or exaggerated/reduced joint compression, with a disturbed performance/effort ratio.*
> (Vleeming A, Albert H B, van der Helm F C T, Lee D, Ostgaard H C, Stuge B, Sturesson B).

Based on this definition, the analysis of pelvic girdle function will require tests for excessive/reduced joint compression (mobility) as well as tests for motion control of the joints (sacroiliac (SIJ) and pubic symphysis) during functional tasks (one leg standing, active straight leg raise). Motion control of the joints requires the timely activation of various muscle groups such that the co-activation pattern occurs at minimal cost (minimal compression or tension loading and the least amount of effort) to the musculoskeletal system. Analysis of neuromuscular function will require tests for both motor control (timing of muscle activation) and muscular capacity (strength and endurance) since both are required for intersegmental or intrapelvic control, regional control (between thorax and pelvis, pelvis and legs) as well as the maintenance of whole body equilibrium during functional tasks. Treatment protocols should include techniques to reduce joint compression where necessary, exercises to increase joint compression where and when necessary and education to foster understanding of both the mechanical and emotional components of the patient's experience.

## Passive System Analysis of the SIJ

For many decades, it was thought that the SIJ was immobile due to its anatomy. It is now known that mobility of the SIJ is not only possible (Egund et al 1978, Hungerford et al 2004, Lavignolle et al 1983), but essential for shock absorption during weight bearing activities and is maintained throughout life (Vleeming et al 1992a). The quantity of motion is small (both for angular and translatoric motion) and variable between individuals (Kissling & Jacob 1997).

The passive system (joint/ligaments) is analysed by comparing the amplitude and symmetry of motion between the innominate and sacrum (Lee 2004, Lee & Lee 2004)). The SIJ is then passively taken into the close-packed position (the position where there is maximum congruence of the joint surfaces and tension of the articular ligaments) which for the SIJ is sacral nutation/posterior rotation of the innominate) and the translations are repeated. When the ligaments are intact and healthy, no translation of the joint should occur in this close-packed, stable position. In addition, this test should be pain free. If there is increased motion when the SIJ is in a neutral position and this translation persists in the close-packed position, this suggests that the ligaments have been stretched and a deficit in the passive system is implicated. This test often reproduces SIJ ligamentous pain. If there is increased motion when the SIJ is in a neutral position and no translation occurs when the joint is in the close-packed position, this suggests that the force closure or motor control system is impaired and that there is insufficient (or at least asymmetric) compression of the SIJ in neutral. Further tests are required to determine the specific deficit in the motor control system.

## Motor Control and the SIJ

Function would be significantly compromised if joints could only be stable in the close packed (self-locked or self-braced) position. Stability for load transfer is required throughout the entire range of motion and is provided by the active system (directed by the control system) when the joint is not in the close packed position. Optimal force closure of the pelvic girdle requires just the right amount of force being applied at just the right time (Hodges 2003). This in turn requires a certain capacity (strength/endurance) of the muscular system as well as a finely tuned motor control system, one that is able to predict the timing of the load and to prepare the system appropriately. The amount of compression needed depends on the individual's form closure and the loading conditions (speed, duration, magnitude). Therefore there are multiple optimal strategies possible, some for low loading tasks and others for high loading tasks. The compression, or force closure, is produced by an integrated action and reaction between the muscle systems, their fascial and ligamentous connections, and gravity. The timing, pattern and amplitude of the muscular contractions depend on an appropriate efferent response of both the central and peripheral nervous systems which in turn rely on appropriate afferent input from the joints, ligaments, fascia and muscles. It is indeed a complex system, often difficult to study, yet when one returns to the definition of joint stability (the ability to transfer loads with the least amount of effort which controls motion of the joints) not difficult to assess or treat.

A healthy, integrated neuromyofascial system ensures that loads are effectively transferred through the joints while mobility is maintained, continence is preserved and respiration supported. Non-optimal strategies result in loss of motion control (excessive shearing or translation) often associated with giving way, and/or excessive bracing (rigidity) of the hips, low back and/or rib cage. These strategies often create an excessive increase in the intra-abdominal pressure (Thompson et al 2004) which can compromise urinary and/or fecal continence. In addition, non-optimal respiratory patterns, rate and rhythm can develop. Often, patients with failed load transfer through the pelvic girdle present with inappropriate force closure in that certain muscles become overactive while others remain inactive, delayed or asymmetric in their recruitment (Hungerford et al 2003). These alterations in motor control must be considered during assessment because if altered, the system is not prepared for the loads which reach it and repetitive strains of the passive soft tissues can result. In particular, the recent evidence regarding the role of transversus abdominis, the deep fibres of the lumbar multifidus and the pelvic floor muscles suggests that they be singled out.

