Scandinavian Journal of Pain 17 (2017) 22–29

Contents lists available at ScienceDirect

Scandinavian Journal of Pain

journal homepage: www.ScandinavianJournalPain.com

Clinical pain research

Clinical outcome following anterior arthrodesis in patients with presumed sacroiliac joint pain

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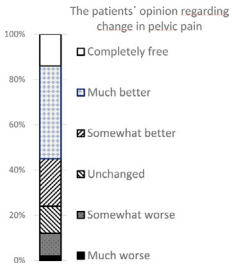
HIGHLIGHTS

- During a 6-year period we treated 55 patients with presumed SI joint pain.
- Anterior arthrodesis was performed using microsurgical technique.
- Statistically significant improvement in pelvic pain and quality of life at 2 years.
- Patient symptoms and the preoperative investigations performed are described.
- Problems remain about how to identify patients with SI joint pain.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 22 February 2017
Received in revised form 13 June 2017
Accepted 20 June 2017
Available online 24 July 2017

Keywords:
Outcome
Pelvic pain
Sacroiliac arthrodesis
Sacroiliac joint
Sacroiliac symptoms
Surgical treatment

ABSTRACT

Background: It has been reported that in 13–32% of patients with chronic low back pain, the pain may originate in the sacroiliac (SI) joints. When treatment of these patients with analgesics and physiotherapy has failed, a surgical solution may be discussed. Results of such surgery are often based on small series, retrospective analyses or studies using a minimal invasive technique, frequently sponsored by manufacturers.

Purpose: To report the clinical outcome concerning pain, function and quality of life following anterior arthrodesis in patients presumed to have SI joint pain using validated questionnaires pre- and post-operatively. An additional aim was to describe the symptoms of the patients included and the preoperative investigations performed.

Material and methods: Over a 6 year period we treated 55 patients, all women, with a mean age of 45 years (range 28–65) and a mean pelvic pain duration of 9.1 years (range 2–30). The pain started in connection with minor trauma in seven patients, pregnancy in 20 and unspecified in 28. All patients had undergone long periods of treatment including physiotherapy, manipulation, needling, pelvic belt, massage and chiropractic without success, and 15 had been operated for various spinal diagnoses without improvement. The patients underwent thorough neurological investigation, plain X-ray and MRI of the spine and plain X-ray of the pelvis. They were investigated by seven clinical tests aimed at indicating pain from the SI joints. In addition, all patients underwent a percutaneous mechanical provocation test and extra-articular local anaesthetic blocks against the posterior part of the SI joints. Before surgery all patients answered the generic Short-Form-36 (SF-36) questionnaire, the disease specific Balanced Inventory for Spinal Disorders (BIS) questionnaire and rated their level of pelvic and leg pain (VAS, 0–100). At follow-up at a mean of 2 years 49 patients completed the same questionnaires (89%).

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http://dx.doi.org/10.1016/j.sjpain.2017.06.005

Results: At follow-up 26 patients reported a lower level of pelvic pain than before surgery, 16 the same level and six a higher level. Applying Svensson's method $RP_{pelvic\ pain} = 0.3976$, with 95% CI (0.2211, 0.5740) revealed a statistically significant systematic improvement in pelvic pain. At follow-up 28 patients reported a higher quality of life and 26 reported sleeping better than pre-operatively. In most patients the character of the pelvic pain was dull and aching, often accompanied by a stabbing component in connection with sudden movements. Referred pain down the leg/s even to the feet and toes was noted by half of the patients and 29 experienced frequency of micturition.
Conclusions: It is apparent that in some patients the SI joints may cause long-term pain that can be treated by arthrodesis. We speculate that continued pain despite a healed arthrodesis may be due to persistent pain from adjacent ligaments. The next step should be a prospective randomized study comparing posterior fusion and ligament resection with non-surgical treatment.
Implications: Anterior arthrodesis can apparently relieve pain in some patients with presumed SI joint pain. The problem is how to identify these patients within the low back pain group.

1. Introduction

Most patients seen in spine clinics present with symptoms that are possible to diagnose with the aid of clinical, radiological and/or laboratory investigations. However, in some cases no such tentative spinal diagnosis may be plausible, instead a suspicion of pain originating in the sacroiliac (SI) joints or their surrounding ligaments. It has been reported that in 13–32% of patients with chronic low back pain, the pain may originate from these joints [1–4], although doubt about the diagnosis has also been expressed [5]. SI joint pain is reported to occur following trauma, pregnancy, osteoarthritis, lumbar fusion operations with or without bone harvesting from the iliac crest, as well as in patients with ankylosis spondylitis [3,4,6–8]. In some patients with no such background the condition is called SI joint dysfunction [6,9].

