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Review Article

The Sacroiliac Joint as a Cause of Lateralising Lower Back Pain? Rediscovery of an Old Paradigm

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Abstract

Lateralising low back pain is a common problem in approximately 80% of western society at some time in their lives. At least 10% of these will develop a chronic problem with significant disability. Ironically, 15% of these patients will be shown to have intervertebral disc prolapse as the culprit cause while 85% will be classified as non-specific low back pain (NSLBP). NSLBP is a term the hides ignorance of the accurate diagnosis, making therapy a vexing issue with little likelihood of permanent success. Multiple studies have shown mechanical dysfunction of the sacroiliac joint (SIJ incompetence) to be the cause in 20% of NSLBP. Importantly, the condition can be successfully treated with targeted physiotherapy in 80% of cases and with alternative therapies in the remainder. This manuscript reviews the history, diagnostic criteria, physical examination, imaging and therapy of SIJ incompetence.

Keywords: *Sacroiliac Joint; Incompetence; Pelvic Girdle Pain Syndrome; Scintigraphy; Platelet Rich Plasma*

Introduction

Low back pain (LBP) remains a significant and prevalent source of controversy both medically and socially. Although the prevalence of the disease may be relatively constant, the disturbing and growing incidence of disability as a result of LBP is the principal issue [1]. Tied to the increasing rate of disability is a progressive rise in cost to the community which on a worldwide basis has been estimated at between $50 and $100 billion US dollars [2].

Statistically, low back pain may be caused by intervertebral disc pathology with nerve root compression in approximately 15% of cases [3]. The remaining 85% is considered of obscure origin and has been termed non-specific low back pain (NSLBP). It is a nihilistic term that hides a failure to reach an adequate diagnosis in the vast majority of patients with low back pain. It is indeed the source of much controversy, particularly regarding the issue of surgery in patients with non-specific low back pain. Many publications have shown poor outcomes, particularly where a clear initial diagnosis has not been evident [4].

Ironically, a major source of lower back pain in young women of childbearing age with onset in the peri-partum period has been identified and defined in the northern European literature by a number of authors [5-12]. The constancy of an identifiable clinical presentation led to the term of pelvic girdle pain syndrome, where the sacroiliac joint (SIJ) was identified as the principal site of pathology and was thought to be responsible for approximately 20% of non-specific low back pain. The irony lies in the identification of the sacroiliac joint as a principal source of pain generation as far back as 1905 [13]. The diagnosis being swamped by the publication of the 1934 citation classic on intervertebral disc prolapse by Mixter and Barr in the New England Journal of Medicine [14]. It seemed to cement this pathological entity as the cause of all lateralising low back pain. Perhaps this belief system is difficult to penetrate, as numerous other publications have shown the importance of the sacroiliac joint as a pain generator in low back pain with little acceptance [15,16]. Furthermore, it frequently fails to be considered in the diagnostic algorithm of lateralising lower back pain. One publication found that it took an average delay of 4.8 years for the SIJ to be identified as the cause of lateralising lower back pain [17].

Purpose of the Study

The purpose of this review is to discuss the anatomy, function and pathophysiology of the sacroiliac joint and its applications in the clinical setting. Complexities of the clinical examination and the role of imaging will be discussed, as will therapeutic strategies.

Anatomy of the sacroiliac joint

The bony pelvis forms the structural connection between the vertebral column and the lower limbs. Three bones and five joints form the pelvis. The paired ilia and the sacrum are connected to each other through the two sacroiliac joints and the pubic symphysis and the lower limbs to the pelvis at the hips. Significant differences in structure are apparent between males and females, with the female pelvis being shorter, broader and more mobile [18]. The articular surfaces of the ilium and sacrum are L-shaped with the shorter cranial segment being more vertical. These surfaces contain multiple irregularities, particularly adjacent to the S1 and S2 segments, which essentially lock the sacrum between the two iliac bones in the formation of an inherently stable ring [18]. Ligaments around the SIJ strongly support the integrity of the joint [19]. Ventral ligaments are a thickening of the joint capsule. There is no joint capsule in the dorsal aspect of the joint and the primary supportive role is from the dorsal interosseous ligament that prevents excess sacroiliac movement (Figure 1) [20]. It consists of a deep and superficial component, with the superficial component blending with the dorsal sacroiliac ligament [19]. Importantly, the more caudal fibres of the dorsal sacroiliac ligament that run obliquely from S3 and S4 to the posterior superior iliac spines are continuous with slips from the sacrotuberous ligament [19]. Synchronised contribution of the abdominopelvic and hip musculature is considered crucial for stability of the pelvic ring [20]. As Alderink [20] has discussed in his exhaustive review of the SIJ, erector spinae, multifidi, abdominal muscles, hip adductors, abductors and extensors, pyriformis and iliopsoas are involved in this process. Innervation of the SIJ region is from L5, S1 and S2 posteriorly and L3 to S1 anteriorly [19].

