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REVIEW ARTICLE

Sacroiliac joint pain after lumbar/lumbosacral fusion: current knowledge

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Abstract Recently, the sacroiliac joint (SIJ) has gained increased attention as a source of persistent or new pain after lumbar/lumbosacral fusion. The underlying pathophysiology of SIJ pain may be increased mechanical load, iliac crest bone grafting, or a misdiagnosis of SIJ syndrome. Imaging studies show more frequent degeneration of the SIJ in patients with lumbar/lumbosacral fusion than in patients without such fusion. Using injection tests, it has been shown that SIJ pain is the cause of persistent symptoms in a considerable number of patients after fusion surgery. Recent articles reporting on surgical outcomes of SIJ fusion include a high percentage of patients who had lumbar/lumbosacral fusion or surgery before, although well-controlled clinical studies are necessary to assess the efficacy of surgical treatment. Taking these findings into consideration, the possibility that the SIJ is the source of pain should be considered in patients with failed back surgery syndrome after lumbar/lumbosacral fusion.

Keywords Sacroiliac joint pain · Lumbosacral fusion · Lumbar fusion · Pathophysiology

Introduction

The past decade has seen an increase in the number of lumbar/lumbosacral fusion surgeries [1]. One multicenter study reported that this type of surgery brings about greater relief than classic conservative treatment [2]. However, the failure rate across the different studies ranges between 5 and 30 % [3, 4]. Indeed, some patients continue to complain of persistent or new low back pain after surgery. Cases of recurrent low back pain and/or lower extremity pain after lumbar/lumbosacral surgery are referred to as failed back surgery syndrome [5–11]. Several authors have suggested that the sacroiliac joint (SIJ) may be a possible source of persistent pain [4, 12, 13].

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Pathophysiology

Theories of pain generation include ligamentous or capsular tension, extraneous compression or shear forces, hypomobility or hypermobility, aberrant joint mechanics, and imbalances in the myofascial or kinetic chain that result in inflammation and pain [14]. Intra-articular sources of SIJ pain include osteoarthritis; extra-articular sources include enthesis/ligamentous sprain and primary enthesopathy. In addition, ligamentous, tendinous, or fascial attachment and other cumulative soft tissue injuries that may occur posterior to the dorsal aspect of the SIJ may be a source of discomfort.

There are three possible causes of SIJ pain: (1) an increased mechanical load transfer onto the SIJ after fusion; (2) bone graft harvesting in the iliac crest close to the joint; and (3) the misdiagnosis of an SIJ syndrome before fusion (i.e., the lumbar spine is thought, erroneously, to be fused) [4].

Numerous clinical and experimental studies of adjacent segment disease after lumbar fusion procedures have demonstrated increased mobility in the adjacent cephalad and/or caudad segments and increased stress on the facet and/or disc of adjacent mobile segments [15–25]. In the case of lumbosacral fusion, the SIJ is the joint adjacent to the fused segment, and similar biomechanical responses

could apply to the SIJ [26]. Ha et al. [27] reported that the incidence of SIJ degeneration is higher in patients in whom fusion is down to S1 than in patients in whom fusion is down to L5. Onsel et al. [28] reported increased SIJ uptake on single photon emission computed tomography (SPECT) after lumbar fusion and/or laminectomy and concluded that increased SIJ uptake is usually caused by changes in spinal mechanics. Although the differences failed to reach statistical significance, Maigne and Planchon [4] reported a trend for more cases of SIJ pain in patients with fusion to the sacrum than in those without. Furthermore, DePalma et al. [29] reported that patients with lumbosacral fusion had an increased frequency of positive SIJ blocks than those without.