Although certain features of the symptoms of patients with presumed pain from the SI joints have been reported [9,10], a specific clinical syndrome is not clearly described and radiological correlates are mostly absent [1,4,8,11]. Several clinical tests aimed at revealing SI joint pain have been described and accepted as valid by some authors [8,12–15] but not by others [2,9,11]. There is also controversy regarding the use of local anaesthetic blocks to reveal pain from these joints [2–4,8,11,16].

Thus there is a huge problem treating patients presumed to have pain from the SI joints or their ligamentous surroundings. In cases of slight or moderate pain the situation may be improved by the use of analgesics and physical therapy, although there are also diverging opinions regarding the effect of physiotherapy [8,17,18]. In cases of severe pain the consultation might end with a discussion about whether a surgical intervention with arthrodesis of the SI joints would be of value. Results following such surgery are mostly based on small series of patients, often with only retrospective analysis, although a few larger series using open surgery have been reported, albeit with conflicting outcomes [19,20]. Over the last few years there has been a remarkable increase in the number of articles published concerning arthrodesis in cases of presumed SI-joint pain, which is due to the use of minimally invasive techniques [21–28]. However, this increase in SI-joint surgery is not a result of better clinical pre-operative evaluation of the patients. Conflicting opinions about SI joint fusion have recently been reported [29].

Over a 6-year period we treated 55 patients with presumed pain from the SI joints or their ligamentous structures. The aim of this article is to report the clinical outcome concerning pain, function and quality of life following anterior arthrodesis in patients presumed to have SI joint pain using validated questionnaires pre- and post-operatively. An additional aim was to describe the symptoms of the patients included and the preoperative investigations performed.

Table 1
Basic patient characteristics.

Age, mean (range)	45 years (28–65)
Pain duration, mean (range)	9.1 years (2–30)
Pelvic pain, side	
Left	26
Right	23
Bilateral	6
Debut in connection with	
Trauma	7
Pregnancy	20
Unspecific	28
Preoperative level of pain	
Pelvic pain, VAS, median (range)	67 (14–98)
Leg pain, VAS, median (range)	50 (0–95)

2. Material and methods

During the period from September 2000 to June 2006 55 patients, all women, were treated by anterior arthrodesis of one or both sacroiliac joints due to long-term pelvic pain, judged at clinical investigation to emanate from the SI joints or their ligamentous structures.

2.1. Clinical history

The clinical history included a description of the pain starting in a restricted area in the pelvis, around the SI joint on one or both sides. All patients had continuous pain in that area for long periods. The basic patient characteristics are presented in Table 1.

2.2. Previous treatment

All patients had undergone long periods of physiotherapy and many had tried several other treatments, including manipulation, needling, pelvic belt, massage, chiropractic and also psychological measures. Five patients had been operated once at other clinics for the diagnosis of lumbar disc herniation and two patients twice without success. Six patients were operated on due to the suspicion of spinal stenosis and one with single nerve root decompression, all without improvement. Another patient was treated by dorsal column stimulation. Therefore, a total of 15 out of the 55 patients had been treated surgically before, indicating the magnitude of their pain problems.

Table 2
Clinical tests used to identify pain from the sacroiliac joints.

1. While standing straight the patients were asked to stand on one leg at a time and report whether this changed the pain. The test was considered positive if the pelvic pain increased when standing on the leg on the affected side.
2. The patients were asked to walk on their heels and thump the heels against the floor with straight legs. The test was considered positive if the pain in the pelvic area increased when thumping the floor with the heel on the affected side.
3. Deep palpation of the lower abdomen against the ventral part of the SI joints on both sides with the patient relaxed in supine position with the hips flexed. The test was considered positive when the deep palpation could elicit or increase the pain.
4. Palpation medial to the superior and inferior iliac spines in the groove to the sacrum with the patient relaxed in a prone position. The test was considered positive when palpation elicited or increased the pain.
5. Impact against the posterior superior iliac spine. The test was performed by applying the base of a tuning fork against the iliac spine and tapping it in a longitudinal direction, thus producing percussion to the iliac spine. The test was considered positive when the tapping elicited or increased the pain.
6. Hyperextension of the leg/s with the patient in a prone position. The test was performed by holding one hand against the sacrum and with the other extending one leg at a time. The test was considered positive when eliciting or increasing the pain.
7. With the patient supine the leg was raised straight by about 20 degrees. The patient was instructed not to raise the leg by muscular activity and to remain completely relaxed. At that moment, unexpected by the patient, a blow was delivered to the heel in the longitudinal direction of the leg. The test was considered positive if it elicited or increased the pelvic pain on the affected side.

