Reproducibility of manual pressure force on provocation of the sacroiliac joint

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ABSTRACT

Background and Purpose. Previous studies of pain-provocation sacroiliac (SI) joint tests have revealed conflicting results. The aim of the present study was to evaluate the intra- and inter-test reliability of pressure force applied during distraction test, compression test and pressure on the apex sacralis. Methods. Seventeen physiotherapists (PTs), median age 43 years and median clinical experience 11 years, all experienced in musculoskeletal evaluation and therapy, participated in the study. Each PT performed each test on the same healthy volunteer for 20 s, on three separate occasions, at intervals of one week using a specially constructed examination table which registered pressure force. Results. The PTs were capable of maintaining a relatively constant pressure force for 20 s. The intra-test reliability was acceptable even though there were individual differences on different occasions between those PTs who used the SI joint tests often and those who seldom or never used them. The inter-test reliability was insufficient. Conclusions. The findings indicate the advantage of registering pressure force as a complement for standardized methods for pain-provoking tests and when learning provocation tests, since individual variability was considerable.

Key words: force, pain provocation, reliability, sacroiliac joint.

INTRODUCTION

Pain in the lumbosacral joint and in the sacroiliac (SI) joints is a common complaint for which physiotherapists (PTs) are consulted. The SI joint is part synovial and part a syndesmosis, a joint characterized by restricted movement with a strong capsule, resistant and well-developed ligaments and a roughened articular surface. The capsule is reinforced by strong ligaments which contribute to the stability of the joint, keep the sacrum in place and prevent the rotation of its apex (Walker, 1992).
The innervation of the SI joint is complex with an abundant intra-articular nerve supply (Norman, 1968; Bradley, 1974). The most superficial aspect of the SI joint is situated approximately 2 cm from the skin surface allowing only indirect manual examination (Russell et al., 1981).

Some of the tests used in examination of the SI joints are intended to provoke pain in the joints and surrounding structures. The patient may be asked to give a subjective value of the degree of pain/discomfort on a visual analogue scale (VAS) (Huskinsson, 1974) or on a category-ratio score (Borg, 1982). The patient may also indicate the quality of pain/discomfort and its location (Melzack & Torgerson, 1971; Melzack, 1975). To permit the reliable comparison of manual pain-provocation in SI joint tests, they must be performed in exactly the same way each time. The standardized testing of the patient with regard to position, the reference areas of the body where force is applied and its duration, is straightforward. However, the amount of force applied at each examination is certainly of equal importance but more difficult to standardize.

Some studies evaluating SI joint tests have revealed conflicting results. Russell et al. (1981) concluded that none of six different SI joint tests was of clinical value in discriminating between causes of chronic pain in the lumbar vertebrae and/or in the SI joints. However, Blower and Griffin (1984) found that the same tests had good inter-test reliability and that the distraction test and pressure on the apex sacralis were significantly correlated with ankylosing spondylitis and with pain in the SI joints associated with pregnancy. Potter and Rothstein (1985), studying 13 SI joint tests, observed that 11 of them had poor inter-test reliability. Only the distraction test and the compression test showed inter-test reliability in more than 70% of cases. McCombe et al. (1989) found poor reliability and recommended caution in the use of the same tests. Östgaard et al. (1994) evaluated a unilateral provocation test for the lumbosacral joint and the SI joint in pregnant women. These authors documented a strong correlation between pain history and pain provoked by the test. In a study by Laslett and Williams (1994), five of seven SI joint tests (including the distraction test and compression test) demonstrated moderate to good inter-test reliability, contrasting with the poor performance of pressure on the apex sacralis. Maigne et al. (1996) performed a double block to establish the frequency of SI joint dysfunction and concluded that none of seven SI joint tests was a useful predictor of a positive block. All these studies were based on the patients' subjective complaints and/or their pain drawings. None of the published reports take into account the applied force or the duration of its application.

The amount of pressure force applied is crucial for the pain response in various provocation tests. Misjudgement of the capacity to exert reproducible pressure force may dupe the therapist into believing that the same force has been applied each time. It is therefore of clinical relevance to examine how experienced PTs perform in the standard SI joint tests.

The aim of the present study was to evaluate the intra- and inter-test reliability of pressure force during three SI joint tests: the distraction test; the compression test; and pressure on the apex sacralis. The following questions were posed:
• Are PTs capable of maintaining a constant pressure force for 20 s, and what force is exerted?
• Can PTs reproduce the same pressure force on different occasions when examining the same healthy volunteer?
• Do individual PTs apply the same pressure force in a selected test on the same healthy volunteer?

The design of the study was approved by the Ethical Research Committee, Huddinge Hospital.

