Feature Article

Can manual therapists diagnose instability of the sacro-iliac joint?

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Introduction

Pelvic girdle pain (PGP) is the term used to describe musculoskeletal disorders affecting the pelvis (O'Sullivan Beales 2007). It is defined by pain experienced between the posterior iliac crest and the gluteal fold, near sacroiliac joint (SIJ) (Vleeming et al 2008). PGP primarily involves the SIJ, symphysis pubis and associated ligaments and muscles, as well as the appreciation for how these structures are influenced by the whole body (Vleeming et al 2012) (e.g. first metatarsal) (Dannenberg 1986, O'Leary et al 2013).

The epidemiology on PGP is variable and is in part due to the terminology used (e.g. PGP, sacroiliac joint), the populations and time frame studied (e.g. chronic low back pain, PGP during or post pregnancy) and the diagnostic methods utilized. In the overall population of low back pain (LBP) up to approximately 30% may be due to PGP (O'Shea et al 2010, Cohen et al 2013, Carlson et al 2014). It should be noted that in specific populations this may be higher (Kanakaris et al 2011).

The clinical diagnosis of PGP is made through the subjective history (e.g. pain location, aggravating and easing factors), physical assessment and exclusion of other sources of LBP. Pain provocation tests show higher reliability and diagnostic accuracy and are dependent on patient responses rather than clinician palpation of joint motion. A combination of subjective and objective findings can have high diagnostic accuracy. The reliability, diagnostic accuracy and critical appraisal of various tests are summarized by Cook and Hegedus (2011).

Instability has been proposed as a source of PGP. This has largely been associated with pregnancy related pelvic girdle pain (PR-PGP) (Vleeming et al 1992, Mens et al 1999, Kanakaris et al 2011) but has also been discussed with reference to non-specific LBP (Cook 2007). The purpose of this paper is to discuss if physiotherapists can diagnose instability of the SIJ. This narrative review will focus on three common clinical strategies used to assess SIJ instability in PGP. These are the active straight leg raise (ASLR) test (Mens et al 1999), the One Leg Standing (OLS) test (Hungerford et al 2007) and manual joint examination (Lee 2004).

Form and Force Closure

Vleeming et al (1993) proposed a model of form and force closure to describe the stability of the SIJ. Briefly, form closure is related to the shape, structure or form of a joint as well as the related passive structures. Form closure is achieved passively at end range or by the shape of the supporting surface. This occurs through posterior rotation of the innominate or relative nutation of the sacrum. Force closure is related to the compressive forces and congruency between two surfaces which provide friction to increase stability. This is achieved by external forces such as musculature or a pelvic belt (Vleeming 1992, Comerford 2005).

A self locking mechanism should occur during activities in which load is transferred through the pelvis. This consists of nutation of the sacrum or posterior rotation of the innominate (Vleeming et al 1993) which engages the close packed position of the SIJ. Evidence for this is supported in vivo. The loss of self locking is considered anterior rotation of the innominate or counter-nutation of the sacrum, which has also been observed in vivo in PGP populations (see Vleeming et al 2012 for summary). The load to the pelvis may be applied via the trunk or lower limb. The One Leg Standing (OLS) test and Active Straight Leg Raise (ASLR) test challenge these, respectively.

Reliability of the ASLR and OLS tests

The ASLR test has demonstrated high test - retest reliability with one assessor in a group of fifty women with LBP of various etiologies including PR-PGP (Mens et al 2001). Roussel et al (2007) reported substantial agreement with test- retest reliability with two examiners in a group of thirty-six subjects with chronic non-specific LBP. Kwong et al (2013) found almost perfect agreement between three raters with the ASLR test in a group of thirty one women with and without LBP or PGP. Similarly, Gibbons (2008) found almost perfect agreement between two raters in a mixed group of thirty-two subjects with and without LBP. Bruno et al (2014) found substantial agreement between two raters in a group of thirty subjects with LBP and forty without LBP, while Rabin et al (2014) reported moderate agreement between two raters in a group of thirty subjects with general LBP.

