The Evolution of Myths and Facts Regarding Function and Dysfunction of the Pelvic Girdle

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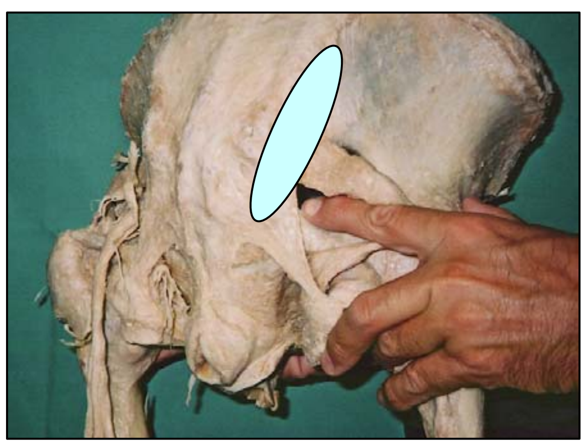
In: Vleeming A et al eds. Movement, Stability & Low Back Pain – The Essential Role of the Pelvis 2nd edn (at press 2006)

The pelvic girdle is a source of mystery to many health practitioners and yet amongst some there is a long held belief that it plays a significant role in low back pain. In the past, models for assessment and treatment of the pelvic girdle were taught by experienced clinicians whose protocols and techniques were accepted without scientific evidence of reliability or efficacy. Recently, some of these long held beliefs have been challenged for their apparent lack of reliability, sensitivity and specificity. This chapter will outline the evolution of some of these myths and what the recent research has revealed regarding them. In addition, some of the conclusions from this research will be challenged in the hope of preventing the perpetuation of more myths. The gap between what we *know* about the function of the pelvic girdle and what we *need to know* as clinicians treating pelvic girdle pain will be outlined and suggestions for future research offered.

Myths & Facts

Does the sacroiliac joint cause low back pain?

A commonly held myth is that pain in the pelvic girdle is merely referred from the lumbar spine (Cyriax 1954, Kirkaldy-Willis & Hill 1979). The question is, can the sacroiliac joint (SIJ) cause pain and if so, where does this occur? This is important for establishing inclusion criteria for research pertaining to the pelvic girdle. Fortin et al (1994a,b, 1999) investigated the location of pain which resulted when healthy subjects had the SIJ irritated by injecting the joint under fluoroscopy with a contrast material (enough to irritate the joint structures) followed by an anaesthetic. The sensory changes (hyperesthesia and anesthesia) were mapped subsequent to each injection. From these studies, the SIJ is now known to cause pain approximately 10 cm caudally and 3 cm laterally from the posterior superior iliac spine (Fig. 1). Occasionally (2 out of 10 subjects) the pain referred into the posterolateral thigh to the superior aspect of the greater trochanter. Therefore, the SIJ is capable of producing *pelvic girdle pain*



(between the iliac crest and the gluteal fold) and not low back pain. This pattern is known as 'Fortin's distribution of pain'. In 1995, Schwarzer et al investigated the prevalence of pain from the SIJ joint in the chronic low back pain population. By injecting a local anesthetic via fluoroscopy into the SIJ and recording the pain relieving response, they demonstrated that the SIJ can contribute to low back pain in 15 – 21% of the subjects studied. Would this percentage have been higher if the inclusion criteria had specified just pelvic girdle pain and not low back pain? Would this percentage have been higher if the capsule and ligaments of the SIJ had been considered in the pain production?

Vleeming et al (2002) confirmed that the long dorsal SIJ ligament is a significant pain generator in patients with pelvic girdle pain (sensitivity 76%). When the study was repeated with more specific inclusion criteria (severe pelvic girdle pain coupled with a positive posterior pelvic pain provocation test (Ostgaard et al 1994) and a positive active straight leg raise test (Mens et al 1999, 2001, 2002)), the sensitivity was 98%.

In short, we know that the SIJ joint and the associated ligaments are capable of generating pelvic girdle pain which is confined to the region between the iliac crest and the gluteal fold; this fact should be noted for inclusion criteria in future studies.