MATERIALS AND METHOD

Subjects
Eighteen PTs participated in the study; 14 worked in a hospital and four in a private physiotherapy clinic in Stockholm, Sweden. All the PTs were volunteers and were experienced in musculoskeletal evaluation and therapy. They were fully informed of the experimental procedure and were aware that they were free to withdraw from the study at any time. All except one were female, median age 43 years (range 27–56 years), median body weight 61 kg (range 50–77 kg), median height 168.5 cm (range 157–179 cm), median clinical experience 11 years (range 1–30 years). Seven of the PTs performed SI joint tests often and 11 seldom or never. One PT with six years’ clinical experience was excluded as she was unable to participate on the second test occasion.

Provocation SI joint tests
The following tests were performed.

Test 1
Sacroiliac distraction test (Figure 1). With the patient lying supine a firm pressure was applied on both anterior superior iliac spines in an effort to stretch the anterior ligaments and the capsule ventrally and to compress the posterior part of the SI joints. The test was performed with crossed arms and elbows locked in extension (Russell et al., 1981; Blower & Griffin, 1984; Potter & Rothstein, 1985; Laslett & Williams, 1994; Hallgrimsson, 1980; Lee, 1989).

Test 2
Sacroiliac compression test (Figure 2). The PT stood over the patient who was lying on her side and applied a firm downward pressure on the uppermost margin of the iliac crest in an effort to stretch the posterior ligaments and the capsule dorsally and to compress the anterior part of the SI joints. The test was performed either with the
FIGURE 1: The distraction test.

FIGURE 2: The compression test.
elbows locked in extension or in flexion (Russell et al., 1981; Blower & Griffin, 1984; Potter & Rothstein, 1985; Laslett & Williams, 1994; Hallgrimsson, 1980; Lee, 1989).

Test 3
Pressure on the apex sacralis (Figure 3). With the patient lying prone a firm pressure was applied on the apex sacralis in attempt to stretch the ligaments and the capsules of the SI joints as well as of the lumbosacral junction and to compress the joints. The test was performed with elbows locked in extension (Grieve, 1976; Russell et al., 1981; Blower & Griffin, 1984; Laslett & Williams, 1994).

Each PT independently performed the three SI joint tests for 20 s (Lee, 1989), at the same time of day, on three separate occasions at one- or two-week intervals. All the PTs performed the tests on the same volunteer. The volunteer was a healthy woman who never had low back pain or SI joint complaints and who had never been pregnant. She was aged 42 years, with a body weight of 70 kg and height of 175 cm.

Instrumentation
A specially constructed examination table (Levin, 1989) was used in the trial. A sheet of chipboard (1880 x 680 x 15 mm) was placed on a height-adjustable examination table. Digital scales 500 gr/1 lb (EKS International AB, S-333 00 Smålandsstenar, Sweden) were placed on the chipboard 700 and 800 mm from the
upper and lower ends, respectively. On the chipboard was an additional padded examination board (1900 x 680 x 32 mm) with a hole (400 x 400 mm) for the scales, its surface level with that of the scales (Figure 4). A sheet of padded, 5 mm hardboard (500 x 680 mm) was placed across this board, resting on the scales (Figure 5). The pressure force was read in kilopounds (kp) in a display connected to the scales by a cable and attached to the base of the examination table. The display was connected to a digital/analogue converter (D/A-converter built around component ZN 435 at a laboratory in the Department of Physiology II, Karolinska Institutet, Sweden). In
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turn, this was connected to an electrical ink recorder (Brush 220 Recorder, Gould Inc., 8333 Rockside Road, Valley View, Ohio 44125 6104, USA) with graph paper.

The volunteer’s position was marked with tape on top of the examination table for each test.

For recording the pressure force, an ink recorder was used (Figure 5 above). The recorder was calibrated in a workshop before the trial so that a square on the \( y \)-axis of the graph paper corresponded to 19.62 Newton (N) pressure force when the sensitivity was set to 20 millivolt. A square on the \( x \)-axis corresponded to 1 s at a speed of 1 mm/s. During the trial the examination table was calibrated before each individual PT’s trial on all three examination occasions, with standard weights (total 20 kg). Calibration was in seven steps: 0 kg, 5 kg, 10 kg, 20 kg, 10 kg, 5 kg and 0 kg. The pressure forces were calculated by counting the squares every second and multiplying the number of squares by 19.62 to yield N.

Procedure

The order of the three tests was randomized for each PT by lottery. Any PT wishing to practise the tests on the volunteer was allowed to use an ordinary examination table. The PTs were instructed to perform the tests as if examining a patient by provoking pain in the SI joint. The volunteer was instructed to report any pain or discomfort at once whereupon the PT would cease the test immediately.