The one leg standing (OLS) test demonstrated moderate inter-rater reliability with three raters in a mixed group of thirty-three subjects with and without LBP (Hungerford et al, 2007). Gibbons (2008) found substantial agreement between two raters in a mixed group of thirty-two subjects with and without LBP, however Kwong et al (2013) reported less than chance agreement of inter-rater reliability in a group with and without LBP. It should be noted that the latter study had one rater with limited experience. These ASLR and OLS tests are described in figures 1 and 2, respectively.

Validity of the ASLR and OLS tests

The ASLR has been investigated for various types of validity in PR-PGP. Concurrent validity was reported and related the ASLR to increased pelvic mobility (Mens et al 1999). However a recent study concluded that the use of the Chamberlain method (the method of measurement used in this original study) is likely inadequate for the examination of SIJ movement in PGP (Kibsgård et al 2014). Other studies may be interpreted as having reported discriminant validity related to identifying PR-PGP versus healthy subjects (Mens et al 2001), predictive validity of the ASLR related to disability (Mens et al 2002, Robinson et al 2010) and an aspect of convergent validity related to the force produced by the patient during the ASLR (Mens et al 2010). A review by Kanakaris et al (2011) calls into question the predictive validity of the SIJ as it relates to the concurrent validity. Further, the results of Damen et al (2002) and Rost et al 2004 did not suggest adequate discriminant validity.

The ASLR validity research has been conducted on PR-PGP. This represents spectrum bias (Knottnerus et al 2002) and is a threat to external validity as applied to other types of lumbo-pelvic pain. Given the manoeuvre and musculature required, the ASLR has the potential to place load on the SIJ, hip and lumbar spine (Cowan et al 2004, Mens et al 2006, Roussel et al 2007, Liebenson et al 2009, Hu et al 2012, Vleeming et al 2012). It is plausible to assume that false positives may occur if hip or lumbar stability is compromised. The reader is directed towards deVon et al (2007) for an interpretation of the validity terms used above and Ferguson (2004) for a description of internal and external validity*.

The OLS test has undergone concurrent validity in PGP for relative motion of the innominate and sacrum. The study may be criticized due to the use of surface markers on the pelvis. The authors discussed this and stated that they were not looking for a range of motion, but patterns of bone motion (Hungerford et al 2004). Based on the in vivo work of Sturesson et al (2000), Vleeming et al (2012) concluded that motion during this test is too small to be detected by manual palpation and that movement of the external pelvis relative to the hips gives the (manual) illusion that the SIJ is repositioned. The small movement that occurs was also reported by Kibsgård et al (2014) to be too small to palpate manually.

Manual Assessment of SIJ Motion

Laboratory investigations suggest increased motion of the SIJ exists (Mens et al 2009) and asymmetry of motion may be related to pain (Damen et al 2001, 2002) in PR-PGP. Manual palpation of the SIJ accessory movements has been described by Lee (2004). Although face validity exists, reliability studies have not been undertaken. Goode et al (2008) suggest that there may be limited clinical utility in using palpation for diagnosing SIJ pathology given the small amount of motion at the SIJ. There is also a general history of poor reliability of joint based tests that require the therapist to make a judgment on joint feel (McGrath 2006). Liebenson and Lewit (2003) highlight the issues regarding reliability and validity of manual palpation and suggest a battery of tests could be used before abandoning manual palpation.