Can we reliably identify patients who have painful sacroiliac joints?

Several studies (Albert et al 2000, Carmichael 1987, Dreyfuss et al 1996, Herzog et al 1989, Laslett & Williams 1994, Maigne et al 1996, Ostgaard et al 1994, Potter & Rothstein 1985) have investigated the inter-examiner reliability of pain provocation, position and mobility tests for the pelvic girdle. Whereas the pain provocation tests have shown reliability (Albert et al 2000, Laslett & Williams 1994, Ostgaard et al 1994), the position and mobility tests have not.

Albert et al (2000) note that the low reliability of the position and mobility tests may be due to examiner bias and skill and propose that instead of abandoning these tests, we should seek to improve the skills of the examiners. They emphasize that a higher degree of standardization for all tests is required if inter-examiner reliability is to occur.

With respect to sensitivity and specificity, Albert et al's (2000) study of 15 tests demonstrated high values for several tests. For the SIJ and the associated ligaments, the posterior pelvic pain provocation test (Ostgaard et al 1994), FABER test and craniocaudal glide scored well. For the pubic symphysis and the associated ligaments, palpation of the joint for tenderness and Trendelenburg's test scored well.

These findings differ from often quoted studies of Maigne et al (1996) and Dreyfuss et al (1996). In both of these studies, the investigators could not find any test (or medical history) which accurately predicted when pain was arising from the SIJ. In both of these studies, the SIJ was injected with an anesthetic block and the impact was corelated to the pain provocation tests. This procedure specifically studies the synovial portion of the SIJ and the thin anterior ligaments while excluding the dorsal structures such as the interosseus and dorsal SIJ ligaments. To date, there are no anesthetic block studies that consider the role of the dorsal ligaments in the production of posterior pelvic girdle pain nor any studies which corelate these structures with the traditional pain provocation tests for the SIJ.

In conclusion, external pain provocation tests of the pelvic girdle are reliable, sensitive and specific but cannot identify which structure is causing the pain. To date, the position and mobility tests for the SIJ joint and pubic symphysis have not shown reliability although some question remains as to the standardization of the techniques investigated and skill level of the examiners.

Does the sacroiliac joint move?

A long held myth has been that the SIJ joint is immobile except during pregnancy. Since the middle of the 19th century, both postmortem and in vivo studies have been done in an attempt to clarify the movements of the SIJs and the pubic symphysis and the axes about which these movements occur (Colachis et al 1963, Egund et al 1978, Jacob & Kissling 1995, Lavignolle et al 1983, Miller et al 1987, Sturesson et al 1989, 2000, Walheim & Selvik 1984, Weisl 1954, 1955). From this research two studies are of note (Jacob & Kissling 1995, Sturesson et al 1989, 2000).

Jacob & Kissling (1995) inserted Kirschner wires into the innominate bones and sacrum and then used roentgen stereophotogrammetric analysis (RSA) to investigate mobility of the SIJ joint in healthy subjects during standing forward and backward bending as well as left and right standing hip flexion. The average values for rotation and translation of the SIJ were low; 1.8^0 of rotation coupled with 0.7mm of translation for the men and 1.9^0 of rotation coupled with 0.9mm translation for the women. No statistical differences were noted for either age or gender.

Sturesson et al (1989, 2000) also used roentgen stereophotogrammetric analysis (RSA) to investigate mobility of the SIJ after the insertion of small tantalum balls into the sacrum and innominate bones. The subjects studied had been independently diagnosed by an orthopaedic surgeon, chiropractor and two physiotherapists as having a SIJ joint disorder. In this study, the investigators found a mean of 2.5^0 of innominate rotation (coupled with a mean of 0.7mm of translation). This study considered the positional changes between the sacrum and the innominate in supine, prone with hyperextension of the left and then the right leg, standing, sitting with straight knees and standing hip flexion. Of note is that this study found the *same amplitude* of motion in their unhealthy subjects as Jacob & Kissling found in their healthy group.