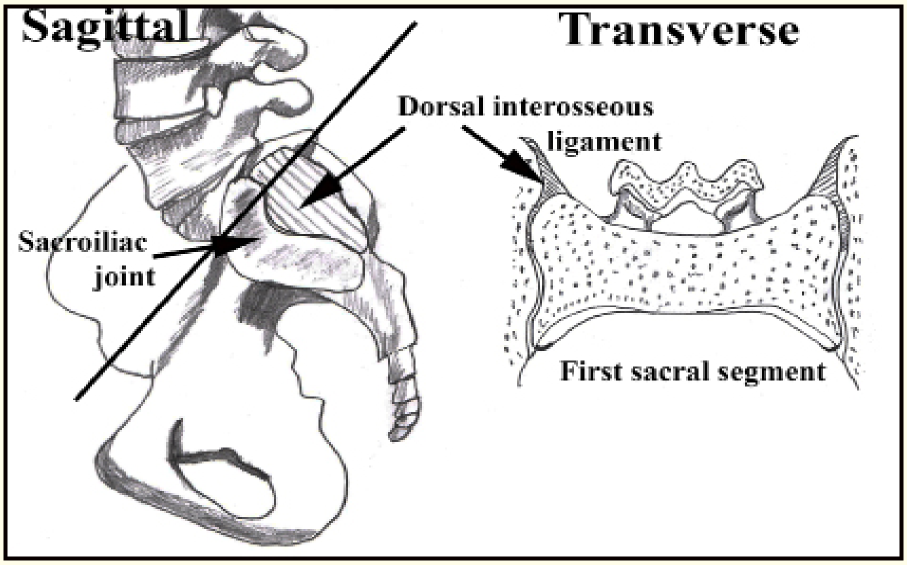

Figure 1: *Anatomy of the dorsal interosseous ligament. The sagittal image demonstrates the L shaped sacroiliac joint with the dorsal interosseous ligament anchoring the sacrum to the adjacent iliac bone. The oblique line extending through the top of the joint is the level of the first sacral segment through which the transverse drawing demonstrates the extent of the ligament in cross-section.*

Functional considerations

The function of the sacroiliac joint is perhaps best considered in terms of the integrated model proposed by Lee and Vleeming [21]. The lower limbs connect to the trunk through the sacroiliac joints. When standing, the weight of the trunk from above and the ground-reactive forces to the lower limbs engage the sacroiliac joints with the sacrum burying itself into the pelvic ring in a stable configuration. There is further reinforcement of the ring by the synchronised co-contraction of abdominopelvic muscles, lumbar erector spinae including multifidus and gluteals which help close and stabilise the pelvic ring. Lee and Vleeming [21] proposed that the manner in which the sacrum moved anteriorly (nutation) into a close fit into the posterior aspect of the pelvic ring constituted "Form" closure. Synchronised contraction of the abdominopelvic, gluteals and multifidus muscles exerted "Force" closure on the pelvic ring. These concepts are best appreciated in figure 2.