Clinical Studies and Laboratory Studies for the OLS test: Discordance

There is a discordance between what the most accurate in vivo tests show versus the reliability seen in clinical studies. Explanations should be sought to explain this disagreement before the validity of the manual assessment of the OLS test is discarded. The markers used to assess movement of the SIJ in the above in vivo validity studies during one leg standing were placed posteriorly. Is it possible that if the angle is extended (using basic trigonometry principles) to the point of the innominate at the anterior superior iliac spine, that the movement would increase enough to be reliably palpated? Is it possible that the methodology of the validity studies were not standardized sufficiently? For example, false negatives are commonly found in clinical practice when people have started with any weight bearing on the side to be assessed. It is necessary to take the full weight off the leg to be assessed and then transfer the load back through the trunk-pelvis-lower limb. The logic for this standardization is that if the loss of force closure occurs on initiation of weight bearing, the patient will already be in a loose packed position and will not move further during the test (Gibbons 2008). Patient selection and diagnostic accuracy may also play a role. The normal false positive rate of the tests (Cook and Hegedus 2011) and those who may present with PGP or have a hypomobile SIJ could be up to 30-40% of the subject population. Given the low numbers in the study, these subjects could lower the results (i.e. show less movement of the SIJ). It is unlikely this would influence the results enough to change the conclusions relating to the use of the OLS test on its own, but should be considered with other potential sources or error.

Although there is a debate in the discipline of statistics (Mislevy 2004), there is a perspective that it is possible to have reliability without validity, but not the reverse (Moss 1994). The OLS test does also place load on the lumbar spine and lower limb, and thus challenge and influence the musculature in these regions. It may be that manual therapists are reliably palpating some other aspect of lumbo-pelvic-hip motion.

Terminology Issues Related to Instability as a Diagnosis

An important issue when discussing instability is the definition and terminology used. It does appear that a positive ASLR has been interpreted as being SIJ instability (Lee 2004, Liebenson et al 2009, Verheul 2012) however, there are no widely accepted guidelines in the literature for the clinical diagnosis of sacro-iliac instability (Zelle et al 2005). The orthopedic manual therapy literature discusses lumbo-pelvic instability with reference to mechanical (radiological) and functional (clinical) instability (Panjabi 2003, Cook et al 2006, Beazell et al 2010, Ferrari et al 2015). Mechanical instability is present when there is a marked disruption of passive osseoligamentous anatomical restraints (loss of passive integrity) which leads to an increase in end range of motion, excessive translation or rotation and is seen on radiological imaging (Dupuis et al., 1985).

Functional instability does not have a marked defect in anatomical structures, but there is abnormal translation of one or more joints. This is believed to be related to deficits in motor control and sensori-motor function (Cook 2006, Tateuchi et al 2013). These definitions are not universally accepted, nor interpreted the same by all professionals (Leone et al 2007). Snijders et al (1993) feels instability is an impairment of the ability of the pelvic girdle to transfer loads between trunk and legs. This may be related to either definition above.

The interpretation of hypermobility versus instability is also important. It would seem that some authors describe any hypermobility in accessory movement as an instability (Sniders et al 1993) and others try to differentiate (Beazell et al 2010). This terminology has important research and clinical implications. During reliability testing in research, reliability is more likely achieved if there are fewer choices based on probability since an increase in options would statistically decrease reliability. Another issue is the stigma of the diagnostic term "instability". In a study of lumbo-pelvic pain patients that looked at the meaning of various diagnostic terms, a diagnosis of "instability" was second only to "disc herniation" in perceived seriousness. Diagnostic terminology can have deleterious effects on certain individuals including: increased kinesiophobia, expectation of poor recovery, a desire for specialist consult and further investigations (Gibbons 2011b).

Figure 1: An example of the ASLR test. The patient lies supine with legs straight feet 20 cm apart (Figure 1a). The patient is instructed to raise one leg 20cm and then the other without bending the knee (Figure 1b). It can be useful for the therapist to hold their hand at 20cm to let the patient know they have gone far enough, although this was not done in the original description. The patient is asked whether they felt weakness, pain or any other unpleasant feelings during the test and whether they notice any difference between the two sides.
The examiner assesses the velocity of raising, the appearance of a tremor of the leg, the amount of rotation of the trunk, and verbal and non-verbal emotional expressions of the patient The patient is asked to score any feeling of impairment (on both sides separately) on a 6-point scale: not difficult at all = 0; minimally difficult = 1; somewhat difficult = 2; fairly difficult = 3; very difficult = 4; unable to do = 5. Any subjective or objective difficulties are considered positive (Mens et al 1999, Vleeming et al 2008).

