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Movement of the sacroiliac joint during the Active Straight Leg Raise test in patients with long-lasting severe sacroiliac joint pain

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ABSTRACT

Background: The Active Straight Leg Raise is a functional test used in the assessment of pelvic girdle pain, and has shown to have good validity, reliability and responsiveness. The Active Straight Leg Raise is considered to examine the patients' ability to transfer load through the pelvis. It has been hypothesized that patients with pelvic girdle pain lack the ability to stabilize the pelvic girdle, probably due to instability or increased movement of the sacroiliac joint. This study examines the movement of the sacroiliac joints during the Active Straight Leg Raise in patients with pelvic girdle pain.

Methods: Tantalum markers were inserted in the dorsal sacrum and ilium of 12 patients with long-lasting pelvic girdle pain scheduled for sacroiliac joint fusion surgery. Two to three weeks later movement of the sacroiliac joints during the Active Straight Leg Raise was measured with radiostereometric analysis.

Findings: Small movements were detected. There was larger movement of the sacroiliac joint of the rested leg's sacroiliac joint compared to the lifted leg's side. A mean backward rotation of 0.8° and inward tilt of 0.3° were seen in the rested leg's sacroiliac joint.

Interpretation: The movements of the sacroiliac joints during the Active Straight Leg Raise are small. There was a small backward rotation of the innominate bone relative to sacrum on the rested leg's side. Our findings contradict an earlier understanding that a forward rotation of the lifted leg's innominate occur while performing the Active Straight Leg Raise.

1. Introduction

According to the European guidelines for low back pain, pelvic girdle pain (PGP) is a subgroup of low back pain and is defined as pain experienced between the posterior iliac crest and the gluteal fold, particularly in the vicinity of the sacroiliac joint (SIJ) (Vleeming et al., 2008). Hence, the SIJ is of interest in understanding PGP. Patients suffering from PGP commonly have functional impairments and the Active Straight Leg Raise (ASLR) test is commonly used to assess patients with PGP. The ASLR test is a functional test compared to provocation tests (Laslett et al., 2006; Vleeming et al., 2008). Whereas the provocation tests are designed to provoke and trigger pain in the SIJ and surrounding structures, the ASLR test is considered to assess the ability to transfer load from the spine to the legs through the pelvis (Mens et al., 1999). The ASLR test is found to be reliable, valid and responsive and can be used to evaluate the severity of PGP (Kwong et al., 2013; Mens et al., 1999; Mens et al., 2001, 2002a; Mens et al., 2012). When performing the ASLR test the patients are lying supine and raise one leg 20 cm and consequently grade their difficulties to do so from 0 (no difficulties) to 5 (unable to do). When the scores from each leg are summarized the patient can score between 0 and 10 (Mens et al., 2002b).

It is still debated what the actual movements in the SIJs are. The opinions differ from movement that can be felt by an examiner (Hungerford et al., 2007) to almost no movement at all (Goode et al., 2008; Kibsgard et al., 2014; Sturesson et al., 1989; Sturesson et al., 2000a, 2000b). There is increasing evidence that the movements in the SIJs are small and it has been reported that in a loaded pelvis the rotational movements between the innominates and the sacrum are no more than 1–2° with almost no translation (Goode et al., 2008; Kibsgard et al., 2014; Sturesson et al., 1989; Sturesson et al., 2000a, 2000b). This limited movement has been explained by the concept of form and force closure, where a combination of pelvic anatomy, ligaments and muscular forces more or less locks the SIJs (Snijders et al., 1993; Vleeming

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et al., 2012). Because of the SIJ's anatomical position it is difficult to measure the actual movement. The radiostereometric analysis (RSA) has been used in several studies that measure SIJ movement (Kibsgard et al., 2014; Sturesson et al., 1989; Sturesson et al., 1999; Sturesson et al., 2000a, 2000b; Tullberg et al., 1998), and the method has high precision and accuracy (Kibsgard et al., 2012). All the studies that have used the RSA method have measured SIJ movement in a loaded pelvis. The degree of movement in an un-loaded situation is however not well studied.

It has been hypothesized that a lack of ability to stabilize the SIJs is one reason why patients have difficulties performing the ASLR test. A high ASLR score could theoretically represent hypermobility in the SIJ and/or an inability to stabilize the pelvic girdle, which could be expected to be found in patients with severe symptoms. This theory has been strengthened by studies showing that patients perform the ASLR test easier with a pelvic belt applied (Hu et al., 2010; Mens et al., 1999). Mens et al. (1999) reported a downward ipsilateral displacement in the pubic symphysis on X-ray during the ASLR test and concluded that this displacement was caused by a forward rotation of the ipsilateral innominate bone relative to sacrum. Since the hip flexors are the major muscles involved when the ASLR test is performed a forward rotation of the lifted leg's innominate could be expected (Hu et al., 2010; Hu et al., 2012). However, earlier RSA studies have shown that the innominate is in a forward rotation in supine position with straight legs and posterior rotation in standing position (Sturesson et al., 1989). If the innominate is in a maximal anterior rotation before the patients lift the leg during the ASLR, a further forward rotation might seem unlikely. As the actual movement of the SIJ during the ASLR has not been tested by precise RSA methods, the aim of the current study was to measure this movement during the ASLR test by using RSA, in patients with severe PGP.