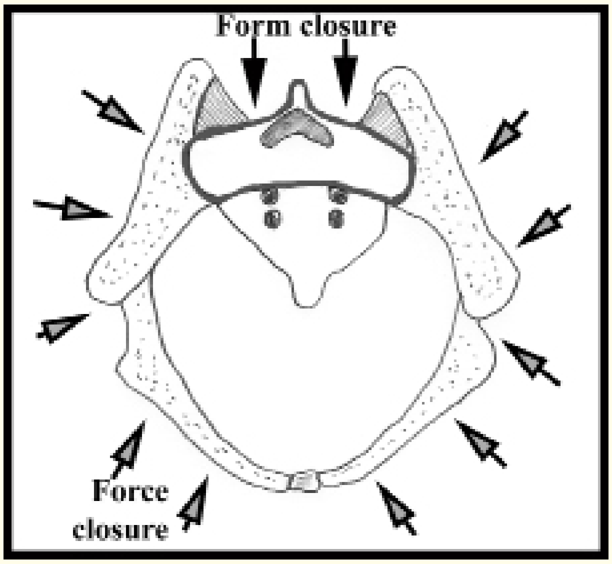

Figure 2: *Form and Force closure of the sacroiliac joints. Form closure is the fit of the irregular sacral articular surfaces with the adjacent iliac bones. The angulation of the sacrum leads to an anterior movement that essentially buries the sacrum into the pelvic ring (nutation). Force closure is the co-ordinated contraction of the abdominopelvic muscles that essentially locks the sacrum into the pelvic ring by compression. The integrity is maintained by the dorsal interosseous ligament. Injury to the ligament triggers loss of the integrity of the form fit and loss of the integrated co-ordination of the abdominopelvic muscles that compress the pelvic ring shut.*

Pathophysiology

The fundamental pathophysiology of SIJ dysfunction arises from injury to the dorsal interosseous ligament of the joint [21] (Figure 1). This may occur in the peripartum period due to laxity of the ligaments or due to direct trauma to the buttocks in discrete falls or repetitive injury in sports such as gymnastics. The early literature pointedly found this to be a disease of the peri-partum period [5] and categorised it as the pelvic girdle pain syndrome. Cusi., *et al.* [17] however showed that a high proportion of patients in their series was due to trauma and coined the term "sacroiliac joint incompetence' with the clear implication that the pelvic girdle pain syndrome was a subset of sacroiliac joint incompetence. Injury to the dorsal interosseous ligament was postulated as the principal site of pathophysiology in the integrated model of Lee and Vleeming [21], although some literature suggested that local anesthetic block to the relevant sacroiliac joint was a critical aspect of the diagnosis [22]. This was generally accepted until the publication of a crossover trial by Murakami., *et al.* [23] in which intra-articular SIJ injection was compared with direct injection into the dorsal interosseous ligament. The intra-articular injection provided effective anaesthesia in 9 of 25 patients, whereas the periarticular injection induced pain relief in all 25 patients in the comparative group. More importantly, when the patients who had failed the intra-articular injection were crossed over into the periarticular arm, there was effective pain relief in all patients. These findings added significant weight to the proposed integrated model of Lee and Vleeming [21].

The core mechanism of dysfunction was postulated as significant injury to the dorsal interosseous ligament (DIOL) which allows the posterior motion of the sacrum (counter-nutation), relative to anterior rotation of the iliac bone. There is then significant pain in a similar distribution to "sciatica" raising suspicion of a nerve root lesion due to intervertebral disc injury [23]. When this is found not to be the case, the term "pseudo-sciatica" has been coined to explain the symptoms. This is thought to trigger a complex abdominopelvic and gluteal muscle response which inhibits the normal pattern of muscle sequencing that creates "force closure" of the pelvic ring. Fundamentally there is substitution of the internal and external oblique muscles (core abdominals), plus increased activation of the adductors around the pubic symphysis, hamstring and iliopsoas muscles. Hungerford., *et al.* [24] demonstrated significant alterations in lumbopelvic muscle recruitment by electromyographic activity in patients with sacroiliac joint dysfunction. Specifically, there was delayed recruitment of the internal oblique, lumbar multifidus and gluteus maximus on the symptomatic side in these patients. Concepts involving both direct injury to the dorsal interosseous ligament and the enthesopathy resulting from muscle spasm has been clearly demonstrated in the scintigraphic study utilising single photon emission computed tomography and x-ray computed tomography (SPECT/ CT) of the bone scan (Figure 3A and 3B) [17].