In another version of the test, if pain is felt during the ASLR, compression can be manually applied to the pelvis by compressing the anterior superior iliac spines medially (Figure 1c) or by placing a sacroiliac belt around the pelvis. If the ASLR is no longer painful during the compression, the test is considered positive (Cook and Hegedus 2011).

1a **1b** **1c**

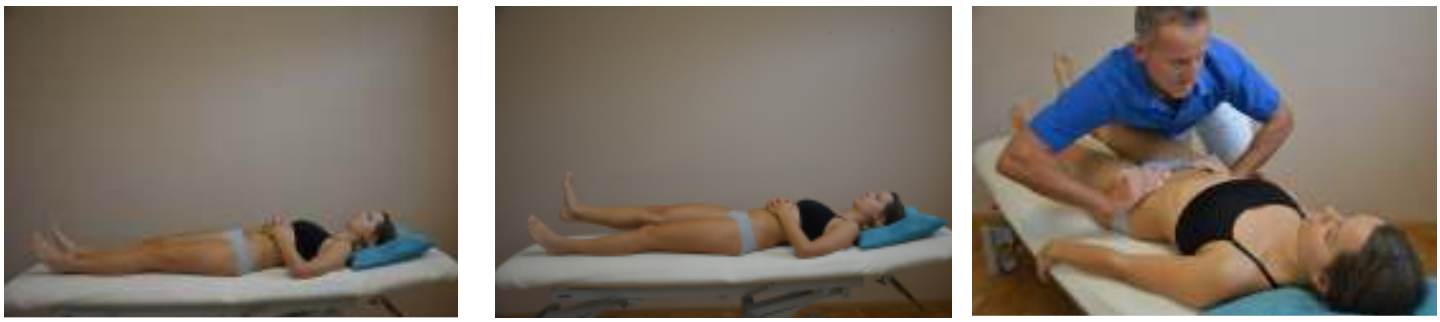

Figure 2: An example of the OLS test on the right. The patient should not be in prolonged weight bearing before the test. They are asked to stand shoulder width apart (Figure2a). To test the right leg, the weight must be taken off the right leg so the patient is asked to shift their weight to the left leg (Figure 2b). They are asked to shift their weight to the right and flex their left hip (Figure 2c). The therapist should palpate the weight bearing side by placing their thumb directly on the right posterior superior iliac spine and allow the rest of the right hand to contact the right innominate bone. The left thumb should palpate the S2 spinous process of the sacrum (Hungerford et al 2007) (Figure d). An alternate palpation is recommended by the author. Here the therapist uses the same palpation with the left hand as above, but they also palpate the anterior superior iliac spine with their index or third finger and allow the rest of the hand to contact the right innominate bone (Figure 2e). In both palpation methods, any anterior rotation of the innominate is a positive test. If a positive test is suspected, the therapist should do the above weight transfer procedure and palpate both ASIS's and iliac crests concurrently to rule out rotation since this would be felt bilaterally (figure 2f).

2a

2b

2c

Standardization appears to be critical to reduce false negative results on the One Leg Standing Test

2d

2e

Can manual therapists diagnose instability of the SIJ?

There are several points to summarize from above in order to form an opinion on the diagnosis of instability of the SIJ.

- The validity research on the ASLR was conducted on PR-PGP. There is a lack of evidence of external validity for the interpretation of SIJ instability to be applied to other types of LBP.
- The study by Kibsgård et al (2014) does raise concerns regarding the concurrent validity of the ASLR.
- There is conflicting evidence of discriminant validity for the ASLR.
- The ASLR has high test - retest reliability in one study in PR-PGP and very good inter-rater reliability in multiple studies with different types of LBP.
- Different methodologies and interpretation of a positive test were used for the reliability and validity research for the ASLR
- The concurrent validity of the OLS used surface markers which is a threat to the internal validity of the study. The study was done on PGP patients so has external validity.
- The in vivo studies suggest any movement of the SIJ may be too small to palpate.
- When the study involves experienced clinicians and they dichotomize their judgment of movement into two variables (e.g. normal or movement) there is adequate inter-tester reliability (Note: one of these studies is unpublished and is by the author so bias may exist). Different methodologies and palpation techniques were used during these studies
- There is a lack of evidence for reliability, content validity, or any type of criterion validity on manual examination for the SIJ.
- There is not agreement on the method for a clinical diagnosis of SIJ instability. The interpretation of instability by Snijders et al (1993) is broad and not universally accepted.
- A diagnosis of "instability" can have harmful effects on at risk individuals.

