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Manipulation Does Not Alter the Position of the Sacroiliac Joint: A Roentgen Stereophotogrammetric Analysis

[Mobilization]

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Abstract

Study Design. A roentgen stereophotogrammetric analysis study of patients with sacroiliac joint dysfunction.

Objectives. To investigate whether manipulation can influence the position between the ilium and the sacrum, and whether positional tests for the sacroiliac joint are valid.

Summary of Background Data. Sacroiliac joint dysfunction is a subject of controversy. The validity of different sacroiliac joint tests is unknown. Long-standing therapeutic tradition is to manipulate supposed dysfunctions of the sacroiliac joint. Many manual therapists claim that their good clinical results are a consequence of a reduction of subluxation.

Methods. Ten patients with symptoms and sacroiliac joint tests results indicating unilateral sacroiliac joint dysfunction were recruited. Twelve sacroiliac joint tests were chosen. The results of most of these tests were required to be positive before manipulation and normalized after manipulation. Roentgen stereophotogrammetric analysis was performed with the patient in the standing position, before and after treatment.

Results. In none of the 10 patients did manipulation alter the position of the sacrum in relation to the ilium, defined by roentgen stereophotogrammetric analysis. Positional test results changed from positive before manipulation to normal after.

Conclusions. Manipulation of the sacroiliac joint normalized different types of clinical test results but was not accompanied by altered position of the sacroiliac joint, according to roentgen stereophotogrammetric analysis. Therefore, the positional test results were not valid. However, the current results neither disprove nor prove possible beneficial clinical effects achieved by manipulation of the sacroiliac joint. Because the supposed positive effects are not a result of a reduction of subluxation, further studies of the effects of manipulation should focus on the soft tissue response.

The sacroiliac joint (SIJ) as a source of back pain is a recurrent subject of controversy.[1-4,20,48] The results of the study of Schwarzer et al [40] provide support for the opinion that patients with SIJ dysfunction are a subgroup of the large population of people with back pain. Although the SIJ is accepted as a source of pain, there is no general agreement concerning the different diagnostic tests and their validity.[2,8,12,13,21,27,29,30,35,36,44,47] Consequently, SIJ dysfunction cannot be defined by standard criteria.

In spite of this, long-standing therapeutic tradition is to manipulate supposed dysfunctions of the SIJ. One theoretical explanation for the clinical effect achieved by manipulation-mobilization of the SIJ might be that

manipulation results in a reduction of subluxation of the joint. There are studies on movement in the SIJ,[10,14,17,24,28,32,34,37,39,43,46,49] but the conclusions concerning normal mobility vary considerably. Roentgen stereophotogrammetric analysis (RSA), according to Selvik,[41] enables high precision measurement of minor three-dimensional movements in skeletal joints. This technique has been used to analyze movements in the normal SIJ as well as in patients with dysfunction.[14,46]

The objective of the current study was to investigate by RSA whether manipulation and mobilization of the SIJ affect the positional relation between the sacrum and the ilium, and whether some frequently used positional tests for the SIJ are valid.

Patients and Methods

Ten women aged 21-53 years (mean age, 41 years) with symptoms of unilateral SIJ dysfunction were studied. Several patients had a history of earlier manipulation of the SIJ, with a subjective report of good outcome but with relapses of symptoms. The patients were examined by two orthopedic specialists (TT and BB) and one physician with the most advanced qualifications in manual medicine available in Sweden (SB). All three examiners had to agree on the diagnosis for a patient to be enrolled. All selected patients had typical clinical signs of SIJ dysfunction, according to positional, functional and pain provocation tests.

A battery of the most widely used SIJ dysfunction tests was chosen. Most of the test results had to be positive in each patient. The results of the tests were rechecked and documented immediately before the first RSA (Table 1), which was followed by manipulation and mobilization of the dysfunctional SIJ. This treatment was clinically successful in all cases, confirmed by normalization of most of the test results immediately after treatment (Table 1). A second RSA was performed, followed by reconfirmation of all tests results. At each testing, the three examiners (TT, BB, and SB) agreed on the results.