A history of bone graft harvesting is a potential risk factor for SIJ pain. After discounting the SIJ as the etiologic source of pain based on a lack of objective findings on physical examination and imaging studies, Frymoyer et al. [12] concluded that sacral sulcus pain encountered in 37 % of patients with low back pain after lumbar fusion was related to the iliac graft donor site. Ebraheim et al. [13] studied patients with donor site pain and found a high frequency of a sacroiliac inner table disruption that resulted in accelerated degeneration of the joint and sacroiliac pain. In addition, Ha et al. [27] reported that the SIJ on the side from which cancellous bone was harvested developed degeneration more often than on the normal side, although damage to the SIJ was not evident on computed tomography (CT) scans. This is in agreement with other studies that have reported that the harvesting of cancellous bone for a bone graft induces pelvic instability and has a negative effect on the SIJ [30–32]. However, Katz et al. [33] failed to find any correlation between the side of low back pain and the side of graft harvest, rendering direct SIJ damage after graft harvesting improbable. In the study of Maigne and Planchon [4], bone graft harvesting is definitely not the only cause of SIJ syndrome, which was present at similar frequencies in patients who had not undergone bone graft harvesting. Recently, Howard et al. [34] reported that 54 % of patients complained of tenderness over the iliac crest, with most having tenderness over both crests rather than just one, regardless of whether a bone graft had been harvested or not. That study found that iliac crest graft site pain can occur even in the absence of iliac crest graft harvesting and is thus a poor marker for graft site morbidity. Furthermore, Liliang et al. [35] have reported that there is no significant association between iliac crest bone graft harvesting on the painful side and positive responses to SIJ blocks.

The presence of a misdiagnosed sacroiliac syndrome as a cause of pre-fusion low back pain is also a possibility. Some patients may have lumbar fusion for misdiagnosed SIJ syndrome or some may have only lumbar fusion for lumbar pathology and SIJ syndrome. Sembrano and Polly [36] reported that up to 14.5 % of patients presenting to a spine surgeon's clinic for low back pain had SIJ pathology. In another study, Weksler et al. [37] found that patients with low back pain and disc herniation who responded positively to pain provocation tests for SIJ dysfunction exhibited significant improvement in visual analogue scale (VAS) pain scores after SIJ injection. Therefore, a third possible cause of SIJ pain is errors made during the preoperative screening of patients. This cause of SIJ pain can be differentiated from SIJ pain caused by an increased mechanical load when patients are not pain free for even a short period of time after fusion surgery.

In very rare cases, SIJ pain may be caused by hardware. For example, Ahn and Lee [38] reported iatrogenic SIJ syndrome caused by the screw head and rod of percutaneous pedicle screw fixation at the L5–S1 level. The sharp rod tip and the laterally located screw head may irritate the iliac crest and distract the SIJ, leading to intractable SIJ pain.

Biomechanical studies

Frymoyer et al. [12] conducted a clinical study of sacrum motion in patients after lumbar fusion, using flexion–extension lateral radiographs. Although doubts exist as to the validity of using a two-dimensional method to assess SIJ motion, Frymoyer et al. [12] failed to find any significant differences in mobility in the SIJ after spinal procedures.

Ivanov et al. [26] assessed angular motion of the sacrum and stress across the SIJ using a finite element lumbar spine–pelvis model with simulated posterior fusion surgical procedures. The results of that study indicated that posterior fusion of the lumbar spine leads to increased motion at the SIJ and increased stress across SIJ articular surfaces. In addition, the values of the parameters measured were related to the number of spinal segments involved. The authors noted that the differences in angular motion between the intact and instrumented models were not large; however, the ligaments around the sacroiliac articulation are richly innervated and, therefore, even small increases in motion may trigger pain.

Clinical features and pain patterns

Early published referral patterns of SIJ provocation or irritation were based on patients' complaints and physical examination. Dreyfuss et al. [39] reported that only 4 % of patients with SIJ pain marked any pain above L5 on self-reported pain drawings. Referral of pain into various

locations of the lower extremity does not distinguish SIJ pain from other pain states. For example, Schwarzer et al. [40] found that pain below the knee and into the foot was as common in SIJ pain as for other sources of pain. Slipman et al. [41] conducted a retrospective study to determine the pain referral patterns in 50 patients with injection-confirmed SIJ pain. The most common referral patterns for SIJ pain were found to be radiation into the buttock (94 %), lower lumbar region (72 %), lower extremity (50 %), groin area (14 %), upper lumbar lesion (6 %), and abdomen (2 %). Twenty-eight percent of patients experienced pain radiating below their knee, with 12 % reporting foot pain. Based on the existing data, the most consistent factor for identifying patients with SIJ pain is unilateral pain (unless both joints are affected) localized predominantly below the L5 spinous process. Maigne and Planchon [4] reported that the only criterion characterizing patients with SIJ pain following lumbar fusion was postoperative pain that differed from preoperative pain in its distribution. Liliang et al. [35] reported similar results, namely that 67 % of patients diagnosed with SIJ pain after lumbar and lumbosacral fusion had pain with characteristics that differed from their preoperative pain.