It is the author's opinion that there is not sufficient external evidence to suggest manual therapists can diagnose any type of SIJ instability in all types of lumbo-pelvic pain using the ASLR, OLS tests or manual examination of the SIJ. It must be appreciated that evidence based practice does not solely rest with external evidence. It also involves integrating clinical expertise with this and patient values must also be considered (Sackett et al 1996).

There are adequate physical assessment tests to make a clinical diagnosis of PGP (Cook and Hegedus 2011). If the clinician wants to qualify a diagnosis of PGP further by diagnosing instability, the clinician should consider the level of evidence their decision is based upon (Howick et al 2011), evidence based medicine principles (Straus et al 2010), use suitable judgment regarding the use of above tests, and use care in communicating this information to patients (Gibbons 2011b). To more further qualify PGP, the author generally prefers the term 'hypermobility' rather than 'instability' given the problems with the negative connotation of the term by some patients, the easy misinterpretation of mechanical and functional instability by other health care professionals, and the limited evidence of the physical assessment strategies described above. The author does acknowledge that there can be exceptions to this in very specific circumstances where the clinical history and physical assessment do strongly suggest instability may exist (e.g. trauma, PR-PGP, genetic connective tissue disease such as Ehlers- Danlos syndrome), but in the author's opinion, this diagnosis should not be used routinely in general PGP.

Recommendations

As mentioned, to make a diagnosis of PGP, it is recommended that the clinician use a suitable subjective history and physical assessment (Cook and Hegedus 2011) and exclude other sources of LBP.

In the form and force closure model described above, hypermobility would be reduced force closure and would manifest as relative anterior rotation of the innominate during tasks that challenge the transfer of load across the pelvis. Hypomobility would be increased force closure. This is not as clinically obvious as above. This would be suspected when there is PGP, but no signs or symptoms of reduced force closure. It is the author's opinion that the reduced joint movement is frequently due to an altered axis of rotation due to alterations in motor control rather than joint restrictions. The author agrees with the sub-classification model proposed by O'Sullivan and Beales (2007), however the author does not agree with specific motor control stability exercise (SMCE) training being inappropriate for this group. It should also be noted that there are a broad spectrum of exercises under the umbrella term "stability". Specific motor control stability exercise (SMCE) training being inappropriate for this group. It should also be noted that there are a broad spectrum of exercises under the umbrella term "stability". Specific motor control stability exercises (SMCSE) (i.e. bias for transversus abdominus, deep lumbar multifidus) are fundamentally different from Pilates or ball training. It is the author's clinical observation that when the patient has mechanical pain, can appropriately learn the exercise, and behavioral factors are ruled out, SMCSE for deep sacral gluteus maximus or psoas major (Gibbons 2007) are frequently relieving when other SMCSE aggravate PGP.

The author uses a sub-classification model (Gibbons 2014, Gibbons and Andreotti 2015) different from O'Sullivan and Beales (2007). In this model (table 1), the patient would be classified as "Behavioral" (Gibbons 2014) if they presented with most of the criteria used by O'Sullivan and Beales (2007) to classify hypomobility. SMCSE would be used only when the behavioral symptoms were reduced. Frequently, the motor control patterns and behavioral presentation in these patients would prevent them from performing the SMCSE properly due to the high level of precision and neurocognitive demands required to perform and benefit from these exercises. Hence they would be sub-classified with a Central Nervous System Coordination deficit (inability to learn SMCSE) (Gibbons 2011a). Treatment would focus on specific sensorimotor function strategies such as two point discrimination training, proprioception (repositioning), midline crossing tasks and primitive reflex inhibition (Gibbons 2009).

