ELSEVIER

The Spine Journal 5 (2005) 520–528

THE SPINE JOURNAL

Functional and radiographic outcome of sacroiliac arthrodesis for the disorders of the sacroiliac joint

Jacob M. Buchowski, MD, MS[a], Khaled M. Kebaish, MD[a,*], Vladimir Sinkov, MD[b], David B. Cohen, MD, MPH[a], Ann N. Sieber, RN, MSN[a], John P. Kostuik, MD[a]

[a]*Department of Orthopaedic Surgery, Johns Hopkins University School of Medicine, 600 N. Wolfe St., Baltimore, MD 21287, USA*
[b]*Department of Orthopaedic Surgery, Union Memorial Hospital, 201 E, University Parkway, Baltimore, MD 21218, USA*

Received 1 July 2004; accepted 28 February 2005

Abstract

BACKGROUND CONTEXT: The sacroiliac joint is known to be a possible cause of chronic low back pain, but the diagnosis and treatment of disorders of the sacroiliac joint have been difficult and controversial.

PURPOSE: To describe the outcome of sacroiliac joint arthrodesis for sacroiliac joint disorders, with the hypothesis that sacroiliac arthrodesis leads to improved postoperative function.

STUDY DESIGN/SETTING: Consecutive case series performed in an academic medical institution.

PATIENT SAMPLE: The patient population consisted of 20 patients undergoing sacroiliac joint arthrodesis between December 1994 and December 2001. Patients undergoing concomitant procedures at the time of sacroiliac joint arthrodesis were excluded. The 3 men and 17 women in the study group had an average age of 45.1 years (range 21.8–66.4 years), a mean duration of symptoms of 2.6 years (range 0.5–8.0 years), and a mean follow-up period of 5.8 years (range 2.0–9.0 years).

OUTCOME MEASURES: Outcome measures included general health and function, clinical evaluation, and radiographic assessment.

METHODS: For all 20 patients, nonoperative treatment had failed, and for all, the diagnosis was confirmed by pain relief with intraarticular sacroiliac joint injections under fluoroscopic guidance. Sacroiliac joint arthrodesis (via a modified Smith-Petersen technique) was recommended only when a positive response to the injection was noted, and patients had recurrence of symptoms after the initial positive response. Preoperative and postoperative general health and function were assessed via the 36-item Short-Form (SF-36) Health Survey and American Academy of Orthopaedic Surgeons (AAOS) Modems Instrument, which were collected prospectively. Medical records and plain radiographs were reviewed retrospectively to determine the clinical and radiographic outcome.

RESULTS: Multiple etiologies of sacroiliac symptoms were observed: sacroiliac joint dysfunction (13 patients), osteoarthritis (5 patients), and spondyloarthropathy and sacroiliac joint instability (1 each). Seventeen patients (85%) had solid fusion. Fifteen patients (75%) completed preoperative and postoperative SF-36 forms. Significant ($p \leq .05$) improvement occurred in the following categories: physical functioning, role physical, bodily pain, vitality, social functioning, role emotional, and neurogenic and pain indices. Improvement (not statistically significant) was also noted in general and mental health.

CONCLUSIONS: For carefully selected patients, sacroiliac arthrodesis appears to be a safe, well-tolerated, and successful procedure, leading to significant improvement in functional outcome and a high fusion rate. To the authors' knowledge, the current report is the largest series to document

FDA device/drug status: not applicable.

Nothing of value received from a commercial entity related to this manuscript.

* Corresponding author. c/o Elaine P. Henze, Medical Editor, Department of Orthopaedic Surgery, Johns Hopkins Bayview Medical Center, 4940 Eastern Ave., #A672, Baltimore, MD 21224-2780. Tel.: (410) 550-5400; fax: 410-550-2899.

E-mail address: ehenze1@jhmi.edu (K.M. Kebaish)

1529-9430/05/$ – see front matter
doi:10.1016/j.spinee.2005.02.022

the functional and radiographic outcome of sacroiliac joint arthrodesis.

