The Pelvic Girdle: how does research assist best clinical practice for treatment of pelvic girdle pain and the Sacroiliac joint

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Pelvic Girdle pain (PGP) is a broad term used to describe symptoms arising from musculo-skeletal structures of the pelvis[1,2], with Sacroiliac joint (SIJ) dysfunction being one subset of this PGP group. Research has consistently shown that the SIJ is the source of pain in at least 20-25% of patients with long term lumbo-pelvic back pain, however physiotherapists are still often equivocal about treating the pelvis[3,4]. In this article I therefore plan to overview relevant anatomy and functional biomechanics of intra-pelvic motion, and then discuss research outcomes that assist you to understand assessment, diagnosis, and treatment of the pelvis.

1. ANATOMY &FUNCTIONAL BIOMECHANICS OF THE PELVIC GIRDLE

The pelvis contains 3 intra-pelvic articulations, the sacroiliac joints and the pubic symphysis, as well as articulations with L5/S1 disc, L5/S1 zygapophyseal joints, the coccyx and the acetabulum of each innominate with the femurs (Figure 1). The pubic symphysis is a fibrocartilaginous joint and only a few mm's of translational and rotational movement is available between joint surfaces. The sacroiliac joints are synovial joints with hyaline articular cartilage on both surfaces of the joint. A small amount of motion occurs at the SIJ during open chain movements of the trunk and lower limbs[5,6]. However, the primary function of the pelvis during weight bearing activities is to transfer the loads generated by body weight and gravity from the spine to the lower limbs[7]. 60% of body weight is transferred onto the S1 sacral surface in standing, therefore intra-pelvic motion needs to be controlled. How well load transfer is managed dictates the efficacy of pelvic function. The ligamentous structures that surround each SIJ and pubic symphysis create tensile and compressive forces across the joints that limit the available range of intra-pelvic motion[8]. Panjabi[9] states that stability is achieved when the passive, active and motor control systems work together. A balance is created between approximation of joint surfaces, which is created by ligaments and muscles, and tension on the surrounding myofascial structures in order to maintain pelvic stability during movement. The ability to effectively transfer load through the pelvis therefore depends on:

a. Form Closure: structure of the bones, joints and ligament[10].
b. Force Closure: forces external to the joints created by muscles and fascia [11,12].
c. Appropriate neural function[13].

Muscle recruitment and lumbo-pelvic stability

The contribution of muscle force to stabilisation of intra-pelvic motion is dependent on optimal patterning and activation of local and global muscles, and synergistic tensioning of pelvic ligamentous structures that in turn increases stiffness of the sacroiliac joint prior to weight transfer[12,14,15]. Deep trunk muscles, including transversus abdominis (TrA), multifidus (Figure 2), lower fibres of obliquus internus abdominis (OI) and the anterior pelvic floor [16], activate prior to limb or trunk motion. These muscles co-contract and remain tonically active during weight bearing in order to maintain closed-pack alignment of the SIJ[5] while also increasing spinal stiffness and limiting inter segmental motion[13,17]. Gluteus maximus also contributes to stabilisation and load transfer across the SIJ via its connections with

sacrotuberous ligament, posterior layer of thoraco-lumbar fascia and posterior SI ligament complex[18] (Figure 2), while gluteus maximus, medius and minimus all have an important role in stabilising the pelvis on the hip[19].

The biomechanics of intra-pelvic motion and stabilisation of the pelvic girdle

The closed pack position of the SIJ is nutation of the sacrum or relative posterior rotation of the innominate[5,10]. In this position maximum congruence of the SIJ articular surfaces and maximum ligamentous tension increases joint stiffness [11]. Sturesson et al[6] showed that nutation of the sacrum occurs bilaterally whenever the spine is loaded vertically (sitting, standing). Counternutation of the sacrum, or anterior rotation of the innominate, is a relatively less stable position for the SIJ and causes loading onto the dorsal long SI ligament[20], a common sight of posterior pelvic pain.

2. ASSESSMENT AND DIAGNOSIS OF PGP AND SIJ DYSFUNCTION

The debate about how to treat the SIJ is centred on whether manual therapy, exercise rehabilitation, or a cognitive approach is most effective. Research has shown that if the sacroiliac joint is unable to move normally (fixated, stiff, compressed)[21] this alters the information being sent from mechano receptors at the articular surface to the brain[22], and this may explain the pattern of inhibition of TrA, multifidus, and ipsilateral gluteus maximus reported with SIJ dysfunction[14]. Physiotherapists are comfortable to treat a stiff ankle in order to improve the pattern of gliding required for forward translation of body weight with walking. Similarly, treatment of the SIJ with manual therapy is effective for acute and sub-acute presentations[23,24], especially when combined with therapeutic exercise. It is therefore essential that we understand when manual therapy is appropriate, and when progression into exercise rehabilitation is indicated.