Although it does not cross the SIJ directly, transversus abdominis (TrA) can impact stiffness of the pelvis through its direct anterior attachments to the ilium as well as its attachments to the middle layer and the deep lamina of the posterior layer of the thoracodorsal fascia (Barker et al 2004). Richardson et al (2002) suggest that contraction of the TrA produces a force which acts on the ilia perpendicular to the sagittal plane (i.e.

approximates the ilia anteriorly). In a study of patients with chronic low back pain, a timing delay was found in which TrA failed to anticipate the initiation of arm and/or leg motion (Hodges & Richardson 1996). This delayed activation of TrA could imply that the thoracodorsal fascia is not sufficiently pretensed, hence the pelvis not optimally compressed, in preparation for external loading leaving it potentially vulnerable to the loss of intrinsic stability during functional tasks. Three other studies have shown altered activation in TrA in subjects with longstanding groin pain (Cowan et al 2004), low back pain (Ferreira et al 2004) and pelvic girdle pain (Hungerford et al 2003).

Hides et al (1994, 1996), Danneels et al (2000) and Moseley et al (2002) have studied the response of multifidus (deep, superficial and lateral fibres) in low back and pelvic girdle pain patients and note that the deep fibres of multifidus (dMF) become inhibited and reduced in size in these individuals. It is hypothesized that the normal "pump-up" effect of the dMF on the thoracodorsal fascia, and therefore its ability to compress the pelvis posteriorly, is lost when the size or function of this muscle is impaired.

Using the Doppler imaging system, Richardson et al (2002) noted that when the subject was asked to 'hollow' their lower abdomen (resulting in a co-contraction of TrA and dMF) the stiffness of the SIJ increased. These authors state that "under gravitational load, it is the transversely oriented muscles that must act to compress the sacrum between the ilia and maintain stability of the SIJ". Although multifidus is not oriented transversely, both it and several other muscles (erector spinae, gluteus maximus, latissimus dorsi, internal oblique) can generate tension in the thoracodorsal fascia and thus impart compression to the posterior pelvis (Barker et al 2004, van Wingerden et al 2004).

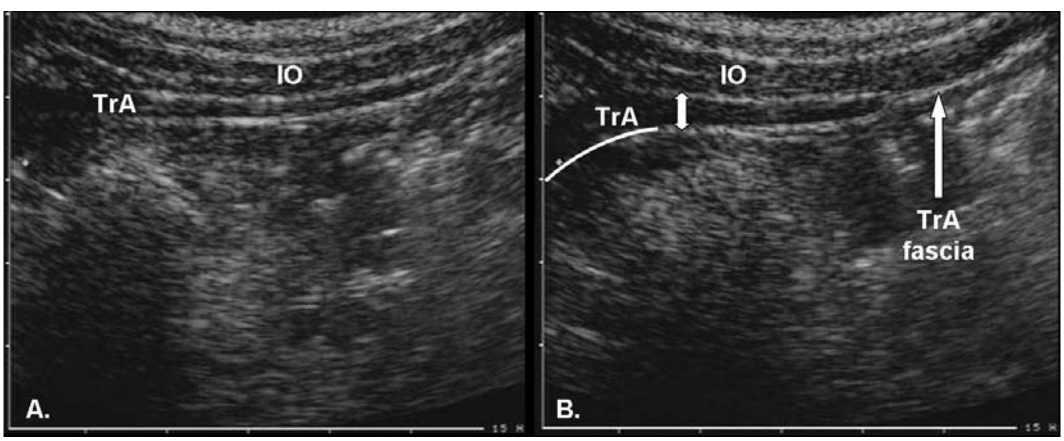
The muscles of the pelvic floor play a critical role in the maintenance of urinary and fecal continence (Ashton-Miller et al 2001, Barbic et al 2003, Bø & Stein 1994, Deindl et al 1993, 1994, Sapsford et al 2001) and recently attention has been directed to their role in the stabilization of the joints of the pelvic girdle (Lee & Lee 2004b,c,d, O'Sullivan et al 2002, Pool-Goodzwaard 2003). The research suggests that motor control (sequencing and timing of muscular activation) plays a critical role in the ability to effectively force close the urethra, stabilize the bladder and control motion of the SIJ during loading tasks.