Physical examinations

One of the most challenging aspects of treating SIJ pain is the complexity of diagnosis. Literally dozens of physical examination tests have been advocated as diagnostic aids in patients with presumed SIJ pain [42]. Examples of these tests include Patrick's test, Yeoman's test, Gaenslen's test, Gillet's test, the compression test, sacral sulcus tenderness, the sacral thrust test, and the thigh thrust test. However, when applying pain provocation tests, it is nearly impossible to define which structures are actually stressed [43, 44]. Even structures such as the iliolumbar ligament or piriformis muscle cannot be excluded as potential sources of pain because they are functionally related [45, 46]. Consequently, it is very difficult to determine whether the pain that is provoked is exclusively intra-articular or whether it is related to capsular ligaments.

Previous studies have reported that there is no one single specific physical examination that can accurately identify a painful SIJ [38, 39, 42, 47]. Dreyfuss et al. [39, 48] found that 20 % of asymptomatic adults had positive findings on three commonly performed SIJ provocation tests and that the test with the highest sensitivity was the test of sacral sulcus tenderness (89 %), although this test exhibited poor specificity. Slipman et al. [47] reported a positive-predictive value of 60 % in diagnosing SIJ pain in patients using a positive response to three SIJ provocation tests. Broadhurst and Bond [49] reported a sensitivity of 77–87 % for positive responses to three SIJ provocation tests. Thus, there is evidence of good diagnostic validity of positive responses to a threshold of three SIJ provocation tests to identify SIJ pain [49–53]. However, there are no studies that have specifically examined provocation tests in patients with SIJ pain after lumbar/lumbosacral fusion.

Radiographic studies

No imaging studies consistently provide findings that are helpful in diagnosing primary SIJ pain.

Radiographs are the most cost-effective technique for imaging the SIJ. However, at least 24.5 % of asymptomatic patients >50 years of age have an abnormal SIJ on plain radiographs [54]. In addition, there is currently no consensus in the literature as to the recommended radiographic view or series of views to evaluate the SIJ.

Changes in the bone can be more sensitively detected using CT scans. A diagnosis of SIJ degeneration can be made on the basis of the presence of sclerosis, erosion, osteophytes, narrowing of the joint space, intra-articular bone fragments, or subchondral cysts. In a retrospective study, Elgafy et al. [55] found that abnormal CT findings, such as sclerosis, erosions, and narrowing, had a sensitivity of 58 % and a specificity of 69 % for determining which patients would experience pain relief following injection of an anesthetic into the SIJ. In a prospective cohort study investigating the relationship between fusion and SIJ degeneration after instrumented posterolateral lumbar/lumbosacral fusion, Ha et al. [27] reported that, based on results from CT scans, the incidence of SIJ degeneration in the fusion group was significantly higher than in the control group (75 vs. 38.2 %, respectively). Furthermore, the incidence of SIJ degeneration was greater in patients in whom fusion was down to S1 than in patients in whom fusion was down to L5. Ha et al. [27] concluded that lumbar/lumbosacral fusion can be a cause of SIJ degeneration, which develops more often in patients undergoing lumbosacral fusion regardless of the number of fused segments.

Magnetic resonance imaging (MRI) can detect edema and enhancement before bone changes are visible on CT. In addition, MRI can detect synovitis or extra-articular sources of SIJ pain, such as ligamentous, tendinous, or fascial attachment and other cumulative soft tissue injuries. When performing MRI of the SIJ, most studies report that short tau inversion recovery (STIR) images are preferable to fat-suppressed T_2-weighted images because they show early marrow edema better [56, 57]. For patients with SIJ syndrome, MRI is not helpful in determining which patients are likely to benefit from anesthetic injections [58].

Bone scanning is a poor screening test for SIJ pain [59, 60]. In studies of patients with SIJ syndrome, Maigne et al.

[59] and Slipman et al. [60] reported sensitivities of 46.1 and 12.9 %, respectively, and specificities of 89.5 and 100 %, respectively, for radionuclide bone scanning in identifying SIJ pain using anesthetic injections into the SIJ.