Correcting the motor control issues can improve the altered axis of rotation and treat the hypomobility and pain. In the author's opinion, the use of this sub-classification process reveals that the management of hypo and hypermobility is very similar with regards to therapeutic exercise. However, other necessary clinical interventions may differ.

In summary, if the sub-classification model proposed by the author is used (Gibbons 2014), once behavioral factors, non mechanical pain, and the inability to learn SMCE are ruled out, the rehabilitation of PGP with exercise would be similar regardless of the further labeling of the diagnosis of PGP; hypomobility, hypermobility or instability. Hence, the term 'translation control deficit' was proposed by Gibbons and Strassl (2012) (to sub-classify a painful tissue structure) which can be accurately diagnosed with a high level of evidence in PGP. This can be qualified further by the clinician if they chose to do so using a lower level of evidence.

Table 1: Sub-classification strategy for neuro-musculoskeletal disorders (from Gibbons 2014)

Sub-classification Mechanisms of each sub-classification (where applicable)				
Behavioral Factors	**Pain Mechanisms**	**CNS Coordination**	**Movement & Motor Function**	**Patho-anatomical**
• Clinical disorders • Personality & developmental disorders • Psychosocial factors	• Nociceptive • Neurogenic • Neuropathic • Central sensitization • Musculoskeletal body image disruption • NISE Syndrome pain	• Neurocognitive • Sensory motor • Primitive reflexes • Postural reflexes • Midline & body awareness	• Movement pattern control • Functional movement pattern • Translation control • Respiratory function • Endurance • Aerobic fitness • Strength	• Articular • Myofascial • Neurodynamic • Connective tissue

Individual Factors					
Medical & Physical conditions	**Expectations & Beliefs**	**Cultural, Social Gender & Age Influences**	**Motivation & compliance**	**Health Behaviors**	**Work & Sport demands**
• General medical conditions • Congenital anomalies • Genetic disorders • Previous episodes	• Health care utilization • Responsibility for health • Assessment • Diagnosis • Investigations • Treatment • Recovery time • Return to work • Pain physiology • Pain & activity	• Pain threshold • Pain responses • Pain behavior • Response to treatment • Expectations and beliefs • Religious and spiritual beliefs	• Social values • Legal claims • Compensation • Education level	• Activity levels • Hobbies • Sleep patterns • Nutrition • Smoking • Alcohol & drugs • Previous time off work • Previous health care utilization • Response to previous interventions	• Ergonomic issues • Biological rhythms • Training regimes • Shift work • Equipment • Climate

Conclusion

This paper is a narrative review and summarizes the evidence on three common clinical strategies to diagnose SIJ instability. These include the ASLR and OLS tests, and a manual joint examination. Most of the tests for the SIJ are pain provocation tests or positional diagnoses and do not help in diagnosing SIJ instability. There are other tests that assess a loss of force closure (e.g. prone over bed hip extension, weight bearing single leg pelvic bridge), but are not published (Comerford 2005). It is the author's opinion that there is not sufficient external evidence to suggest manual therapists can diagnose SIJ instability in lumbo-pelvic pain. Clinicians may use other tests based on their clinical experience but should keep in mind the level of evidence of the tests they use and consider the potentially harmful effects of verbalizing a diagnosis of instability. Future research should aim to critically evaluate the ASLR and OLS tests. For example, using an accepted tool such as the QUAREL for reliability (Lucas et al 2010) and QUADAS-2 for diagnostic accuracy (Whiting et al 2011). Hence, this paper is limited by not being a systematic review. As well, the issues brought up regarding the internal validity of the ASLR and OLS tests should be investigated. Given the normal false positive and false negative rates of diagnostic tests, it would be useful to have alternate validated tests to use to help in decision making (Fardy 2009). The tests described by Comerford (2005) have face validity and could help fill this void if research shows criterion validity and reliability.

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*** Note:** The terminology relating to validity can be easily confused. This is likely because the terminology changes depending on the type of study (e.g. intervention, diagnosis) and type of research (qualitative versus quantitative). There are also different interpretations by different authors. The reference provided is for qualitative research because it provides an easy framework for the reader.

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