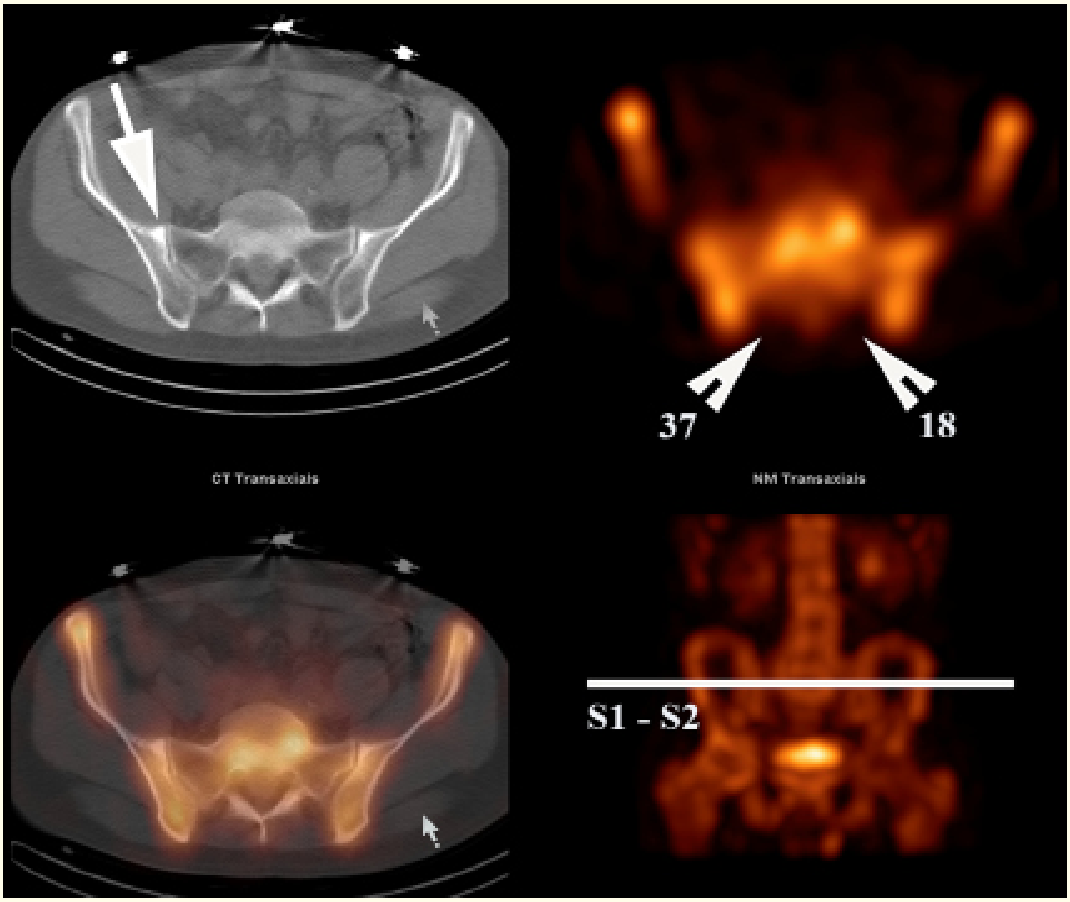

Figure 3A: *Scintigraphic SPECT/CT study at the S1/S2 level. The arrowheads demonstrate increased uptake in the dorsal interosseous ligament on the right side with the count profile showing an increase in counts on the affected side [37] compared with the uninjured side [18]. Note that the right joint is more sclerotic (arrow).*