2. Methods

We used RSA to measure the in-vivo movement of the SIJ during the ASLR test in patients with PGP. This study was conducted at two orthopaedic centres, Oslo University Hospital in Norway and Ängelholm Hospital in Sweden. The study was approved by the Regional Committee for Medical Research Ethics (Number: 1.2006.1574), and all patients signed an informed consent.

2.1. Patients

In the study period from 2007 to 2010 a total of 17 patients with PGP were assigned for SIJ fusion. Inclusion criteria were: long duration of pain localized to one or both SIJs, two out of five positive clinical tests (Posterior Pelvic Pain Provocation test, ASLR, Palpation of the long dorsal sacroiliac ligament, Modified Trendelenburg, Palpation of the symphysis) and high degree of pain and disability measured by visual analogue scale (VAS) and Oswestry Disability Index (Kibsgård et al., 2014). Similar criteria have previously been used when studying women with pelvic girdle pain (Stuge et al., 2004; Stuge et al., 2013) and are recommended by the European Guidelines (Vleeming et al., 2008). All patients had normal MRI of the spine. Pre-operatively these patients had 1 mm RSA tantalum markers implanted in the dorsal part of the sacrum and both ilia under general anesthesia, but after the evaluation of the RSA data only 12 patients, including 11 women and 1 man, had proper X-ray quality to be included in the analysis. The reasons for exclusion were misplaced markers (markers placed outside the bone) or that the markers were unable to be localized in the X-rays during the software analysis. Patients' characteristics are presented in Table 1.

2.2. RSA protocol

Through small skin incisions the 1 mm markers were inserted with a RSA marker gun under general anesthesia as earlier described in detail (Kibsgård et al., 2014). After 2–3 weeks, three pairs of RSA X-ray pictures were taken; one in supine position, two during the ASLR test right and left (Fig. 1). Each pair of radiographs was taken with two X-ray tubes. The specifications are reported in Table 2. The RSA software calculates the translation and rotations in an x, y, z coordinate system (Fig. 2) together with the true axis of rotation and translation (helical axis). The coordinate system is along the Cartesian axis when reporting RSA results which is defined by the calibration caged (Valstar et al., 2005). The movement is always described of one moving segment (ileum) compared to the fixed segment (sacrum). The position of the fixed segment, within this global coordinate system can be different between measurements, but the RSA computer program transforms the data in order to compare different X-ray uptakes.

This coordinate system differs from the coordinate system used in the guidelines from the International Society of Biomechanics in regard of origin and use of x, y, z as definitions for directions (Wu et al., 2002). The rotational angles were Euler angles that describe the movement as rotations about the fixed x-, y- and z axis. In the text we define a forward rotation of the innominate relative to sacrum as a positive rotation around the x-axis and a backward rotation as a negative rotation around the x-axis. In the test text the term inward tilt of the rested leg's innominate is used and this was defined as a positive rotation of the left innominate around the y-axis (Fig. 2). The accuracy of the SIJ RSA has in a previous study proven to be good without any systematic bias (Kibsgard et al., 2012). The precision of the SIJ RSA measurements, when only dorsal markers are used, are for rotations; $x = 0.5^\circ$, $y = 0.4^\circ$, $z = 0.1^\circ$ and for the translation; $x = 0.1$ mm, $y = 0.2$ mm, $z = 0.5$ mm (Kibsgard et al., 2012). As for the quality of the measurements the limit for condition number (CN) was set to 150. A low CN represents a good scatter of markers in the segments and an upper limit of 150 is suggested to ensure a reliable marker distribution (Valstar et al., 2005). The mean error was set to 0.35 mm (maximum movement of a marker within the segment between two examinations).

2.3. Statistical analysis

The ASLR test was performed on both sides in each patient to compare the movement of the SIJ on the lifted leg with the movement of the SIJ of the rested leg. Since there are differences in interpretation of positive and negative movement between left and right side we converted the sign and the calculation were performed in a setting where the lifted leg was right side and the resting leg was left side. The mean of the two sides were used in the analysis. The movement of each direction was presented with mean, standard deviation and range. A one-sample *t*-test was used to calculate if the mean was different from zero. As the measurements were close to the precision of the method, the fraction of measurements that exceeded this threshold was presented together with the range. We used SPSS® Version 18 (SPSS Inc., Chicago, IL, USA) for statistical analysis.

Table 1
Descriptives of the patients.

	Mean	Range
Number of patients	12	
Age (years)	39	(29–47)
Body mass index	24	(19–30)
Female/male	11/1	
Duration of PGP (years)	8	(1.5–20)
Oswestry disability index	56	(26–76)
Evening VAS	75	(53–91)
ASLR score total (0 – 10)	5.8	(4–8)
ASLR score in the most painful joint (0–5)	3.6	(2–4)
ASLR score in the less painful joint (0–5)	2.2	(0–4)
Bilateral pain/unilateral pain	8/4	