2.3. Pre-operative investigations

2.3.1. Clinical examination

The patients underwent thorough neurological investigation without any abnormalities being found.

In addition to the ordinary neurological examination, patients with a history suggesting possible SI joint pain underwent tests aimed at indicating pain from the SI joints or their ligamentous structures, a percutaneous mechanical provocation test, as well as extra-articular local anaesthetic blocks against the posterior part of the SI joint. Several authors consider that the previously described tests, e.g. Patrick's test, Graenslen's test and the PPPP-test, indicate true SI joint origin of the pain [8,12–15], which however, is not supported by others [2,9,11]. Therefore, we did not use these tests, but instead employed seven tests based on personal experience, some of which conform to the tests described in the European guidelines [8], see Table 2.

Patients were accepted for surgery if they presented with a clinical history suggesting SI joint pain and at least three of these seven tests were positive.

2.3.2. Radiological investigations

All patients underwent a plain X-ray and MRI of the spine. In all cases a plain X-ray of the pelvis with special emphasis on the SI joints was also performed.

2.3.3. Percutaneous mechanical provocation test

With the patient lying prone on an X-ray table 18 gauge (1.2 mm) injection needles are introduced into the top of the spinous processes L4 and L5 vertebrae perpendicular to the skin under X-ray control. Two further needles are angled towards the SI joints in the area between the sacrum and the posterior iliac spine. When bone contact has been made with the spinous processes and the SI joint area, respectively, the needles are slightly tapped into the bone to ensure that they remain in a fixed position. A small amount of Lidocaine, usually 0.1 ml, is injected to anaesthetize the periosteum around the needle tip. In that way the slight tapping of the needles is only felt as tapping inside the spine/pelvis, and not as pain. The needles are tapped pairwise in randomized order, always called "needle one" and "needle two". Needle one is tapped first, followed immediately by needle two, after which the patient is asked to judge whether any needle is close to the origin of their actual pain, and if so, which one. In healthy volunteers this test has been found useful in discriminating between deep structures of the spine lying only 2–3 cm apart [30].

2.3.4. Injections

All patients underwent injections against the posterior part of the SI joints with fluoroscopic control, but no intra-articular injections. With the patient in prone position a local anaesthetic (Lidocaine 10 mg/ml) or saline was injected. In total 8–9 ml was distributed, with one third each against the upper, middle and lower part of the joint area. During insertion and placement of the needle the patients' pain reaction was noted, whether they could recognize the needle position as the area in which the pain originated and whether the injection elicited concordant pain or not. The injections were always performed bilaterally, even in patients with unilateral pain. The patients were informed that injections were to be made against the SI joints and that the injected medium, Lidocaine or saline, could be the same on both sides or one medium could be on one side and the second on the other side. They were informed that we normally performed three injections in the course of the day but they were not informed about the schedule of what was to be injected on each side. The schedule was as follows: a first injection with local anaesthetic on the painful side and saline on the other, a second in reverse order and a third with Lidocaine on both sides. The injections were performed at 2–2.5 h intervals. During the first hour after each injection the patients were asked to report any change in their pelvic pain on both the left and right sides. A positive block was predefined as pain reduction of 50% or more marked on a VAS and with a maximum duration of 1.5 h.

2.4. Evaluation

Before surgery all patients answered the generic Short-Form-36 (SF-36) questionnaire [31], the disease specific Balanced Inventory for Spinal Disorders (BIS) questionnaire [32–34] and rated their level of pelvic and leg pain (VAS, 0–100). As a VAS-scale is in fact ordinal, it is in principle not appropriate for calculating averages, standard deviation etc. Therefore we also applied methods developed by Svensson [35] that are especially suitable for the specific situation. See also Section 2.5.

At follow-up at a mean of 2 years (1–3 years) 49 patients completed the same questionnaires (89%). One patient had died from an unrelated disease and five did not respond.