Thus, we can confidently say that yes, the SIJ moves; however, the question that arises is – How significant is the amplitude of SIJ mobility in determining impaired function of the pelvic girdle? This research suggests that amplitude of motion is not an indicator of function or dysfunction in the pelvic girdle.

Can we reliably detect motion at the sacroiliac joint?

Do we have reliable and practical tests for analyzing motion of the SIJ? As you might suspect, the answer is no, not yet. Carmichael (1987), Dreyfuss et al (1996), Herzog et al (1989), Potter & Rothstein (1985), Sturesson (1999) and several others have tried to demonstrate intra- and inter-tester reliability for many tests commonly used clinically to measure either position or motion of the SIJ. None of these studies were able to demonstrate reliability. There is considerable debate in the literature regarding the methods used, the subjects tested, the standardization of the technique, the skill of the tester and the statistical analysis used to determine the results in these studies. For the most part, all of the tests investigated relied on active motion of the patient (standing forward bending, seated forward bending, Gillet or standing hip flexion test) and this can be a problem. Movement of a bone requires not only articular mobility, but also activation of the muscular system; the pattern of motion produced reflects both the individual's motor control and joint mobility. Consider the patient with a complete tear of the rotator cuff of the shoulder. On active abduction of the arm, there is an apparent loss of motion; the arm can often only abduct to approximately 45^0. However, on testing the passive mobility of the glenohumeral joint, full range of motion is noted. Thus, unless the subjects are screened for neuromuscular deficits (anatomical and motor control) there is no guarantee that they are actually performing the same quality/amplitude of motion each time they move! Sturesson et al's studies (1999, 2000) have clearly shown that the standing hip flexion test (Gillet) cannot be used to interpret the apparent motion (or lack thereof) of the SIJ. An active mobility test cannot conclusively determine the passive mobility of a joint.

In 1992, two specific, *passive* tests for evaluating mobility of the SIJ joint were proposed (Lee 1992, 2004) (Figs 2, 3). Since the neutral zone of motion for all joints is greatest when the joint is in its loose-packed or resting position (Panjabi 1992b), these passive mobility tests for the SIJ are done with the patient in supine lying to avoid any self-bracing or self-locking (Vleeming et al 1990a,b). Essentially, these tests examine the ability of the innominate to translate in the anteroposterior and craniocaudal planes relative to the sacrum.

Although this motion is small, experienced clinicians are capable of feeling it. In 1995, a pilot project was conducted to determine if these tests could be reliable for measuring amplitude of motion at the SIJ. We failed, and I was astonished since when allowed to use a clinical reasoning process and a complete subjective and objective examination of the patient, we usually agreed on the clinical diagnosis. What we failed to consider was the significant role that compression (force closure) has on articular mobility and the research which followed has helped to clarify why so many studies have failed to show reliability for both active and passive motion analysis of the SIJ.

In 1995, Buyruk et al (1995a) established that Doppler imaging of vibration (DIV) could be used to measure stiffness of the SIJ. A vibration of 200 Hz was applied to the innominate and the transference of this vibration was measured across the SIJ joint under different experimental conditions. This method could reliably detect when compression of the SIJ was artificially increased (screws placed across the joint and compression applied) or decreased (screws removed and the articular ligaments cut). The subjectivity of the human hand and eye could now be removed and the quantity of 'stiffness' measured in vivo.

In healthy subjects, both Buyruk et al (1995) and Damen (2002a) used the DIV method to show that, in vivo, stiffness of the SIJ is variable and therefore the range of motion between individuals is likely variable. In addition, both researchers found that stiffness of the left and right SIJ is symmetric in healthy subjects (the same on both sides), whereas in subjects with pelvic girdle pain asymmetry was found (one side was less or more stiff than the other) (Buyruk et al 1997, 1999, Damen et al 2001, 2002b). Therefore, in future reliability studies for motion analysis of the SIJ, focus should be on whether or not there is symmetry or asymmetry of motion. Less emphasis should be placed on the *amplitude* of motion (hypermobile, hypomobile).