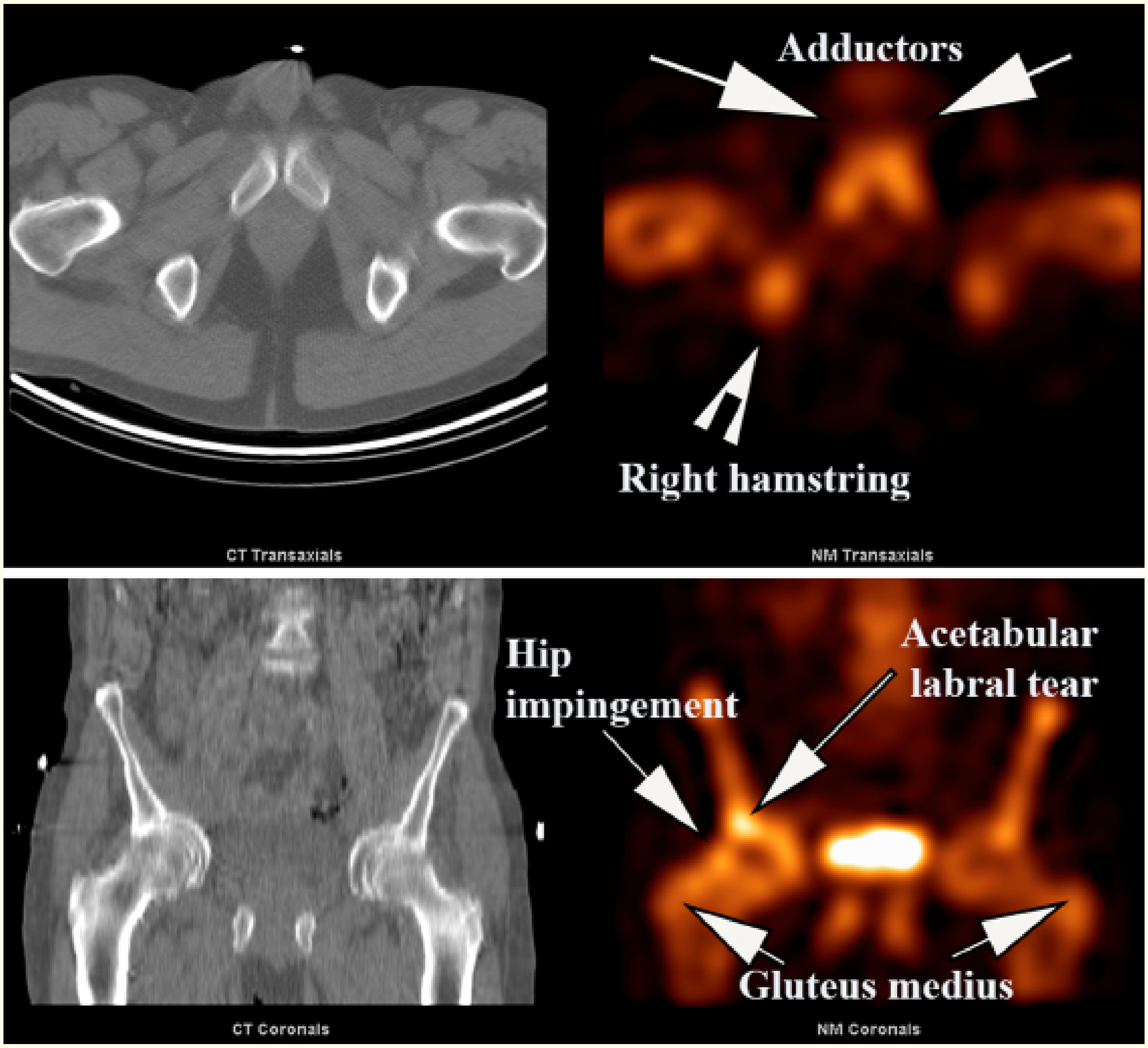

Figure 3B: *Scintigraphic SPECT/ CT study in the same patient from figure 3A. The top panel shows the enthesopathic changes at the sites of adductor (arrows) and right hamstring tendon (arrowhead) insertion. The lower panel shows gluteus medius tendon enthesopathy on both sides and the secondary right hip impingement of the lateral femoral head against the acetabulum that was torn. This was in fact the presenting symptom that led to the diagnosis of the sacroiliac joint incompetence.*

Perhaps the most important support for the integrated model comes from therapy based upon the model, where directed physiotherapy leads to significant and measurable improvement in approximately 80% of patients [25].

Clinical assessment

History

History is a crucial aspect of the clinical assessment of sacroiliac joint incompetence. Broadly speaking, patients either give a history of significant trauma to the buttocks/pelvis or complain of the spontaneous onset of low back pain during the peripartum period. Trauma may be due to rotational injury, falls on to the buttocks or complex trauma resulting from motor vehicle accidents. Trauma may be repetitive as in a sporting setting in gymnastics where there is recurrent landing on the same leg. The other clinical setting of importance is in the peripartum period where about 20% develop spontaneous lateralising lower back pain [5], usually in the L5/S1 distribution. Disturbingly, approximately 8% in this population will develop a long-term disability [21]. A typical presentation is with lateralising lower back pain where the magnetic resonance imaging (MRI) study is reported as normal without evidence of intervertebral disc prolapse and neural compromise (pseudo-sciatica).