It has been reported that SPECT is more sensitive in detecting and localizing lesions than planar scintigraphy [61] and, in addition, that SPECT is useful when evaluating patients postoperatively because it is relatively unaffected by metallic fixation devices and can identify specific bony abnormalities in patients with complex problems, such as surgery at multiple levels, repeated surgery, bony fusions, or internal fixation with pedicle screws or metallic plates [62]. Onsel et al. [28] reported increased SIJ uptake demonstrated by SPECT after lumbar fusion and/or laminectomy. They concluded that such spinal surgery can impact on the loading on the SIJ, leading to mechanical overload and sacroiliitis. Note, increased SIJ uptake is usually caused by altered spinal mechanics. Gates and McDonald [62] also reported increased SIJ uptake by SPECT in 18 of 63 patients with back pain and a history of lumbar spinal surgery.

Diagnostic injections and epidemiology

In a retrospective review of patients with low back pain after lumobosacral fusion, Katz et al. [33] reported that 34 patients met their criteria for SIJ injection. Katz et al. [33] concluded that the SIJ was the cause of pain in 11 patients and possibly the cause of pain in a further 10. They did not report the number of patients who had low back pain after lumbosacral fusion, so prevalence is not certain. Maigne and Planchon [4] performed a prospective study of SIJ pain among patients with persistent low back pain after lumbar fusion using diagnostic SIJ blocks. In that study, 61 patients had persistent back pain after fusion surgery and, of these, 45 patients met the criteria for SIJ injection. Fourteen patients responded positively to the injections; on the basis of these reported data, the prevalence of SIJ pain among patients with low back pain after fusion can be calculated as 23 %. DePalma et al. [29] investigated the etiology of chronic low back pain in patients who had undergone lumbar fusion. In 43 % (12/28) of cases, the SIJ were symptomatic. Ten of these 12 cases had fusion to the sacrum and the remaining two cases had fusion to L5. Liliang et al. [35] investigated whether the SIJ is a potential source of pain in patients who have undergone lumbar/lumbosacral fusions. In that study, 130 patients had persistent chronic back pain after fusion surgery and 52 patients in whom positive findings were obtained for at least three of the provocation tests were selected to receive dual diagnostic blocks. Of these patients, 21 (16 %) were considered to have SIJ pain on the basis of two positive responses to diagnostic blocks. Thus, the prevalence of SIJ pain among patients with low back pain after lumbar/lumbosacral fusion appears to be in the range 16–43 % (Table 1).

Treatment

Conservative treatment

No article has been published as yet detailing treatment outcomes for SIJ pain after lumbar/lumbosacral fusion. However, there are several conservative options for the treatment of SIJ pain.

Non-steroidal anti-inflammatory drugs (NSAIDs) can be used for pain management and to reduce inflammation. Antidepressants may also be useful. However, the use of opiates should be reserved for limited situations only.

Pelvic belts are also a treatment option that work by limiting SIJ motion and improving proprioception. The importance of the correct placement of the belt has been highlighted: the pelvic belts are most effective when worn directly above the greater trochanter, decreasing SIJ motion by approximately 30 % with a 50-N belt [63].

Physical therapy has been an important aspect in the treatment of SIJ pain, along with stabilization. Physical therapy strategies emphasize pelvic stabilization [64] and restoration of postural and dynamic muscle balance, with correction of gait abnormalities [65]. Many studies have described typical muscle imbalance patterns in patients with SIJ pain [66, 67]. Thus, if these imbalances are actually detected, a physical therapy program concentrating on stretching and strengthening the weak muscles is an important aspect in the treatment of SIJ pain [66]. For example, Mooney et al. [68] reported that five women with injection-confirmed SIJ pain had electromyographic (EMG)-documented hyperactivity of the ipsilateral gluteus muscles and contralateral latissimus muscle compared with EMG findings in 15 asymptomatic controls. After an exercise program, all five patients achieved a significant reduction in pain and a return of myoelectric activity to normal patterns.

Intra-articular injections with steroids and local anesthetics are often therapeutic. For example, Liliang et al. [69] reported that 66.7 % (26/39) of patients experienced greater than 50 % pain reduction for more than 6 weeks by SIJ blocks, with an overall mean duration of pain reduction of 36.8 ± 9.9 weeks (range 12–60 weeks). In that study, 12 patients had a history of lumbar/lumbosacral fusion. The block worked in five of the 12 patients (42 %), but not in the remaining seven. Conversely, the block worked in 21 of 27 (78 %) patients without lumbar/lumbosacral fusion and not in six. Furthermore, the duration of the efficacy of the SIJ blocks was shorter in patients with a history of lumbar/lumbosacral fusion.