2.5. Statistical methods

Svensson's method is a rank-invariant non-parametric method adequate for the study of systematic changes in paired ordinal data [35]. The sets of paired data from the patients' assessments on the BIS pelvic pain, quality of life and sleep scales at the onset of the study and at follow-up (Figs. 2 and 5) were analyzed by this method. The pattern of change in assessments is described by the frequency distribution of the pairs of data in a square contingency table (Figs. 2 and 5). The horizontal marginal distribution gives the data before treatment and the vertical distribution the data after treatment. The number of patients who reported a lower level of pelvic pain at the follow-up assessment will appear above the main diagonal of unchanged assessments. The relative position, RP, is a measure of the extent to which pain is shifted towards lower or higher levels after treatment. The values of the coefficient RP ranges from −1 to 1. A positive RP value implies a systematic change

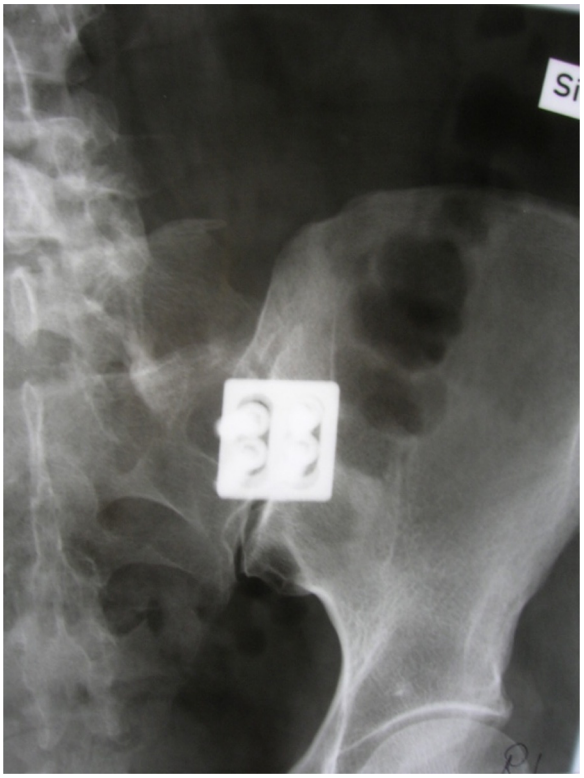

Fig. 1. X-ray, anteroposterior view of plate fixation in anterior arthrodesis of the SI joint.

towards a lower level of pain. The systematic change in concentration, RC, was also calculated. A negative RC value means that the marginal distribution after treatment is less concentrated relative to that before treatment. The 95% confidence intervals were calculated to detect whether the RP or RC values differed significantly from zero. The measures of RP, RC and the 95% confidence intervals (CI) were calculated using a free software program [36].

2.6. Surgical procedure

Three different spine surgeons performed 5, 13 and 37 operations respectively, in cooperation with the same vascular surgeon. The SI joints were accessed by an anterior transverse abdominal incision, usually at the level of the anterior iliac spine. Following retroperitoneal dissection the border between the psoas and iliacus muscles was identified. The superior area of the SI joint was reached by spreading the muscles apart. The femoral nerve was always identified and held laterally. The operation microscope was introduced and the joint capsule incised. Using a drill the joint cartilage and adjacent bone were removed on both sides, creating a groove around 6–7 mm wide, 20–22 mm long and 20–21 mm deep. Bone graft from the iliac crest was formed to fit into the groove and inserted, after which the arthrodesis was fixed by a square plate with two screws on each side of the groove (Fig. 1).

3. Results

3.1. Basic patient characteristics

The mean age of the patients was 45 years and the mean pain duration was 9.1 years. In around half of the patients the condition had started following trauma or pregnancy (Table 1).

Table 3
Character and main triggers of the pelvic pain.

(n = 55)	
Character	
Dull	11
Dull and stabbing	41
Burning	1
Burning, stinging and stabbing	1
Pressing	1
Main triggers	
Sitting	22
Standing	11
Walking	13
Lying	1
Sitting and standing	1
Sitting and walking	4
Standing and walking	3

3.2. Symptoms

In most patients the character of the pelvic pain was a dull ache, with a stabbing component in the same area in connection with sudden movement. A majority of patients reported that sitting was the most provoking situation (Table 3). The radiating pain down the leg/s was dull in most patients and diffuse in localization, suggesting referred pain. In around half of the patients the leg pain extended into the feet and even to the toes (Table 4). In addition to pelvic and leg pain, 29 patients experienced frequency of micturation, one hesitancy and two slight dribbling, while the rest had no bladder disturbance.