Trauma to the SIJ, such as falling onto the bottom or sacrum, can alter patterns of intra-pelvic motion and sacro-iliac joint glide. PGP and trauma are also linked to altered lumbo-pelvic muscle activation[5,14,21,25]. If the SIJ is no longer able to maintain its closed pack position with weight bearing, the SIJ will “unlock” (innominate anterior rotation/ sacral counternutation). This increases strain on the dorsal long SI ligament, creating pain in the PSIS region that is often described as worse with all weight bearing activities. Local lumbo-pelvic muscle activation is often inhibited while global muscle activation becomes more tonic. The altered lumbo-pelvic muscle activation leads to a variety of dysfunctional presentations such as buttock pain, groin pain or hamstring tension plus mal-adaptive posture and movement strategies. It should be emphasised this presentation does not indicate an unstable joint, however it does indicate functional stability is impaired.

3. ASSESSMENT & DIAGNOSIS

The diagnosis of PGP of SIJ origin is difficult, given the variety of clinical tests and no specific gold standard in radiological or injection diagnostics. Double anaesthetic blocks of the SIJ only diagnose intra-articular pathology but do not assess the ligamentous apparatus that supports the SIJ. CT and MRI scans show pathological abnormalities and fractures but are non-specific for ligamentous and bone inflammation caused by micro movement or failed load transfer through the pelvis. Recent research suggests SPECT CT scans may be of greater value in identifying sacroiliac joint incompetence in patients with PGP postpartum or following pelvic trauma[26].

Clinically, it has been shown that no one mechanical test of the SIJ can provide sufficient reliable information. Instead, reliability of test results increases when a cluster of tests including pain provocation and mobility/ stability tests are applied[14,27]. The following tests have been shown to assess different aspects of SIJ function including intra-pelvic motion, intra-pelvic stability and pain provocation:

a. **Posterior Pelvic Pain Provocation (PPPP) test**: stresses the posterior SI ligaments that are often a source of posterior PGP [28]
b. **Long Dorsal SI ligament palpation[20]**: a reliable source of pain in PGP patients and becomes overloaded and inflamed with chronic sacral counternutation that occurs with failed load transfer through the pelvis. Palpate just inferior to the PSIS
c. **Active Straight Leg Raise (ASLR) test[29]**: In a positive ASLR perceived difference of effort or pain is scaled from 0 (not difficult) to 5 (unable to perform ASLR). An improved ASLR with passive compression may assist diagnosis of altered force closure due to insufficient local muscle activation. This is a stability test.
d. **Stork Test – stance phase[30]:** For a **R** Stork stance test, palpate the **R** PSIS with **R** thumb and midline sacral crest with **L** thumb. Patient stands on their **R** leg, and flex their **L** hip/ knee toward 90°. **No** relative movement between innominate and sacrum should occur during single leg support. A **Positive test** (failed load transfer) is indicated if **R** PSIS moves cephalad with innominate anterior rotation relative to sacrum. This tests functional SIJ stability.
e. **Stork test- Hip flexion Phase**: For a **R** Stork HF test, patient stands on **L** leg and flexes **R** hip/knee to 90° as PSIS and sacrum are palpated as above. Compare pattern of innominate movement to opposite side. This is a mobility test.
f. **Passive SIJ glide test[21]**: analysis of symmetry of AP and vertical arm articular motion at each SIJ has been shown to be reliable in a clinical setting[31]. Relative stiffness of articular motion may indicate a requirement for SIJ mobilisation, whereas increased articular glide may indicate SIJ incompetence due to failed load transfer. This is a mobility test.

Lumbo-pelvic pain requires treatment based on a bio-psycho-social model, however it is outside the realm of this article to discuss the psycho-social, visceral and gynaecological issues that could be a factor in a patient's PGP. Similarly, chronic PGP will require a different approach to treatment than acute presentations. The pain associated with any lumbo-pelvic injury often creates fear of movement, and therefore appropriate treatment should include improving movement strategies and positive reinforcement to encourage activity and improved postural habits.

The classification system for musculo-skeletal presentations of chronic low back pain described by O'Sullivan & Beale[32] categorises PGP as a category of non-specific back pain due to either reduced or excessive force closure.