Clinical examination

Clinical assessment of the sacroiliac joint may be viewed as pain provocation or palpation tests and palpation tests of position and movement. As there is no single definitive mechanical diagnostic test for the sacro-iliac joint [26], a cluster of tests increases the reliability and reproducibility of the diagnosis [27-29]. Manual tests rely heavily on the palpation skills of the examiner, and are ultimately ‘‘operator dependent’’. Other tests assess muscle activity patterns around a joint, which in turn reflect motion patterns [30]. The major battery of tests that form the evidence-base [31] for the diagnosis of mechanical dysfunction of the sacroiliac joint are:

1. The posterior pelvic pain provocation test (also known as thigh thrust) has been identified as reliable in the diagnosis of pelvic girdle pain in pregnant women (Figure 4) [32].
2. Palpation of the long dorsal sacro-iliac ligament (Figure 5) [33].
3. The Trendelenburg test in its different forms indicates poor muscle activity of the gluteals [34].
4. The stork test (also known as Gillet test), assesses dynamic pelvic motion [35]. It has two phases, the stance phase and the hip flexion phase for each leg. The sacroiliac joint needs to lock for the stance phase to enable efficient transfer of weight. As is illustrated in the upper panel in figure 6. It recognises changes in muscle activation patterns in the action of weight transfer and elevation of the contra-lateral knee (Figure 6). In patients with sacro-iliac joint pain there is early activation of biceps femoris and delayed contraction of transversus abdominis, gluteus maximus, internal oblique and multifidus (the opposite of normal subjects) [24].
5. The active straight leg raise (ASLR), tests the load transfer through the sacro-iliac joint, and has been shown to be reliable and reproducible (Figure 7) [36-38].
6. Patrick’s, Faber (Flexion, Abduction and External Rotation) and Gaenslen’s test are also useful when used in clusters [34].

Figure 4: *Posterior pelvic pain provocation (P4) test. The leg is held at right angles to the pelvis and steadied by one hand at the foot. The other hand pushes down on the knee leading to a telescoping effect on the ipsilateral sacroiliac joint and reproducing the typical pain.*

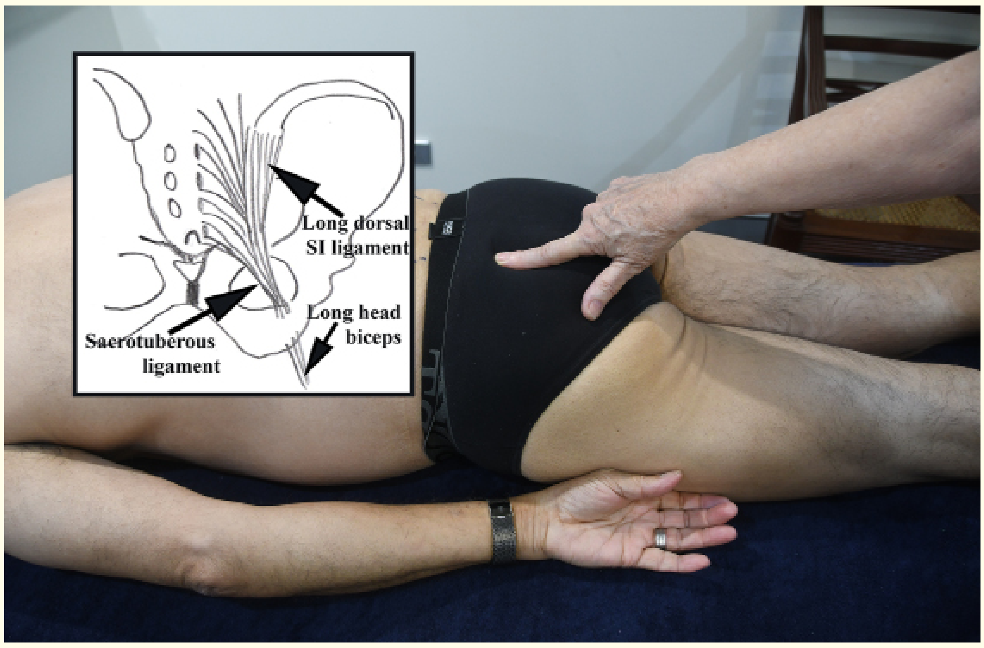

Figure 5: *Palpation of the long dorsal ligament of the sacroiliac joint. The long dorsal sacroiliac ligament lies lateral to the edge of the sacrum on the affected side as the hemipelvis tilts anteriorly placing the ligament in chronic tension. The inset drawing shows the course of the ligament arising from the posterior superior iliac crest and merging with the sacrotuberous ligament.*