3.3. Radiological investigations

Plain X-ray and MRI of the lumbar spine revealed that some of the patients had minor degenerative changes but no specific abnormalities. None showed changes in the SI joints.

3.4. Preoperative clinical tests

As described in Section 2, we used 7 clinical tests (Table 2) in an attempt to identify pain from the SI joints or their ligamentous surroundings. Three of these tests were positive in 8 patients, 4 were positive in 15 patients, 5 were positive in 17 patients and 6 were positive in 12 patients. All 7 tests were positive in only 3 patients.

Table 4
Character and extension of leg pain.

(n = 55)	
Character	
Dull	36
Burning and stinging	5
Shooting	2
Sharp	5
Dull, burning and stinging	3
Numbness	1
Unspecific	1
Not described	2
Extension of leg pain	
To the buttock	1
To the buttock and thigh	13
To the buttock, thigh and lower leg	12
To the buttock, thigh, lower leg and foot	7
To the buttock, thigh, lower leg, foot and toes	21
Unspecified	1

3.5. Percutaneous mechanical provocation test

Under fluoroscopic guidance with the patient in a prone position it was easy to place the needles towards the spinous processes and the SI joint areas. During placement of the needles and the tapping test all patients remarked that although the needles in the midline caused some discomfort, it was not close to the area in which their pain originated. In contrast, all but one of the patients experienced the positioning and tapping of the needles close to the SI joints to be within their usual pain area, with many commenting "this is the pain".

3.6. Preoperative injections against the SI joints

Under fluoroscopic guidance with the patient in prone position the needle was directed towards the upper, middle and lower parts of the posterior joint area. Although in general the procedure was also painful on the unaffected side, all but one patient could differentiate between that pain and the one experienced on the affected side, eliciting increased concordant pain. In most patients the examiner could judge that the injection had taken place within the posterior ligaments, as tested by slow withdrawal of the needle during continuous injection and feeling the loss of resistance when outside the ligament. Concomitantly the pain reaction rapidly declined. Although the volume injected was fairly large, local spread of anaesthetic to, e.g., the sciatic nerve, was never observed and no patient reported numbness or weakness in the leg. Intraarticular injection was never performed.

When injecting local anaesthetic (Lidocaine) or saline in accordance with the schedule described in Section 2, the patients, who were unaware of what was injected, had to report any effect. If we were dealing with actual SI joint origin of the pain, we anticipated that the effect following injection of Lidocaine would be pain reduction, while the effect of saline would be nil. In accordance with the schedule described in Section 2 we performed three injections in each patient. The schedule was designed to ensure that a patient with true SI joint pain would have the following three anticipated reactions (Lidocaine/relief, saline/no relief, Lidocaine/relief), while a patient with pain from another origin would have one anticipated reaction (Lidocaine/no relief, saline/no relief, Lidocaine/no relief). Nineteen patients reacted as anticipated on three occasions, fifteen patients had an anticipated reaction twice, 13 patients once and 8 patients not at all. Our conclusion was therefore that local anaesthetic blocks are unreliable and for this reason they were not used as support for the decision whether or not to operate.

3.7. Surgical observations and parameters

When the anterior joint capsule was opened the joint could be clearly seen under the operating microscope, with joint cartilage on both sacrum and ilium and a narrow joint space. Sometimes synovial fluid could be seen but not in excess or abnormal. A blunt dissector could be pressed into the joint space but when trying to rotate or bend the dissector no further movement was seen, just the very slight spreading apart of sacrum and ilium by the dissector, less than one millimetre.

Bleeding during the operation was 142 ml (mean) and the operation time was 104 min (mean). The post-operative hospital stay was 8 days (mean).