	Patient 1 (pre/post)	Patient 2 (pre/post)	Patient 3 (pre/post)	Patient 4 (pre/post)	Patient 5 (pre/post)	Patient 6 (pre/post)	Patient 7 (pre/post)	Patient 8 (pre/post)	Patient 9 (pre/post)	Patient 10 (pre/post)
Crista	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−
PSIS	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/+	+/−	+/−
ASIS	+/−	+/−	+/−	+/−	+/−	+/−	+/+	+/+	+/+	+/−
Vorlauf	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−
Rucklauf	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−
Adduction	+/−	+/+	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−
Patrick	+/+	+/−	+/−	+/−	+/+	+/−	+/+	+/+	+/−	+/−
Derbrolowsky	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−
ILA	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−	+/−
Provocation forward	−/−	−/−	+/−	+/−	+/−	+/−	+/−	+/−	−/−	+/−
Provocation backward	+/−	+/−	−/−	−/−	+/−	+/−	−/−	−/−	+/−	+/−
Musculus iliacus	+/+	+/+	+/−	+/−	+/−	+/−	+/+	−/−	+/+	+/+
Total no. of positive tests	11/2	11/2	11/0	11/0	12/1	12/0	11/3	10/3	11/2	12/1

+ = pathological test according to the description in Materials and Methods; − = normal findings; ILA = interior lateral angle; ASIS = anterior superior iliac spine; PSIS = posterior superior iliac spine.

Table 1. Clinical Findings Before and After Manipulation

To enable RSA, three pairs of 0.8-mm tantalum indicators each were implanted percutaneously into the sacrum and the ilium on the dysfunctional side with the patient under local anesthesia approximately 2 days before the manipulation and RSA.

Sacroiliac Joint Tests. *Positional Tests.* Crista height (posterior superior iliac spine [PSIS] and anterior superior iliac spine [ASIS]): The positional tests were performed with the patient standing and prone or supine. The results were considered positive if the height on one side differed from that on the other.

Functional Tests. The Vorlauf test: With patient standing, thumbs were used to palpate both PSIS from the caudal direction as the patient bent forward slowly. The result was considered positive on the side where the PSIS seemed to move further forward when compared with the PSIS on the other side.

The Rücklauf test: With the patient standing, the PSIS was palpated with one thumb from the caudal direction on the side that was tested and compared with the other thumb positioned on the sacrum. The patient lifted the knee on the tested side slowly. Normally, the PSIS moves downward. The result was positive if the PSIS did not move, moved upward, or moved less compared with the PSIS on the other side.

Adduction test: With the patient supine and the hip in 90° flexion, the anterior superior iliac spine on the ipsilateral side was fixated. The result was positive if adduction was reduced compared with that on the other side.

Patrick's test: With the patient supine, the leg was flexed and abducted with the foot resting proximal to the contralateral patella. The result was positive if abduction was limited compared with the other side.

The Derbrolowsky test: With the patient supine, leg length was estimated by comparing the medial malleolus' position in the supine and sitting positions with straight legs. The result was positive if leg length in the supine position differed with that in the sitting position.

Inferior lateral angle (ILA) palpation: With the patient prone, inferior lateral angle of the apex sacri was palpated bilaterally for asymmetry. The patient repeatedly moved into extension by resting on the elbows. The result was positive if there was an asymmetric movement.[33]

Pain Provocation Tests. Forward rotation test: Conducted with the patient prone. The result was positive if pain was reproduced by pushing the iliac crest anteriorly with one hand and fixating the apex sacri with the other.

Backward rotation test: Conducted with the patient prone. The result was positive if pain was reproduced by pushing the tuberosity of ischium anteriorly with one hand and fixating the base of the sacrum with the other.

Iliacus muscle palpation: Conducted with the patient supine. The result was positive if pain was provoked when the muscle was palpated deeply medially to the anterior superior iliac spine.

Manipulation and Mobilization. The treatment was provided by SB and was started by applying a high-velocity, short-lever, short-amplitude thrust on the ILA (left or right) being palpated caudally and posteriorly. This technique was a simplification of the original one.[33] This was followed by the essential therapeutic maneuver mobilization for SIJ dysfunction according to Kubis,[25] which was originally a thrust technique. However, the addition of an Evjenth and Hamberg locking technique [15] and a strictly applied muscle energy technique procedure [33] created a gentle maneuver. This procedure was supplemented by a high-velocity thrust at the end of the treatment.