Richardson et al (2002) and van Wingerden et al (2004) have also used the DIV method to confirm that activation of certain muscle groups can increase compression (stiffness) of the SIJ joint. Both the deep stabilizing (local) and muscle sling (global) systems (Bergmark 1989) were tested in these studies and although a few muscles were measured in each, it is impossible to know exactly which muscles were responsible for the increase in stiffness/compression.

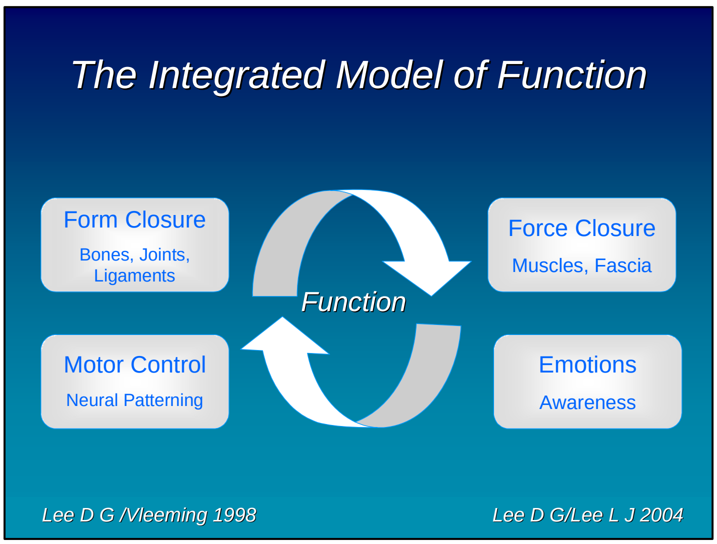
In conclusion, we know that the SIJ joints are capable of a small amount of both angular (1-4^0) and translatoric (1-3mm) motion and that the amplitude of this motion is variable between subjects; however, within one subject it should be symmetric between sides. This research also suggests that any passive motion analysis of the SIJ joint needs to consider:

1. the patient position at the time of testing – arms by the sides since an arms overhead position will passively tighten the anterior and posterior oblique muscle slings
2. the degree of resting tone in the myofascial systems

With this in mind, future studies for motion analysis can be designed without these methodological flaws.

Current thoughts – a changing paradigm

Recent anatomical and biomechanical research has led to a clearer understanding of how load is transferred through the low back and pelvic girdle (Hodges & Richardson 1996, 1997, Hodges 1997, 2003, Hodges et al 1999, 2001a,b,c, 2003b, Hungerford et al 2003, 2004, Mens et al 1999, Richardson et al 1999, Snijders et al 1993a,b Vleeming et al 1990a,b, Vleeming et al 1995, Vleeming et al 1996). From this research, an integrated model based on function and not pain has evolved (Lee & Vleeming 1998) (Fig. 4).



Since the joints of the pelvic girdle are mobile, stabilization is required if loads are to be transferred optimally. Stability (effective load transfer) is achieved when the passive, active and control systems work together to approximate the joint surfaces at the time of loading. The amount of approximation required is variable and difficult to quantify since it depends on an individual's structure and the forces they need to control. Consequently, the ability to effectively transfer load through the pelvic girdle is dynamic and depends on optimal function of the bones, joints and ligaments (form closure) (Vleeming et al 1990a,b), optimal function of the muscles and fascia (force closure) (Barker et al 2004, Hungerford 2003, 2004, McGill 2002, O'Sullivan 2000, Richardson et al 2002, 2004, Vleeming et al 1995) and appropriate neural function (motor control, emotional state) (Hodges 1997, 2003, Hodges et al 2001, 2003, Holstege et al 1996, Hungerford 2003).