3.8. Outcome

3.8.1. Pelvic pain

Two years after surgery 26 patients reported a lower level of pelvic pain than before surgery (Fig. 2), 16 patients the same level on both occasions (on the diagonal) and 6 patients a higher level of

Pelvic pain

Follow-up \ Preop	Very severe	Rather severe	Moderate	Negligible	No pain	Total
No pain		3	1			4
Negligible		6	4			10
Moderate	3	8	2			13
Rather severe	1	13	4			18
Very severe	1	2				3
Total	5	32	11			48

Fig. 2. The frequency distribution of the pairs of assessments of perceived pelvic pain made by the patients at the start of the study and at follow-up. The diagonal of unchanged assessments is marked. Twenty-six patients improved and six showed a deterioration, $\chi^2 = 12.5$, $p < 0.001^{xxx}$. For a more detailed analysis, see Table 5.

Table 5
Summary of the measures of systematic change (RP) and relative concentration (RC) for pelvic pain, quality of life and sleep, see text and Figs. 2 and 5.

Outcome aspects	RP	95% CI (RP)	RC	95% CI (RC)
Pelvic pain	0.3976	(0.2211, 0.5740)	−0.7246	(−0.5511, −0.1670)
Quality of life	0.4826	(0.3125, 0.6527)	−0.1474	(−0.3630, 0.0681)
Sleep	0.3086	(0.1224, 0.4947)	−0.2690	(−0.5075, −0.0304)

pelvic pain at follow-up than before surgery. The results applying Svensson's method are shown in Table 5. All RP values are positive which implies a systematic change at follow-up towards lower levels of pelvic pain and also better quality of life and sleep. As can be seen in Table 5 there is also a statistically significant change in concentration from more severe to less severe categories for pelvic pain and sleep, in Fig. 2 seen as a shift from predominantly rather severe pelvic pain to moderate or negligible.

The patients' own assessments of change in their pelvic pain at follow-up in comparison with the situation before the operation, as reported in the BIS questionnaire, is presented in Table 6, which shows that 37 patients reported an improvement in pelvic pain, 7 of them being completely pain free. The change in pelvic pain (VAS) is illustrated in Fig. 3. Pelvic pain (VAS) changed from 67 (median) before surgery to 37 (median) at follow-up.

3.8.2. Leg pain

Leg pain (VAS) changed from 50 (median) pre-operatively to 10 (median) at follow-up.

3.8.3. Quality of life

The pre- and post-operative situation as analyzed by the SF-36 questionnaire is presented in Fig. 4 and the patients' assessments of quality of life before surgery and at follow-up as reported in the BIS questionnaire can be seen in Fig. 5. At follow-up 28 patients

Table 6
The patients' opinion of the change in pelvic pain following arthrodesis. Forty-nine patients responded at follow-up.

Completely free	7
Much better	20
Somewhat better	10
Unchanged	6
Somewhat worse	5
Much worse	1

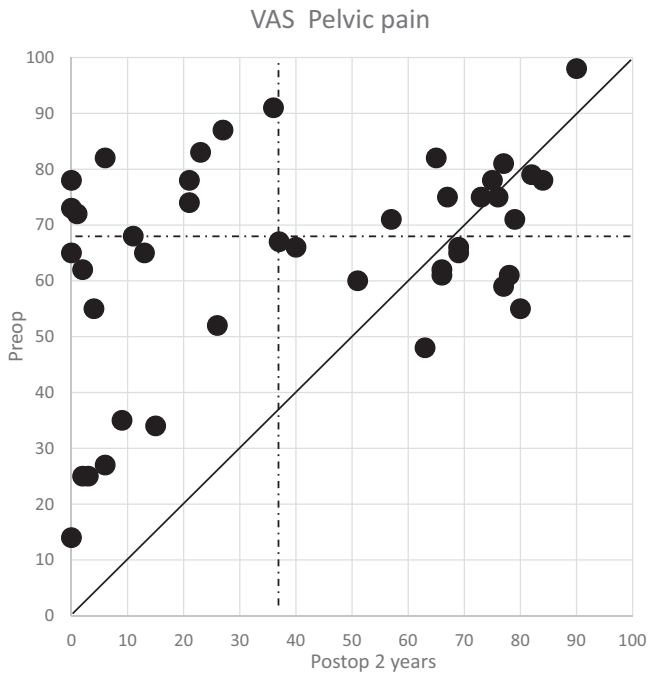

Fig. 3. In the figure the paired pre- and 2-year postoperative pelvic pain VAS values for each individual patient are plotted, 31 of 43 patients reporting a lower VAS value at follow-up than at the start of the study, $\chi^2 = 8.39$, $p < 0.01^{xx}$. Dotted lines show the pre- and post-operative median values.

reported a higher quality of life than pre-operatively, 14 patients the same quality on both occasions (on the diagonal) and 5 patients a lower quality of life post-operatively.