Table 1 Summary of clinical studies of diagnostic injection for sacroiliac joint pain after lumbar/lumbosacral fusion

Reference	Study type	No. patients	Inclusion criteria for injection	Fusion levels for injection cases	Diagnostic criteria	Results
Katz et al. [33]	Retrospective	34 pts who had LBP after prior lumbar fusion to the sacrum met the criteria for injection	History of pain in the low back below the waist and at or just distal to the posterior iliac crest with or without radiation to the posterior thigh or groin	8 at L5–S1 14 at L4–S1 6 at L3–S1 2 at L2–S1 4 with thoracolumbosacral fusion	Positive when both >75 % pain relief with the local anesthetic and at least 10 days of continued relief with corticosteroids	11 pts were considered positive 10 pts were considered to have possible SIJ dysfunction
Maigne and Planchon [4]	Prospective	61 pts had persistent back pain after fusion surgery 45 pts met inclusion criteria for injection 5 pts had unsuccessful block	Unilateral persistent pain for >6 months Distribution compatible with a sacroiliac origin: not radiating below the knee, tenderness of the sacroiliac sulcus at palpation, and no evidence of a lumbar cause	2 at L2–S1 2 at L2–4 4 at L3–S1 1 at L3–4 3 at L3–5 8 at L4–5 8 at L4–S1 12 at L5–S1 So, 26 at L5–S1 fused and 14 at L5–S1 not fused	Considered positive when the contrast was injected strictly into the joint and when the pain relief was up to 75 %	14 pts (23 %) are positive 11 pts are L5–S1 fused 3 pts are L5–S1 not fused
DePalma et al. [29]	Retrospective	28 pts with chronic LBP after fusion surgery undergoing definitive diagnostic procedure No description for no. pts who had SIJ injection	Paravertebral LBP without midline LBP and three of five positive responses to SIJ provocation tests without centralization during the McKenzie evaluation	2 at L2–5 2 at L3–5 5 at L4–5 2 at L2–S1 4 at L3–S1 5 at L4–S1 6 at L5–S1 2 at T–L4 (Details for 28 pts, not SIJ injection pts)	Deemed positive if the patient's index pain was relieved by ≥75 % after anesthetic injection	12 pts (43 %) were positive for SIJ 10 of 12 pts had fusion to the sacrum
Liliang et al. [35]	Prospective	130 pts had persistent chronic back pain after fusion surgery 52 pts met inclusion criteria for injection	Positive for at least three of the provocation tests for SIJ pain	21 with one level fused 21 with two levels fused 10 with more than two levels fused (20 with lumbosacral fusion)	A positive response was defined as characteristic pain reduction of 75 % or greater for 1–4 h following the block Two positive responses are necessary	21 pts (16.2 %) were considered to have SIJ pain on the basis of two positive responses

LBP lower back pain, *pts* patients, *SIJ* sacroiliac joint

Prolotherapy and radiofrequency neurotomy have also been used to treat SIJ pain and several studies have reported significant pain relief lasting between 6 months and 1 year [70–72]. However, there are no studies reporting treatment efficacy in patients with SIJ pain after lumbar/lumbosacral fusion.

Although neuroaugmentation has also been reported, it is not a common procedure. Calvillo et al. [73] reported on two cases of severe SIJ pain that had undergone lumbosacral fusion. These patients were treated for 1 week with stimulation following the implantation of a neural prosthesis at the third sacral nerve roots and experienced pain relief of approximately 60 % during the trial. Following permanent implantation, improvements in pain status and in the activities of daily living were reported.

Surgical treatment

Surgical treatment should be considered only in patients with SIJ pain proven by controlled diagnostic anesthetic

blocks and without any pain sources in the lumbar spine. It also should be reserved for those who continue to have disabling symptoms that have not responded to aggressive conservative care [14].

Surgical options include open surgery and, recently, minimally invasive surgery. Open surgical access for SIJ arthrodesis can be achieved anteriorly or posteriorly, although the anterior approach has several advantages in that it provides direct exposure of the ventral and cranial synovial portion of the sacroiliac complex without sacrificing any of the primary soft tissue (ligamentous) stabilizers [14]. The incidence of significant complications after open SIJ fusion has been reported to be between 6 and 25 % [74, 75]. Recently, a percutaneous sacroiliac procedure has also been reported [76, 77]. This technique enables arthrodesis by inserting bone material in the cage-type screw and may avoid wound-related complications. However, no comparison studies of successful fusion rates or clinical outcomes exist for the various arthrodesis techniques. Postoperative management includes protected weight bearing for 8–12 weeks.