The active straight leg raise test (ASLR) examines the ability of the patient to transfer load through the pelvis in supine lying and has been validated for reliability, sensitivity and specificity for pelvic girdle pain after pregnancy (Mens et al 1999, 2001, 2002). It can also be used to identify non-optimal stabilization strategies for load transfer through the pelvis. The supine patient is asked to lift the extended leg 20 centimeters and to note any effort difference between the left and right leg (does one leg seem heavier or harder to lift). The strategy used to stabilize the lumbopelvic region during this task is observed and the effort scored from 0 to 5. The pelvis is then compressed passively (anterior to simulate the force of TrA and posterior to simulate the force of the dMF (Lee & Lee 2004a,c)) and the ASLR is repeated; any change in strategy and/or effort is noted.

Subsequently, the patient's ability to voluntarily contract the TrA, dMF and the pelvic floor is assessed and the results co-related to the findings of the ASLR test. To assess the ability of the left and right TrA to co-contract in response to a pelvic floor cue, the abdomen is palpated just medial to the ASISs and the patient is instructed to gently squeeze the muscles around the urethra or to lift the vagina/testicles. When a bilateral contraction of TrA is achieved in isolation from the internal oblique, a deep tensioning will be felt symmetrically and the lower abdomen hollows (moves inward) (O'Sullivan et al 2003, Richardson et al 1999).

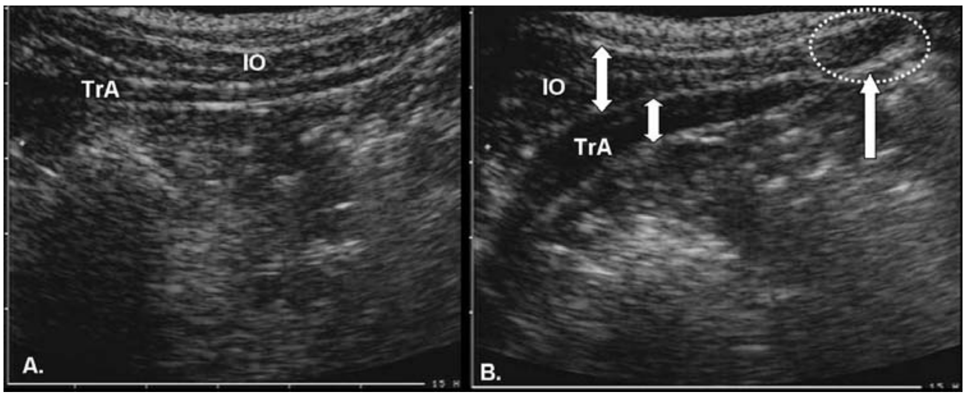
The dMF is palpated bilaterally close to the spinous process or the median sacral crest. In a healthy system, a cue to contract the pelvic floor should result in a co-contraction of the dMF (clinical experience – Lee & Lee 2004a,c). When a bilateral contraction of dMF is achieved the muscle can be felt to swell symmetrically beneath the fingers (Richardson et al 1999). There should be no evidence of substitution from the more superficial multisegmental fibers of the multifidus which will produce extension of the lumbar spine and a phasic bulge of the substituting muscle. TrA should co-activate with the dMF and both muscles can be palpated unilaterally to assess co-contraction during a verbal cue to contract the pelvic floor (clinical experience – Lee & Lee 2004a,c).

The activation patterns of the deep muscle system can also be assessed using rehabilitative ultrasound imaging (Henry & Westervelt 2005, Lee & Lee 2004c, Richardson et al 1999). The figure below on the left is of the right anterolateral abdominal wall at rest and the