3.8.4. Sleep

Pain always affects sleep, which is fundamental for a good quality of life. Twenty-six patients reported better sleep at follow-up, 17 the same situation pre- and post-operatively and 5 a worse situation at follow-up.

3.8.5. Satisfaction with the result

When the patients were asked for their overall assessment of the outcome of the operation 10 of the 49 patients stated that they were completely satisfied, 26 were satisfied in spite of some residual symptoms, 7 were in some doubt and 6 were not satisfied.

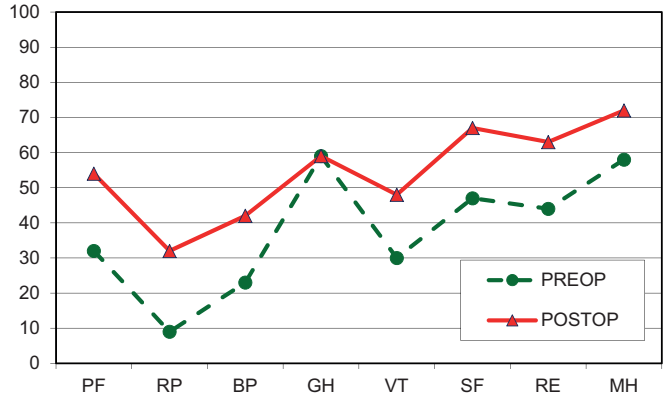

Fig. 4. Graph showing the mean SF-36 values at the start of the study, 55 patients (broken line) and at follow-up, 49 patients (unbroken line).

Ouality of life

Follow-up \ Preop	Very bad	Rather bad	Neither good nor bad	Rather good	Very good	Total
Very good	2	3	3	5		13
Rather good	2	7	1	4		14
Neither good nor bad		4	6	2		12
Rather bad	1	3	2	1		7
Very bad	1					1
Total	6	17	12	12		47

Fig. 5. The frequency distribution of the pairs of assessments of perceived quality of life made by the patients at the start of the study and on the follow-up occasion. Twenty-eight patients improved and 5 became worse, $\chi^2 = 16$, $p < 0.001^{xxx}$.

3.8.6. Complications

Three patients noticed decreased sensibility within the area of the lateral femoral cutaneous nerve post-operatively, in one of the patients only for a month. One patient had a slight weakness of the muscles innervated by the femoral nerve for 2 months. Two patients were re-operated due to persistent symptoms and defective bone healing as revealed by a CT scan.

4. Discussion

Many authors present positive results following arthodesis in patients with presumed SI joint pain [6,19,37–43], whereas others report unsatisfactory outcomes [20,44] and surgery is not recommended by the European guidelines [8]. Most studies using open surgery include very few patients and only retrospective analysis, although those of van Zwienen et al. [19] and Kibsgård et al. [20] each include over 50 patients, but with conflicting results. Kibsgård et al. [20] found no difference in outcome between a group of patients operated by the Smith-Peterson technique and an unoperated group at follow-up after 23 years, where the patients were not randomized. In our material about half of the patients were pain free or much better at follow-up and bodily pain (BP) in the SF-36 changed from 23 for the group pre-operatively to 42 post-operatively, an improvement similar to that reported by Buchowski et al. [6]. In a recent review Zaidi et al. [45] found that the satisfaction rates following open surgery varied from 18% to 100%.

In studies using minimal invasive surgery the reported outcome is surprisingly positive when measured as a reduction in pelvic pain (VAS). However, most of these studies include few patients [22,23,25], have a substantial drop-out at follow-up with results from only 28–54% of the patients treated [24,27], have only a retrospective study design [22] or a short observation time (6 months) [27]. A recent review of the minimal invasive technique in SI-joint fusion reported that this technique is favourable regarding blood loss and operating theatre time, as well as for providing substantial clinical improvement in SI joint pain and disability, especially when using the iFuse Implant System [46]. The authors of the review were all connected to the manufacturer of this system. Furthermore, a recently published prospective randomized study comparing surgery with the use of the actual implant versus non-surgical treatment reported surgery to show much better results at follow-up after a short period (6 months). This study was sponsored by the implant manufacturing company [47].