The volunteer was placed in the marked position on the examination table. The height of the table was recorded by measuring the distance from its lower surface to the floor and was adjusted for each PT. The volunteer’s bodyweight in her actual position on the examination table was read from the display and thereafter the ink recorder was set to zero. The PTs applied what they regarded as the optional pressure force for each test in order to provoke the SI joint and indicated vocally when the pressure was attained. This moment was registered on the graph paper by pushing a marker button on the ink recorder. The pressure force was to be kept constant for 20 s (Lee, 1989). The pressure force applied and its duration were recorded by the ink recorder. The PT followed the time on a chronometer but could not see the recording of pressure. As a control measure, the procedure was monitored continuously on the display by the supervisor during the entire test.

The second and third examination occasions were conducted identically to the first with respect to table height, the position of the volunteer and the PTs’ elbow positions. The PTs were instructed to apply, if possible, the same pressure force for each test.

Data analysis

For each individual PT and each SI joint test, the pressure force per second, the mean pressure force for each occasion, as well as the mean of the three sessions were calculated. The same variables were calculated for the entire group of PTs.
The regression line was calculated from the pressure force per second for each individual PT. The maintenance of a constant pressure force for 20 s by each PT was estimated from the slope of the regression line. The mean slope and its 95% confidence interval (95% CI) were then estimated. One-way analysis of variance for repeated measures was used to analyse the differences in slope on the three occasions. The force exerted was reported as the mean of each second and the mean of each occasion. Performance when repeating the same pressure force on different occasions was assessed by calculating the variance of three sessions for each individual PT, the mean variance, the standard deviation (SD), and the coefficient of variance (CV) and the intraclass correlation coefficient [1,1] (ICC) (Shrout & Fleiss, 1979; Lahey et al., 1983). The force exerted, as applied by different PTs, was assessed by calculating SD, SEM and CV from the mean of three sessions for the entire group of PTs.

RESULTS

The analysis of variance showed no systematic difference in the mean slope of the entire group of PTs on the three occasions of the distraction test \( F(df 2, df 32) = 0.41; p = 0.6671 \); the compression test \( F(df 2, df 32) = 1.182; p = 0.3196 \), and for pressure on the apex sacralis \( F(df 2, df 32) = 0.562; p = 0.5754 \). The 95% CI for the mean slope of individual PTs covers zero, indicating that no systematic change over time was demonstrated (Table 1). The mean of exerted force on three occasions was 232 N in the distraction test, 251 N in the compression test and 222 N for pressure on the apex sacralis.

Figure 6 shows the means of force pressure on three occasions for each PT in the distraction test, the compression test and for pressure on the apex sacralis. Table 2 presents the SD, the CV and the ICC [1,1] for the entire group of PTs, for the PTs who performed the SI joint tests often and for the PTs who performed the tests seldom or never.

Figure 7 shows the mean of three occasions for each individual PT in the distraction test, the compression test and for pressure on the apex sacralis. Table 3 presents the mean, range, SD, SEM and CV for the entire group.

| TABLE 1: Means and 95% CI of the mean slope of pressure forces during 20 s for the entire group of PTs in the distraction test, the compression test and pressure on the apex sacralis |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | First occasion  |                 | Second occasion |                 | Third occasion  |                 |
|                 | Mean (95% CI)  |                 | Mean (95% CI)  |                 | Mean (95% CI)  |                 |
| Distraction test| -0.43 (-1.112–0.251) | -1.161 (-2.614–0.292) | -0.87 (-2.146–0.407) |
| Compression test| 0.04 (-1.144–1.215)  | -0.335 (-1.519–0.849) | 0.68 (-0.441–1.801) |
| Pressure on apex sacralis | 0.09 (-0.747–0.933) | -0.39 (-0.837–0.056) | -0.147 (-0.679–0.385) |
FIGURE 6: Mean pressure force during 20 s for each PT on the first, second and third occasions (OCC) in the distraction test, the compression test and putting pressure on the apex sacralis. PT numbers 1–7 performing the tests often; PTs 8–17 performing the tests seldom or never.
FIGURE 7: Mean force pressure for three occasions for each PT in the distraction test, the compression test and putting pressure on the apex sacralis; PTs 1–7 performing the tests often, PTs 8–17 performing the tests seldom or never.

**DISCUSSION**

A new technique was used to study intra- and inter-test reliability when performing SI joint tests. The results showed that PTs were capable of maintaining a relatively constant pressure force for 20 s. Intra-test reliability was acceptable even though there were individual differences on different occasions between those PTs who used
the SI joint tests often and those who seldom or never used them. Inter-test reliability was insufficient as the spread was about 25% of the mean for each test.