Keywords: Sacroiliac arthrodesis; Sacroiliac joint; Surgical treatment; Outcome

Introduction

For quite some time, the sacroiliac joint has been known to be a source of pain. According to Lynch [1], interest in the sacroiliac joint began with the observation by Hippocrates that a woman's pelvis separated during labor and remained so after birth. In 1905, Goldthwait and Osgood [2] reported that the sacroiliac joint can be a source of unexplained low back and leg pain; more recently, other authors [3–7] have reported similar findings. In fact, the sacroiliac joint has been implicated as a cause of chronic low back pain in at least 13% to 30% of patients seen in a specialty spine care center [8–10].

Many causes of sacroiliac joint pain have been described. Perhaps the most common, but also the most controversial, is sacroiliac joint dysfunction [11,12], which is thought to be the primary source of low back pain in 22.5% of patients with low back pain [3]. In patients with previous spine surgery, sacroiliac joint dysfunction can be an even more important source of pain and is one of the potential causes of failed back surgery syndrome [8,13,14]. Inflammatory arthritides can also affect the sacroiliac joint, leading to sacroiliitis and in many cases ankylosis of the sacroiliac joint [4,15–17]. Sacroiliac joint osteoarthritis and posttraumatic arthritis can also lead to sacroiliac pain [4,18–23]. Pain in the sacroiliac joint can also result from infection [18,19,24–26] and other less common disorders of the sacroiliac joint [1,2,4,27–29]. Because pain originating from the sacroiliac joint may be difficult to diagnose and may mimic pain referred from other sources [4,8,9,30–33], physical examination is not particularly useful [8,9,11,34,35]. Plain radiographs and other noninvasive radiology tests can be used as adjunctive diagnostics for sacroiliac joint disorders, but none have proved both sensitive and specific enough to be reliable for diagnosis when used alone [4,8,12,33]. With the advent of fluoroscopy, intraarticular sacroiliac joint injections have become keys in diagnosing disorders of the sacroiliac joint [8,10,12,31,32,34,36–38].

The mainstay of therapy for disorders of the sacroiliac joint has been nonoperative treatment, including rest, nonsteroidal anti-inflammatory agents, and physical therapy [4]. When these modalities fail, some have recommended sacroiliac joint arthrodesis [4,7,16,18–20,22–25,33,39,40]. Although sacroiliac joint arthrodesis has been described as a treatment for sacroiliac joint osteoarthritis and posttraumatic arthritis [18–20,22,23], sacroiliitis secondary to spondyloarthropathy [16], and infection of the sacroiliac joint recalcitrant to antibiotic treatment [18,19,24,26], the reports have suffered from small numbers of patients and lack of information on functional outcome. For this reason, the current authors elected to conduct a study to examine the surgical, radiographic, and functional outcome of patients undergoing sacroiliac joint arthrodesis for disorders of the sacroiliac joint, with the hypothesis that in carefully selected patients, the procedure is safe, is well-tolerated, has a high fusion rate, and leads to significant improvement in functional outcome.

Materials and methods

Patient selection

The current authors reviewed the records of one multidisciplinary tertiary care university hospital to identify consecutive patients from December 1994 to December 2001 with disorders of the sacroiliac joint who were treated surgically and who had a minimum of 24 months of follow-up. Patients who had concomitant other procedures at the time of sacroiliac arthrodesis were excluded from the study. Twenty patients who satisfied the criteria were found and recruited for the study.

The medical records were carefully and thoroughly examined to establish demographic information, determine the etiology of the sacroiliac joint disorder, identify intraoperative and postoperative complications, and determine outcome. This review, as well as assessment of radiographic and functional outcome (see below), was performed independently of the senior operative surgeons (KMK, DBC, JPK). Institutional review board approval was obtained before initiation of the study.