1. *PGP due to reduced force closure* occurs due to altered motor control with "loss of functional patterns of co-contraction of local force closure muscles of the pelvis" (TrA, lumbar multifidus, pubococcygeus) and resultant inability to maintain the closed pack alignment of the SIJ with weight bearing. The subsequent sacral counternutation increases load onto the dorsal long SI ligament, and hence patients often present with PSIS pain.
2. *PGP due to excessive force closure* may occur due to the brains response to pain and loss of lumbo-pelvic stability. If the brain cannot create co-ordinated local lumbo-pelvic muscle activation to maintain the closed pack position of the SIJ for weight bearing, it will find another way to keep you upright. Global muscles such as piriformis, biceps femoris, erector

spinae, and the posterior pelvic floor become over-active causing a variety of pain symptoms, mal-adaptive postures and altered loading on the lumbar spine, SIJ's and hips. Beales et al[2] also acknowledge the presence of another category of PGP; impairment of passive pelvic stability (form closure), that is omitted from the original classification and added into an amended PGP classification (Table 1). Articular dysfunction causing altered form closure commonly occurs from a fall onto the bottom or extreme force across the SIJ. Cusi et al[26] reports that 52% of his subjects diagnosed with SIJ incompetence had a history of trauma. The next largest group in his study were postpartum women. This sub-group may only account for a small percentage of patients with PGP, however clinically these people will seek help from physiotherapists, and inability to assess their dysfunction would be our failure. I have therefore added 2 more categories of PGP:

3. PGP due to intra-articular injury where the joint is no longer gliding adequately[6,21] or
4. SIJ incompetence: extra-articular injury where the ligamentous support network has been injured (see Table 1 for diagnostic procedure).

4. TREATMENT

The SIJ is a synovial joint that is meant to move, just not very much. Its main function is to maintain its stable closed pack alignment during all weight bearing activities to assist optimal load transfer through the pelvis and therefore treatment of SIJ dysfunction usually incorporates retraining lumbo-pelvic stability. Unfortunately sometimes an injury occurs that causes altered SIJ motion or excessive global muscle activity that compresses the SIJ. These injuries require specific manual therapy to regain normal joint glide and force closure, prior to motor control and functional lumbo-pelvic muscle retraining. Treatment of the 4 sub-groups of PGP (Table 1) can be summarised as follows:

a. PGP due to reduced force closure: appropriate rehabilitation of local lumbo-pelvic muscles coordinated with functional retraining of global stabilisers such as the gluteal muscles and postural retraining is indicated.
b. PGP due to excessive force closure alters functional control of lumbo-pelvic stability and increases SIJ compression. Manual therapy and re-patterning motor control to decrease the effect of overactive lumbo-pelvic muscles is required initially. Maladaptive postural habits require retraining, plus specificity in local muscle co-contraction, prior to progression into a functional lumbo-pelvic stability exercise program to improve activity.
c. An articular injury where the joint no longer moves normally. Manual techniques are directed specifically according to whether AP or vertical arm motion is restricted. Once joint glide is restored treatment progresses to lumbo-pelvic stability, posture & functional movement retraining.
d. An extra-articular injury to the ligamentous support network of the SIJ that causes SIJ incompetence (altered form closure). Specific retraining of timing and co-contraction of local lumbo-pelvic muscles is coordinated with functional retraining of global stabilisers into weight bearing activities. If rehabilitation fails to improve stability, and SPECT CT and passive SIJ glide tests show SIJ incompetence, prolotherapy or SIJ fusion may be indicated[33].

Rather than group all presentations of PGP into a non-specific basket, I feel it is essential for physiotherapists to provide specificity in assessment and diagnosis, thereby empowering us to choose the right treatment, whether manual therapy, exercise, cognitive therapy, or a combination of all three for optimal care of our patients.

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Figure 1: The sacral articular surface and its alignment relative to the lumbar spine & vertical loading from body weight (©Dr J Read)

Figure 2: Posterior Pelvic anatomy including the extent of attachment of lumbar multifidus, deep hip external rotator muscles, pelvic floor, plus sacrotuberous & sacrospinous ligaments.