Open surgery, especially anterior surgery, has been found to have a high risk of complications. Among eight operated patients Kibsgård et al. [48] reported major complications in three patients and transient loss of sensibility in the area of the lateral cutaneous femoral nerve in a further three, thus a total of six out of eight patients suffered adverse effects. Walheim and Olerud [49] also used the anterior approach to the SI joints and reported that ten out of 15 patients required complementary surgery for various reasons. In our study six out of 55 patients (11%) suffered adverse effects. This lower level of complications in our material compared to previously published articles on the anterior approach might be due to our use of the microsurgical technique.

A specific symptomatology of patients presumed to have pain from the SI joints has not yet been described. Authors dealing with the subject have described pain originating below the L5-S1 level on the side [1,4] or starting between the iliac crest and the gluteal fold [8,15] but provided no details about its character. In our material most patients had a continuous dull ache and many also reported a stabbing component, previously described by Sturesson [10]. Injection tests within the SI joints have been described as only producing referred pain in the immediate buttock region [50]. Diffuse radiation of referred pain down the leg and even into the foot in patients considered to have SI joint pain has been previously reported, although it was not possible to differentiate it from pain of another origin [9]. In our material about half of the patients reported diffuse dull pain radiating into the feet and toes. We found no difference in outcome between those with this extension of the referred pain and those who only had extension to the buttock or thigh.

Several clinical tests are available for identifying pain from the SI joints (Graenslen's test, Patrick's test, the PPPP-test etc.) and according to the European guidelines for the diagnosis and treatment of pelvic girdle pain, these tests are valid [8]. In contrast, Maigne et al. [2] and Berthelot et al. [16] found provocative sacroiliac joint manoeuvres unreliable for diagnosing sacroiliac joint pain. Due to this uncertainty we instead used seven tests developed by experience in our clinic, some of which conform to the tests described in the European guidelines [8]. A varying number of these tests (from three to seven) were positive in patients accepted for operation in our study. There was, however, no statistically significant difference in outcome between those with few and those with many positive pre-operative tests.

Intra-articular local anaesthetic blocks are described by several authors as the gold standard for identifying SI joint pain [1,4,6,7,37–39,51], whereas others question this opinion [8,11,16], remarking that intra-articular blocks can only reveal purely articular pain. Extra-articular pain from, e.g., the ligaments, may still occur [8,16]. We only performed extra-articular blocks and our intention at the start of the study was to use the results from these blocks as support for the decision to operate or not. As described in Section 3.6, we expected two patient groups to emerge following the injection tests. However, as we found that this was not the case after the first 5–6 patients, we decided not to use the injections as support for the decision to operate or not. Instead, the most striking experience from these injections was the patients' experience of concordant severe pain during injection when the needle tip was apparently within the posterior ligament. The pain sensation rapidly declined during withdrawal when the needle tip moved outside the ligament, felt by the examiner as a sudden loss of resistance.

There may be several reasons for the diverging clinical outcome among our patients, one being the possibility of wrong inclusion of some patients. Another reason may be the presence of post-operative pain of, e.g., muscular origin in the buttocks and thighs, mimicking persistent SI joint pain. If the pre-operative pain really originates in the SI joints it should subside following a healed arthrodesis. If, however, the pain emanates from the posterior ligaments these may not be relaxed by the arthrodesis and the pain may persist despite bone healing. Our experience with the placement and tapping of the needles close to the posterior aspect of the SI joint indicates a possible pain origin in the posterior ligaments. In contrast, there is little to suggest movement induced pain in the joints because movement is extremely restricted as we could see under the operation microscope and as previously shown by Sturesson et al. [52–54]. It is noteworthy that Haufe and Mork [55] performed operations during which the posterior ligaments were merely detached from the medial iliac border with very good results.

The next step to further investigating the possibility of pain originating in the SI joints or the posterior ligaments would be a prospective randomized study comparing surgery including posterior fusion and ligament resection with non-surgical treatment.

5. Conclusions

It is apparent that the SI joints or their ligamentous structures may cause long-standing pelvic pain that in some patients is possible to treat by means of SI joint arthrodesis. We speculate that persisting pain despite a healed arthrodesis may be due to the ligaments. The next step should be a prospective randomized study comparing surgery including posterior fusion and ligament resection with non-surgical treatment.

Ethical issues

All patients were thoroughly informed about the study and gave their informed consent. The study was approved by the Institutional Review Board.

Conflicts of interest

The authors have no conflict of interest.

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