The demographic information for the 20 study subjects (summarized in Table 1) is divided into three subgroups: all patients, those who completed the 36-item Short-Form (SF-36) Health Survey and American Academy of Orthopaedic Surgeons (AAOS) Modems Instrument ("Responders"), and those who did not complete the surveys ("Nonresponders").

A history of previous spine surgery was very common in the current patient population: 15 of the 20 patients (75%) had at least one such surgery (average, 3.5 ± 3.7 surgeries per patient; range, 1–13 surgeries), and in 8 patients (40%) previous surgery included fusion to the sacrum (Table 2). Understandably, half of the patients (10/20, 50%) had undergone iliac crest harvest for bone graft. Of those 10 patients, 9 developed subsequent ipsilateral sacroiliac joint symptoms, possibly implicating iliac crest bone grafting as an etiology of the sacroiliac joint disorder. It must be emphasized, however, that even in these patients, a positive response after multiple intraarticular sacroiliac joint injections was noted in all cases, at least suggesting that the source of symptoms was likely intraarticular in nature. Four patients (4/20, 20%)

Table 1
Demographic information*

Category	All patients	Responders	Nonresponders
Number of patients	20	15	5
Mean age (years)	45.1±12.7	42.7±11.4	49.8±16.0
Gender (male/female)	3/17	3/12	0/5
Mean follow-up period (years)	5.8±1.9	5.8±1.9	3.2±1.0
Mean duration of symptoms (years)	2.6±1.9	2.7±1.9	1.7±1.2
Patients with previous spine surgery (n)	15 (75%)	11 (73.3%)	4 (80%)
Mean number of previous spine surgeries (n)	3.6±3.6	3.6±1.9	3.2±1.0
Patients with previous iliac crest bone graft (n)	10 (50%)	6 (40%)	4 (80%)
Patients with smoking history (n)	4 (20%)	2 (13%)	2 (40%)
Patients with fusion (n)	17 (85%)	13 (87%)	4 (80%)
Estimated blood loss (mL)	290±186	333±204	180±67
Length of stay (days)	5.2±3.8	5.5±4.5	4.4±1.1
Patients with revision (n)	3 (15%)	2 (13%)	1 (20%)
Patients returning to work (n)	8 (40%)	7 (47%)	1 (20%)
Time to return to work (months)	5.0±1.6	4.9±1.7	6.0±0.0

* Responders, patients who completed the SF-36 Health Survey and AAOS Modems Instrument. Nonresponders, patients who did not complete the surveys. No statistically significant differences were noted between responders and nonresponders.

had a smoking history and were active smokers at the time of surgery despite counseling about the associated risks.

In general, the patient population was fairly healthy; 10 patients (10/20, 50%) had no substantial medical comorbidities; the other 10 had a total of 21 medical comorbidities (Table 3), the most common of which were hypertension (3 patients, 15%) and asthma (2 patients, 10%).

Treatment algorithm

At presentation, all patients had complained of low back, buttock, and/or leg pain, and traditional nonoperative treatment measures, including physical therapy, pain medication, or lifestyle modification, had failed for all. The sacroiliac joint was clinically evaluated in all patients; tests included palpation over the sacral sulcus and posterior sacroiliac joint, Patrick's test, Gaenslen's test, compression test, and hip abduction test [4]. Although the clinical evaluation was completed for all patients, a positive test was thought to be important only when the clinical history and remaining physical findings ruled out other syndromes; in all cases, subsequent radiographic and interventional testing was performed before the recommendation for surgical treatment was made.