Keating et al. (1993) studied the ability of PTs to repeat six given pressure forces varying from 1 kp to 25 kp (9.81–245 N) when examining the intervertebral joints of the lumbar spine on healthy volunteers. The most marked differences in the ability to repeat pressure forces were observed for 1–15 kp (9.81–147 N), with no apparent differences for the higher pressure forces of 20 and 25 kp (196–245 N). In the present study, the means of pressure forces were 232 N, 251 N and 222 N for the three tests, respectively. These can be compared to the 20–25 kp used by Keating et al. (1993), finding no apparent difference in the ability to repeat given pressure forces.

In the clinical situation, the patient is exposed to varying and often low pressure forces since the pressure forces are probably governed by the pain provoked. Low pressure forces were not investigated in this study as the tests were performed on a healthy woman. It may seem irrelevant to evaluate the reliability of SI joint tests on a healthy woman as the tests are intended to provoke pain. However, the investigation of the reliability of pressure force was limited to one healthy person, particularly...
when it came to establish inter-test reliability, as pain often changes from hour to hour and as repeated pain provocation tests were considered to be unethical on a patient with pain.

In the present study all the PTs were instructed to try to provoke pain when performing the tests and, although they had the same purpose, the pressure forces used varied remarkably. There was a difference of 238 N between the mean force of the PT applying the lowest forces and the PT applying the highest in the distraction test. These individual differences could explain the contradictory results of the different reliability studies described in the Introduction (Russell et al., 1981; Blower & Griffin, 1984; Potter & Rothstein, 1985; Laslett & Williams, 1994; McCombe et al., 1989; Östgaard et al., 1994; Maigne et al., 1996). In all reports the results were based only on the patient's indication of discomfort/pain. None of the studies recorded the pressure force used.

As the pressure force most probably varies within small limits there is an obvious need for standardized methods for pain-provoking tests. A more reliable pain evaluation would be accomplished by combining self-reported pain, e.g. scoring on VAS (Huskinsson, 1974) and/or pain drawing (Margolis et al., 1988) with applications of standardized (monitored) pressure forces, alternatively recording the pressure force provoking a pain reaction. A pressure algometer can be applied to many parts of the body for the evaluation of muscle-derived pain in combination with VAS and pain drawing (Jensen et al., 1986). For the evaluation of pain originating from joints the method described in the present study should provide a useful and cheap complement to subjective estimates. This would improve the reliability of different pain-provoking tests not only for the SI joint but also for other joints of the spine. The method described here could be applied to joints of the extremities after appropriate modifications. Many manual methods of investigation resemble an art and are thus difficult to teach merely by simple instruction. Therefore, the specially constructed examination table could be a useful complement in practising manual methods, not least in the basic training of PTs. Quantitative feedback results in greater accuracy than qualitative feedback or no feedback (Salmoni et al., 1984).

The height of the special examination table could not be adjusted low enough for some PTs and the volunteer could only be placed in the middle of the table because of the fixed position of the scales. Thus, the working posture was not always optimal. This might possibly have influenced the results even though none of the PTs complained about their working posture. Increased sensitivity of the equipment would have been advantageous. In particular, each square on the graph paper could correspond to less than 19.62 N. The construction of the examination table might lead to the assumption that some of the pressure force applied could be distributed between the superposed hardboard and the examination table (figures 4 and 5 above). Measurements have shown that that force was marginal.

In the present study there was as much pressure force recorded for the distraction test as the other two tests, which was unexpected, as the distraction test is performed mainly in lateral directions. It would be of interest to study the SI joint tests further using AMTI platforms (Advanced Mechanical Technology, Inc., 176 Waltham
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Street, Watertown, MA 02172, USA) capable of sensing forces in six directions to gain knowledge of the detailed distribution of the pressure vectors bilaterally. Moreover, the possible influence of the patient’s and the PT’s breathing patterns could be studied by use of AMTI platforms. Another parameter of importance for the quality of manual examination tests is the velocity of the pressure force. Since the notion that joint structures can be provoked instantaneously while ligaments and capsules require 20 s provocation time (Lee, 1989) is not documented, this also necessitates further work with more sensitive equipment.

Conclusion

PTs were shown to be capable of maintaining a relatively constant pressure force on the sacroiliac region for 20 s. Intra-test reliability was acceptable even though there were individual differences on different occasions between those PTs who used the SI joint tests often and those who seldom or never used them. Inter-test reliability was insufficient. The findings indicate the advantage of registering pressure force as a complement for standardized methods for pain-provocation tests and when learning provocation tests, since individual variability was considerable.

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