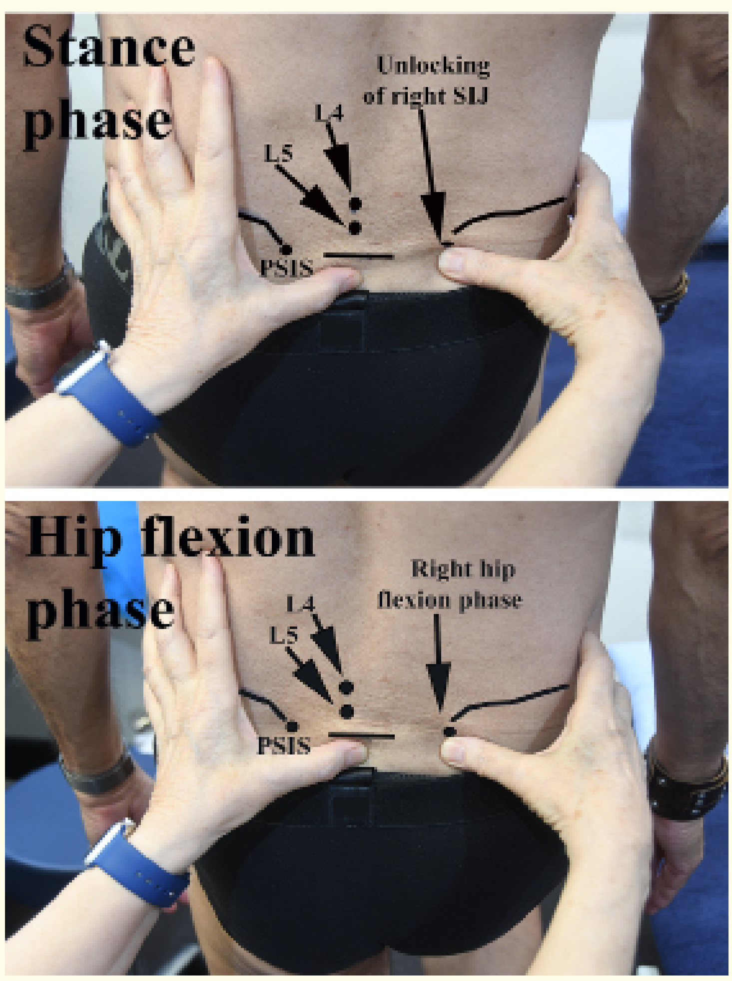

Figure 6: *Stork test. The upper panel illustrates the stance phase of the test as the patient stands on the right leg. This is an abnormal result with the right thumb riding higher and sinking into the unlocked joint. The lower panel is the right hip flexion phase with the thumbs being at the same level indicating a normal result. Had this been abnormal the right thumb would have been higher than the left. It is a mixed result in a patient who has undergone treatment for the condition. (PSIS= posterior superior iliac crest, horizontal black line is the lumbosacral junction and L4 and L5 are the lumbar vertebral spines).*

Figure 7: *Force closure phase of the active straight leg raise (ASLR). Patients with difficulty raising the leg on the affected side will have less difficulty and a subjective improvement in the leg weakness if the pelvis is compressed by the examiner, leading to induced force closure of the pelvis.*

Other clinical manoeuvres have been used by a number of clinicians, and provide valuable information of intra-articular motion, when compared from side to side, particularly the SIJ glide test as described by Lee [39].

Imaging of the sacroiliac joint

While the diagnosis of SIJ mechanical dysfunction was first described in the literature in 1905 [13], it took over 100 years for an imaging test of the condition to be developed and validated [17]. A litany of imaging tests have attempted to established the diagnosis, ranging from ultrasound [40,41] to magnetic resonance imaging (MRI) [42,43], without widespread acceptance and implementation. Early attempts at scintigraphic imaging of the joint were also unhelpful [44]. Part of the reason may be the inaccessibility of the joint and the chronicity and mechanical nature of the condition. Uptake of the scintigraphic agent in the posterior ligaments of the SIJ has been postulated as a calcific healing response rather than the typical oedematous response that characterises most inflammatory conditions [45].