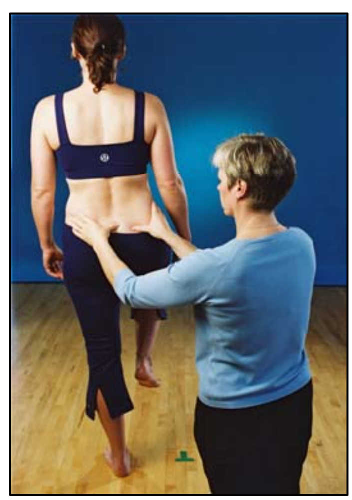
In the self-locked or close-packed position, the joint is under significant compression due to tension from the capsule and ligaments. The resultant compression increases the friction between the articular surfaces and facilitates the resistance to shear (Vleeming et al 1990b, Snijders et al 1993a,b). The self-locked position for the SIJ joint is full nutation of the sacrum or posterior rotation of the innominate (Vleeming et al 1990a,b, van Wingerden et al 1993). This position is therefore ideal for high loading tasks. Studies have shown (Hungerford et al 2004, Sturesson 1999, Sturesson et al 2000) that nutation of the sacrum occurs during forward/backward bending of the trunk and during standing hip flexion.

In low load situations (e.g. lying supine and raising one leg, standing, sitting and parts of the gait cycle), the joints of the pelvic girdle are not self-locked; the sacrum is suspended between the two innominate bones and stabilized by activation of both the local and global muscle systems. The amount of muscular activation required for stability depends on the forces being transferred and the individual's degree of form closure.

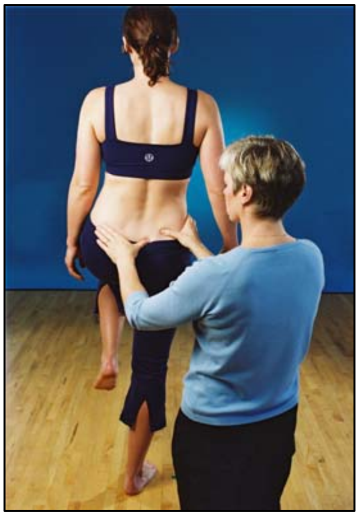
Research has shown (Barbic et al 2003, Bø & Stien 1994, Constantinou & Govan 1982, Hodges 1997, Hodges & Richardson 1997, Hodges & Gandevia 2000a,b, Hodges 2003, Hungerford et al 2004, Moseley et al 2002, 2003, Sapsford et al 2001) that in health, the local system is anticipatory when the central nervous system can predict the timing of the load. In other words, these muscles should increase their activity *before* any loading or motion occurs. This anticipatory contraction prepares the joints of the lumbar spine (Hodges et al 2003) and pelvis (Richardson et al 2002) to receive the impending load and prevents excessive intersegmental and intrapelvic shearing regardless of the position of the joint. The articular compression and the resultant resistance to translation should occur prior to the onset of any movement. The timing of specific muscle contraction is critical for the effective transfer of loads through the pelvic girdle (Hodges 2003). In addition, muscular strength and endurance is required (Hodges 2003, McGill 2002) for all functional tasks. In both the assessment and treatment of patients with pelvic girdle pain, both motor control (sequencing and timing of muscle activation) and muscle capacity (strength and endurance) need to be addressed.

Thus, this research leads us to enquire about tests which examine an individual's functional status (ability to effectively transfer loads) as opposed to those which attempt to identify a pain generator.

Are there any reliable tests for measuring effective load transfer through the pelvic girdle?



The one leg standing test (Stork test, standing hip flexion test) examines the ability of the low back, pelvis and hip to transfer load unilaterally as well as for the pelvis to allow intrapelvic rotation (Hungerford et al 2003, 2004). During standing hip flexion the pattern and symmetry of motion between the non-weight bearing innominate and the sacrum is compared bilaterally (Fig. 5a). This is not a test of amplitude of motion of the *sacroiliac joint* but rather a test of osteokinematic motion of the innominate and the sacrum. When compression and tension forces through the pelvic girdle are balanced, the intrapelvic motion should be symmetric between sides. Many



factors can influence the movement quality and quantity; the SIJ joint is only one of these factors. The stability of the pelvic girdle on the weight bearing side is assessed during standing hip flexion by noting any innominate motion (relative to the sacrum) as load is transferred to one leg (Fig. 5b). The innominate should remain posteriorly rotated relative to the sacrum as weight is transferred onto the supporting leg. A positive test occurs when the innominate anteriorly rotates relative to the sacrum (Hungerford et al 2004). Inter-tester reliability studies for this test have been completed and good results were found (publication pending, Hungerford); the sensitivity and specificity studies are being developed.