Roentgen Stereophotogrammetric Analysis. The RSA was performed using two 40° angulated roentgen tubes with the patient standing in a standardized position. A combined reference plate and calibration device with 0.8-mm tantalum indicators at known positions were placed between the patient and the film plane. By computed data processing using the Kinema program,[41] the three-dimensional translations and rotations of the ilium in relation to the sacrum induced by the manipulation were calculated by one of the authors (RJ) at a designated RSA laboratory.

The technical accuracy of the RSA setup was calculated by double RSA at eight examinations. The SIJ translations and rotations between these double examinations, expected to be zero within pairs, and the standard deviation Equation 1 for each translation and rotation were calculated. By using Student's *t* distribution, the 99% confidence limits for smallest significant SIJ translations along and rotations around the medial-lateral (x), proximal-distal (y), and anterior-posterior (z) axes were calculated.

$$SD = \sqrt{\frac{\Sigma d^2}{(n-1)}}$$

Equation 1

Results

Roentgen Stereophotogrammetric Analysis Accuracy

The standard deviations for the SIJ translations between the double examinations were ±0.05, ±0.06, and ±0.14 mm along the medial-lateral (*x*), proximal-distal (*y*), and anterior-posterior (*z*) axes, respectively. These values correspond to the smallest significant translation of ±0.16, ±0.22, and ±0.48 mm, respectively. Measured translations of the ilium in relation to the sacrum were not considered significant unless they exceeded ±0.2, ±0.3, and ±0.5 mm along these axes, respectively (*i.e.,* the threshold for technical accuracy for SIJ translation in this RSA setup).

In a similar way, the standard deviations for the SIJ rotations were calculated to be ±0.28, ±0.41, and ±0.31° around the medial-lateral (*x*), proximal-distal (*y*), and anterior-posterior (*z*) axes, respectively. These values correspond to the smallest significant rotations of ±0.96, ±1.44, and ±1.08°. Measured rotations of the ilium in relation to the sacrum were not considered significant unless they exceeded ± 1, ± 1.5, and ± 1.1°, respectively, around these axes, (*i.e.,* the technical accuracy for SIJ rotations of this RSA setup).

Sacroiliac Joint Position

In none of the 10 patients did manipulation alter the positional relation, defined by RSA, between the sacrum and the ilium (Table 2). Positional test results changed from positive before manipulation to normal after (Table 1) without corresponding alteration in skeletal position. Thus, the positional tests did not provide a valid description of the sacrum-ilium position.

		Medial/Lateral Axis		Proximal/Distal Axis		Anterior/Posterior Axis	
Patient No.	Age (yr)	Translation (mm)	Rotation (°)	Translation (mm)	Rotation (°)	Translation (mm)	Rotation (°)
1	25	0.0	0.3	0.0	−0.3	0.1	−0.2
2	21	0.0	0.1	0.1	−0.2	−0.1	−0.1
3	46	0.0	−0.2	0.1	−0.1	0.0	0.2
4	51	0.0	0.0	0.0	0.5	−0.3	−0.2
5	39	0.0	0.1	0.0	0.0	−0.1	0.0
6	48	0.1	0.2	0.0	−0.3	0.1	0.3
7	47	0.0	0.1	0.1	0.5	−0.1	0.4
8	32	0.1	−0.1	−0.1	−0.7	0.2	−0.3
9	53	0.1	−0.2	−0.1	−0.2	0.0	−0.3
10	52	0.0	0.6	−0.1	−0.1	0.1	0.0

* There were no RSA values above accuracy.
RSA = roentgen stereophotogrammetric analysis.

Table 2. Patient Characteristics and RSA Translations and Rotations After Manipulation of the Sacroiliac Joint*

Discussion

Dysfunction of the SIJ has been estimated to be the source of lumbosacral pain in 3-80% of the back pain population. 5-7,11,19,31,42,45 The different figures are caused by lack of knowledge about the true pathophysiologic mechanisms, which has created a variety of hypothetical diagnostic criteria for SIJ dysfunction.