The first systematic report of imaging of mechanical dysfunction of the sacroiliac joint was by this group in 2013 [17]. A functional technique was utilised with the standard bone scintigram and the addition of hybrid delayed imaging. The delayed tomographic (SPECT) study was acquired on a gamma camera which was co-located with x-ray computed tomography (CT). This allowed the delineation of tracer uptake in the damaged dorsal sacroiliac ligaments (Figure 3A) and in the upper joint itself due to the abnormal motion. The visual diagnosis was supported by quantitation of the counts in the posterior ligamentous tissues and compared to the normal side with standardised regions of interest (Figure 3A). The ancillary findings of muscle spasm were characterised by increased uptake at the tendinous entheses around the pelvis and hips (Figure 3B). These were commonly at the adductor, hamstring, psoas and gluteus medius origins. Complicating femoro-acetabular hip impingement was also apparent. Table 1 indicates the frequency of these findings.

A high degree of specificity for the diagnosis was found with ligament uptake when compared to other causes of low back pain or in asymptomatic patients being screened for metastatic disease to bone in predominantly breast and prostate carcinoma. Perhaps the most important contribution of this work is in confirming the suspected site of the fundamental ligamentous pathology (injury to the DIOL). It adds weight to the Murakami., *et al.* [23] finding of dorsal periarticular injection erasing the lateralising SIJ pain. It also supports the Lee and Vleeming [21] hypothesis regarding force closure of the SIJ by the abdominopelvic muscles that is disrupted by the ligamentous injury and responds to specific physiotherapy aimed at re-establishing the correct muscle sequence in 80% of cases.

Therapy of mechanical dysfunction of the SIJ

There is a reasonable body of evidence that the pelvic girdle pain syndrome is related to alterations in lumbopelvic stabilisation and muscle activation of the lumbopelvic and hip musculature [46,47]. This has been particularly well studied in the abdominal and pelvic floor muscles [48,49]. Physical therapies for the dysfunction vary widely and extend from exercise [50] to physical conditioning [51], manual therapy [52], pelvic belts [53], massage [54], therapeutic ultrasound [55] and transcutaneous electrical nerve stimulation [56].

Apart from dealing with the abnormalities in lumbopelvic and hip muscle recruitment and strength deficiencies and tendinopathy, rehabilitation programs have also been applied to the primary site of injury to the dorsal interosseous ligament of the sacroiliac joint. This has been achieved with prolotherapy to the ligament with significant improvements in function [25]. More recently work with platelet-enriched plasma injections into the DIOL have also led to significant improvements in symptoms and pain control. Saunders., *et al.* [57] presented data on 45 patients who had ultrasound-guided injection into the dorsal interosseous ligament of the SIJ and were followed up for 12 months. This was compared to a similar cohort of historical controls treated with prolotherapy by the same group [25]. Patients treated with PRP injection had similar results at 3 and 12 months with a mean of 1.6 injections versus 3.0 injections in the prolotherapy group. The major advantage was the avoidance of the radiation exposure in the prolotherapy group who were treated under CT guidance.

The extreme circumstance for surgical fusion of the SIJ occurs when the integrity of the posterior ligaments of the SIJ is so compromised that non-surgical therapy simply cannot work [58]. This type of therapy is rarely required and has been undertaken in a handful of patients in our experience of over 2500 patients.

Importance of early diagnosis

There is evidence in the literature that duration of chronic non-specific low back pain is an important prognostic element in the return to acceptable function [59,60]. This has been shown to be as extreme as therapeutic failure in over 70% of cases after 12 months of symptoms, with disability being a significantly worse predictor for recovery [59]. Complex psychosocial factors such as depression or the perceived intensity of the low back pain may be causal [60]. The key issue is therefore to move patients out of the prevalent NSLBP group (85% currently) into the group with sacroiliac joint dysfunction (currently ~ 20%) so that appropriate and effective therapeutic strategies can be enacted with an improved change of recovery (~ 80%), thus reducing the cohort with NSLBP from 85% to 65%. Awareness of the diagnosis is the fundamental element in this transition.

Conclusion

Mechanical dysfunction of the sacroiliac joint is more common than intervertebral disc prolapse as a cause of lateralising lower back pain. It should be considered as the initial diagnosis in the setting of peri-partum low back pain and where there is direct trauma to the buttocks. Lateralising lower back pain with a "normal" MRI that shows no evidence of significant disc prolapse with neural compromise is the classical setting in which this disease is most often found, yet is poorly recognised by the medical community in general. The diagnosis is important as therapy is successful in over 80% of patients with directed physiotherapy. Patients failing physiotherapy have a number of alternative therapies such as prolotherapy and PRP injection into the dorsal ligament of the SIJ that also yields good results. The key to the problem is early clinical recognition of the condition.

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