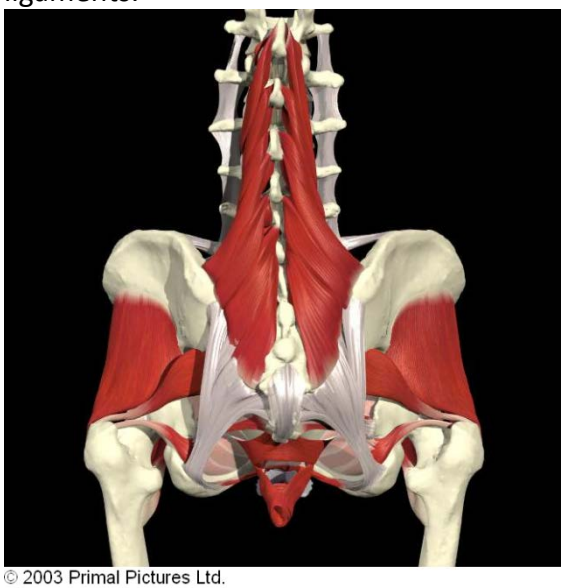
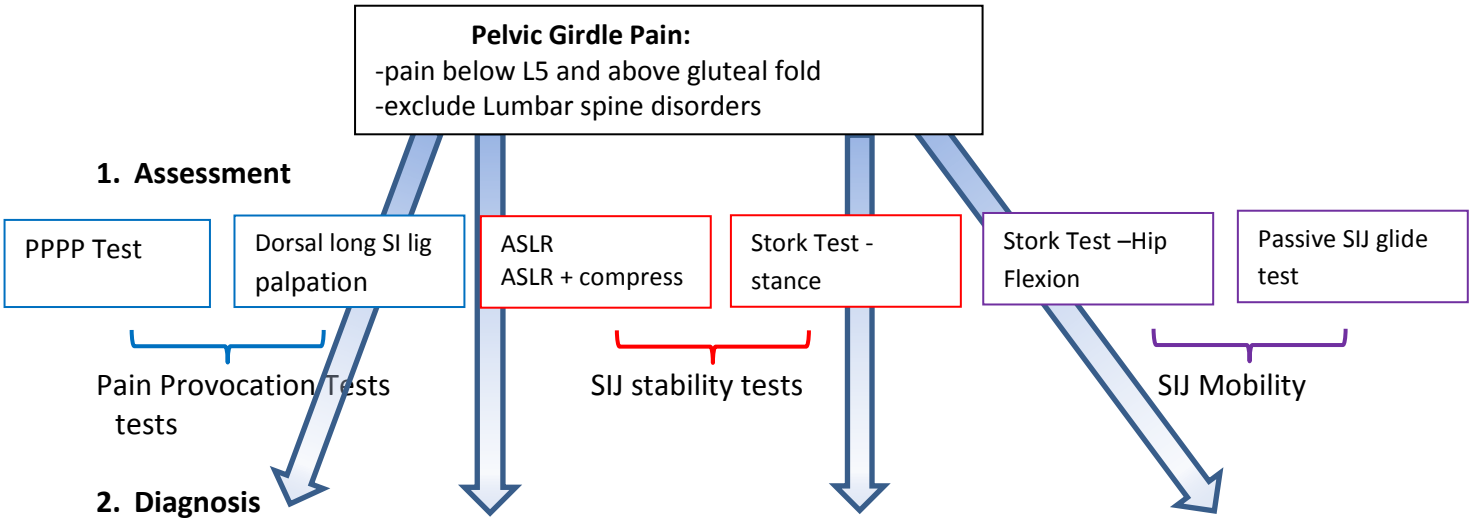


Table 1: Classification of Pelvic Girdle Pain (PGP)



Force Closure- reduced	**Force Closure- excessive**	**Articular injury- decreased joint glide**	**Extra-articular injury- SIJ Incompetence**
-ASLR positive -ASLR better on compress -decreased local lumbo-pelvic muscle activation	-dorsal long SI lig tender -pain provocation test +ve -ASLR negative -mal-adaptive motor control strategies	-mobility tests positive -stability tests positive -dorsal long SI ligament often tender	-increased SIJ glide not stabilised by core activity -stability tests positive -ASLR better on compress -SPECT CT for confirmation

3. Treatment

Force Closure- reduced	**Force Closure- excessive**	**Articular injury- decreased joint glide**	**Extra-articular injury- SIJ Incompetence**
-motor control retraining of local and global muscle activation -restore functional lumbo-pelvic stability	-reduce compensatory muscle overactivity -motor control retraining of local and global muscle activation -restore functional lumbo-pelvic stability	-MET/ mobilisation of specific SIJ articular glide -reduce any muscle overactivity -motor control retraining of local & global mm activation -restore functional lumbo-pelvic stability	-SIJ brace to assist function -motor control retraining of local & global mm activation -restore functional lumbo-pelvic stability -if SIJ articular glide increased ≥ 30% with core activation, prolotherapy may be indicated