The supine active straight leg raise test (ASLR) has been validated as a clinical test for measuring effective load transfer between the trunk and lower limbs (Mens et al 1999, 2001, 2002) and is reliable, sensitive and specific for pelvic girdle pain. When the lumbopelvic region is functioning optimally, the leg should rise effortlessly from the table and the pelvis should not move (flex, extend, laterally bend or rotate) relative to the thorax and/or lower extremity. Since the SIJ is in an unlocked or loose-packed position during this test, proper activation of both the local and global muscle systems are required. Several compensation strategies have been noted (Richardson et al 1999, 2004, Lee 2004) when stabilization of the lumbopelvic region is insufficient or inappropriately timed and the ASLR test can be used to identify these strategies (Fig. 6a).

The application of compression to the pelvis has been shown (Mens et al 1999) to reduce the effort necessary to lift the leg for patients with pelvic girdle pain and instability. Varying the location of the compression force can assist the clinician to determine exactly where more compression is needed functionally to facilitate load transfer through the pelvic girdle (Lee 2004, Lee & Lee 2004) (Fig 6b).

So far, these are the only tests which have withstood scientific scrutiny for the assessment of load transfer through the pelvic girdle; its primary function. Therefore it is still not possible to be totally evidence-based in clinical practice if evidence-based means only using those tests which have withstood scientific scrutiny. However, what does evidence-based practice truly mean? Sackett et al (1997) defines evidence-based practice as the process of integrating the best research evidence available with both clinical expertise and patient values. Clinical expertise and the models which evolve from it are still necessary to bridge the gap between what we know scientifically and what we need to know practically to treat patients with pelvic girdle pain.

How effective are our treatment protocols?

To date, only one randomized controlled trial has considered the efficacy of a physiotherapeutic treatment program for pelvic girdle pain (Stuge et al 2004). The program was conducted on a sub-group of pelvic girdle pain patients; those who experienced ongoing pain after pregnancy. The significant variable tested in this study was 'specific stabilizing exercises' which included exercises to retrain the local system (Richardson et al 1999) and global system slings (Vleeming et al 1990a). The program was individualized to the patient's specific needs and designed to minimize drop-outs and maximize compliance. This program was shown to statistically produce significant improvements in pain intensity and disability and a higher quality of life for those involved.

The future

Recently, guidelines for the diagnosis and treatment of pelvic girdle pain were presented (Vleeming et al 2004). After an extensive review of the literature, this working group recognized the need for much more research in all areas pertaining to pelvic girdle pain (epidemiology, biomechanics, diagnostics) before any controlled trials of clinical outcomes can be done. We need to identify subgroups of patients with pelvic girdle pain according to specific impairments recognizing that all patients with pelvic girdle pain do not have the same impairments. We need to develop more diagnostic tests relevant to motion and load transfer for both the SIJ joint and the pubic symphysis and then to test them for reliability, sensitivity and specificity for pelvic girdle pain. A self-report questionnaire which specifically identifies those patients with failed load transfer through the pelvic girdle is required. Currently, all self-report scales pertain to the low back, not to the pelvic girdle.

When all of this is established, we will then have the ability to develop sound studies (randomized and controlled) to test the efficacy of treatment programs that are specific to each subgroup of impairment which leads to pelvic girdle pain. Until then, the best evidence-based treatment will be to use an integrated multimodal approach which considers the biomechanical, neuromuscular and emotional needs of the patient with pelvic girdle pain.

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