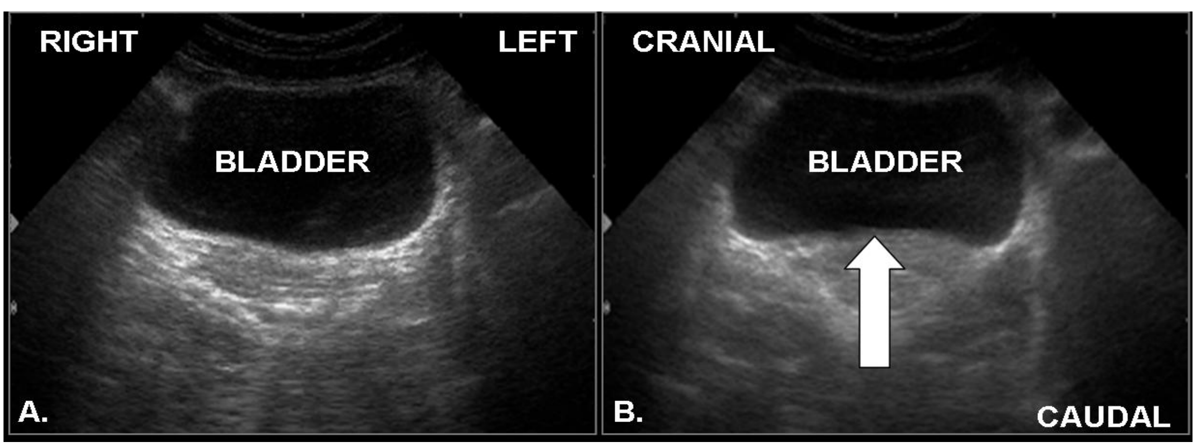



right illustrates an optimal isolated contraction of the transversus abdominis. During an optimal, isolated contraction the medial TrA fascia should translate laterally, TrA should increase in girth and the muscle should corset laterally around the trunk before any change in girth is seen in the internal oblique (IO).

The RTUS figure below on the left is of the right anterolateral abdominal wall at rest and the right is a non-optimal attempt to isolate a contraction of the transversus abdominis. There is over-activation of the internal oblique (circle) during this isolation attempt (note the increase in girth of both the TrA and the IO - arrows). This strategy results in global bracing of the abdominal wall and produces excessive compression of the rib cage which in turn limits the ability to breathe. In addition, this strategy significantly increases the intra-abdominal pressure which can have long term consequences for urinary continence especially in women.




The RTUS figure on the left is a suprapubic, transabdominal view of the pelvic floor muscles and the urinary bladder and the figure on the right is the impact that an optimal contraction of the pelvic floor has on the bladder shape. This midline lift suggests that an optimal contraction of the pelvic floor muscles has occurred.



# *Pelvic Stability & Your Core*

Treatment for the impaired pelvic girdle must be prescriptive since every individual has a unique clinical presentation. Ultimately, the goal is to teach the patient a healthier way to live and move such that sustained compression and/or tensile forces on any one structure are avoided. Exercises for motor control are aimed at retraining strategies of muscular patterning so that load transfer is optimized through all joints of the kinetic chain. Optimal load transfer occurs when there is precise modulation of force, coordination, and timing of specific muscle contractions, ensuring control of each joint (segmental control), the orientation of the spine (spinal curvatures, thorax on pelvic girdle, pelvis in relation to the lower extremity), and the control of postural equilibrium with respect to the environment (Hodges 2003). The result is stability with mobility, where there is stability without rigidity of posture, without episodes of collapse, and with fluidity of movement. Optimal coordination of the myofascial system will produce optimal stabilization strategies. These patients will have:

- the ability to find and maintain control of neutral spinal alignment both in the lumbopelvic region and in relationship to the thorax and hip
- the ability to consciously recruit and maintain a tonic, isolated contraction of the deep stabilizers of the lumbopelvis to ensure segmental control and then to maintain this contraction during loading,
- the ability to move in and out of neutral spine (flex, extend, laterally bend, rotate) without segmental or regional collapse,
- the ability to maintain all the above in coordination with the thorax and the extremities in functional, work specific, and sport specific postures and movements.

The findings from the ASLR test (impact of specific compressions) together with the results of palpation analysis of the transversus abdominis and multifidus coupled with the RTUS findings in response to verbal cuing and the ASLR test help the clinician to determine the specific motor control deficits present in a patient with failed load transfer through the SIJ. These tests also facilitate a prescriptive exercise program which is unique to the patient's clinical presentation.

More information on the integrated multimodal approach to the assessment and treatment of the lumbopelvic-hip region can be found in Lee & Lee 2004b,c, the Discover Phyiso website at www.discoverphysio.ca or Richardson et al 1999, 2004.

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