As some investigators 12,18 have suggested, the most valid test to confirm the diagnosis of SIJ dysfunction is possibly a joint block with local anesthetics. A positive block result does not, however, arise from specific SIJ subluxation, but rather from blocking of all painproducing conditions in and surrounding the joint. Because the concern in the current study was to detect an assumed subluxation of the SIJ and to correlate the clinical results of manipulation to possible positional alteration in the joint, joint blocks were not used.

Three kinds of diagnostic tests are used in this context. Positional tests determined forward or backward rotation of the ilium, functional tests estimated the mobility of the SIJ and provocation tests reproduced and located the pain. A common opinion among manual therapists is that a correct diagnosis is based on positive signs from all three groups of diagnostic criteria.

The intraexaminer and interexaminer reliability of the different tests for SIJ dysfunction have been surveyed in several studies. The palpation test results (position and functional tests) are often questioned,[2,8,21,30,35,47] but Cibulka et al [9] found the results reliable. However, at least three out of four tests had to produce positive results for the diagnosis of SIJ dysfunction in that study. Using three functional tests, Dreyfuss et al [12] reported 20% positive findings in one or more of these tests in a group of asymptomatic people. Pain provocation tests have a good interexaminer reliability, according to some investigators,[27,35] but have been found unreliable by others.[29,30,36]

In the current study, the test results were evaluated by the three therapists together, and their evaluations had to be in agreement. This procedure could affect the estimations compared with individual estimations. However, the tests were so many and the results so distinct that the risk of undue bias should have been eliminated.

Most investigators agree that there is no single test that can confirm the diagnosis of SIJ dysfunction. Opinions differ among manual therapists about which tests are the best. In the current study, 12 tests were chosen that are among the most commonly used in manual therapy. At least 10 test results were positive in all patients, which in the authors' opinions confirmed the tentative diagnosis.

Orthopedic specialists, physiotherapists and chiropractors argue about whether manipulation can influence the position of the SIJ. Several investigations have been performed *in vitro*[17,32,34,37,39] and *in vivo.*[10,14,17,24,28,34,43,46,49] All of the referenced authors state that movement occurs in the SIJ, but there are large variations concerning the range of movement. Weisl [49] recorded a maximum translation of 7 mm and Cholachis et al [10] a translation of 5 mm. Sashin [39] recorded an average rotation of 4°-at most, 8°-and Pitkin and Pheasant [34] reported an average rotation of 7°. The results of many studies have been questioned,[47] and the shortcomings of conventional radiographic techniques in demonstrating minor skeletal positional alterations are well known.

Roentgen stereophotogrammetric analysis, however, is a well-documented method for demonstrating minor three-dimensional movements calculated by computerized mathematical algorithms eliminating observer bias.[41] It has mainly been used to study movements of hip and knee prostheses,[26,38] but also intervertebral movements in the lumbar spine.[22,23] There are two prior RSA studies of the SIJ: Egund et al [14] demonstrated a maximum rotation of 2°, and Sturesson et al [46] recorded a mean translation of 0.7 mm and a mean rotation of 2.5°. The effect of manipulation-mobilization of the SIJ, however, has not been studied previously.

The results in the current study showed that manipulation-mobilization did not alter the position between the sacrum and the ilium, evaluated by RSA in standing position. The accuracy of this RSA setup was so high that any minor alteration of the SIJ's position below the accuracy level could barely be detected by palpation tests.

The positional test results were normalized after manipulation, but they obviously did not describe the position of the ilium in relation to the sacrum. Thus, the use of the expression "forward and backward rotated ilia" should be abandoned in this context. The validity of the functional tests are still to be evaluated.

The current authors are convinced that something happens when manipulating the SIJ, and this is supported by results in some controlled studies,[6,7,50] that indicate a good clinical outcome after SIJ manipulation similar to those applied in this study. This study, however, seems to eliminate the possibility of an RSA-detectable persisting alteration of the SIJ position induced by manipulation-mobilization. Still, a possible instant alteration of the original SIJ position immediately realigned to the original position before the RSA could be a theoretical

reason for the results of manipulation. In addition, the manipulation might influence soft tissue structures, such as joint capsules, muscles, ligaments, tendons, and postural neuromuscular reflex patterns. Consequently, further studies of the effects of SIJ manipulation should focus on soft tissue response instead of on skeletal positioning. Such a mechanism is suggested in a study by Fisk,[16] in which results demonstrate an influence on hamstring tension.

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