As yet, no study has reported the surgical outcomes for selected patients with SIJ pain after lumbar/lumbosacral fusion surgery. Regardless of the underlying etiology, based on the existing studies the long-term success rate for SIJ fusion appears to be around 70 % [78–80]. Recent articles reporting surgical outcomes of SIJ fusion include a high percentage of patients after lumbar surgery or lumbar/lumbosacral fusion. For example, Buchowski et al. [74] evaluated the functional and radiological outcome in 20 patients after an open SIJ fusion using the Smith-Petersen approach. In that study, 15 patients (75 %) had at least one previous spinal surgery and eight (40 %) had fusion to the sacrum. Buchowski et al. [74] reported an improvement in both pain and function. Although 85 % (17/20) of patients had solid fusion, two developed deep wound infection. In a

Table 2 Summary of clinical studies of surgical treatment for sacroiliac joint pain including patients after lumbar/lumbosacral fusion or surgery

References	No. patients	M/F (*n*)	Median (range) age (years)	Median (range) duration of follow-up	Surgery	Clinical outcome	Fusion rate	Complications	Patients after lumbar/lumbosacral fusion or surgery
Buchowski et al. [74]	20	3:17	45.1 (21.8–66.4)	5.8 years (2.0–9.0)	Open	SF-36 significantly improved	85 %	3 pseudoarthrosis 2 deep wound infection	15 pts (75 %) had at least one previous spine surgery
								1 painful hardware	8 pts (40 %) had fusion to the sacrum
Shutz and Grob [75]	17 (bilateral for all pts)	5:12	43.2 (22–76)	39 months (12–66)	Open	18 % of pts were satisfied	35 % (6/17)	11 pts had non-union	8/17 had a history of lumbar fusion down to the sacrum
Wise et al. [76]	13 (bilateral for 6 pts)	1:12	53.1 (45–62)	29.5 months (24–35)	Percutaneous	Back and leg pain score significantly improved	89 % (17/19)	2 non-union joints	8/13 had a history of lumbar fusion down to the sacrum
Khurana et al. [77]	15 (bilateral for 4 pts)	4:11	48.7 (37.3–62.6)	17 months (9–39)	Percutaneous	SF-36 and Majeed's score significantly improved 87 % had good or excellent results	100 %	No complications	6/15 had undergone spine surgery previously

pts patients, *SF-36* short form-36

retrospective study of bilateral SIJ fusion for degenerative SIJ syndrome with a poor outcome, Schutz and Grob [75] reported that of 17 patients who underwent open bilateral posterior SIJ fusion, eight had had fusion surgery down to the sacrum. The clinical results were not acceptable in 82 % of patients and reoperation was performed in 65 % of patients. Seven patients were found to have symptomatic non-union, with union occurring only in six. Wise and Dall [76] reported on the efficacy and outcomes of minimally invasive SIJ arthrodesis in 13 patients via a percutaneous posterior approach (8 of the 13 patients had a history of a lumbar fusion that extended to the sacrum). Wise and Dall [76] used percutaneous insertion of threaded titanium cages packed with recombinant human bone morphogenetic protein-2 (rhBMP-2) into the SIJ. Significant improvements were seen in low back pain and the overall fusion rate was 89 %. There were no infections or neurovascular complications. In another study, Khurana et al. [77] reported outcomes for 15 patients who underwent percutaneous fusion of the SIJ with hollow modular anchorage screws. In that study, 6 of the 15 patients had undergone previous spinal surgery. Good or excellent results were reported for 87 % of patients. Fusion was obtained in all patients and there were no postoperative neurological or wound complications (Table 2).

Conclusion

The SIJ is a possible source of persistent pain or new pain with failed back surgery syndrome after lumbar/lumbosacral fusion. Thorough examinations, including physical examinations, radiographic studies, and diagnostic injections, are necessary to make a diagnosis. Conservative treatment is the first choice and surgical treatment may be an option for retractable cases. However, well-controlled clinical studies are necessary to assess the efficacy of surgical treatment.

Conflict of interest None.

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