In addition to clinical evaluation, all patients underwent plain radiography of the pelvis, lumbosacral spine, and specific views of the sacroiliac joint (Fig. 1). These radiographs were inspected for the presence of sacroiliac joint narrowing, bony sclerosis, or any other evidence of sacroiliac joint disorder. In addition to plain radiographs, some patients underwent other studies, including triple-phase bone scan (6 patients), magnetic resonance imaging (2 patients), and computed tomography (1 patient); however, these tests were not considered necessary or diagnostic of a sacroiliac joint disorder. All patients were required to undergo multiple (average, 2.7 injections; range, 2–4 injections) intraarticular sacroiliac joint injections. All injections were performed under fluoroscopic guidance as described previously [10,11,31,32,41]. For this procedure, patients were positioned prone on the fluoroscopic table; the C-arm fluoroscope then was angled 20 to 25° in a caudal direction and away from the side to be injected so that a clear view of the posterior-inferior (target) aspect of the sacroiliac joint could be obtained. A spinal needle then was advanced in the direction of the X-ray beam under fluoroscopic guidance until it was within the posterior-inferior aspect of the joint. Once intraarticular placement of the needle was confirmed by injection of nonionic contrast, a combination of local anesthetic and a long-acting glucocorticosteroid was injected. The patients were then asked to evaluate their pain both immediately after the procedure and at their next office appointment in comparison to the pain present before injection. Sacroiliac joint arthrodesis was recommended only when a positive response to the injections was noted and patients had recurrence of symptoms after the initial positive response.

Surgical technique

Sacroiliac joint arthrodesis was performed using a modified Smith-Petersen technique [22]. In brief, this approach involves a curvilinear incision over the posterior two-thirds of the iliac crest and dissection parallel to the fibers of the gluteus maximus for approximately 2 to 3 inches. This flap is reflected subperiosteally, exposing the lateral surface of the ilium. Once the surface of the ilium is exposed, a rectangular window of bone is removed from the ilium immediately over the sacroiliac joint, allowing thorough exposure of the articular surface of the joint. Next, the articular cartilage is curetted from the sacrum and the ilium, and the bone block is reinserted. The joint is then stabilized with the use of a T- or L-plate and screws (Fig. 2). Postoperatively, patients remain nonweightbearing on the affected side for a course of 3 months or until evidence of solid fusion is seen. Hip spica cast immobilization was not used.

Table 2
Previous spine surgeries in study population

	Previous surgeries	
Patient	Number	Type
1	1	Repair L4-L5 pars defect*
2	2	PSF T4-T10*
		Rev. PSF T4-S1/ASF L3-S1
3	6	PSF x 3 (T4 to L5)*
		Rev. PSF L2-S1/ASF L3-S1
		L4-S1 decompression
		Removal of hardware
4	5	PSF x 5 (to L5)*
5	0	None
6	0	None
7	0	None
8	1	L5-S1 discectomy*
9	4	L4-L5 discectomy*
		Rev. L4-L5 discectomy*
		PSF L4-L5*
		Decompression L4-S1/Rev. PSF L4-S1
10	5	PSF L4-S1 x 4*
		Rev. PSF L2-L4/ASF L2-4/Decompression L5-S1
11	6	PSF L3-L5/Decompression L4-L5 x 6*
12	7	PSF L3-L5/Decompression L4-L5 x 6*
		Left sacroiliac joint arthrodesis
13	10	PSF L4-S1*
		ASF L4-S1*
		Rev. ASF L4-S1*
		PSF L3-S1
		Rev. ASF L3-S1
		Rev. PSF L3-S1
		Rev. PSF L3-S1
		Exploration of fusion mass
		Rev. PSF L3-S1
		Removal of hardware
14	2	PSF L4-S1*
		ASF L4-S1*
15	0	None
16	1	PSF L4-S1
17	0	None
18	7	PSF L3-L5 x 3*
		Decompression L3-S1/Removel of hardware
		ASF T11-S1
		PSF T11-S1
		Decompression L4-S1/Rev. PSF T11-S1
19	13	PSF L4-S1 x 7*
		Decompression L4-S1/Rev. PSF L3-S1
		Rev. decompression L3-S1/Rev. PSF L2-S1
		Exploration of fusion mass*
		Implantation morphine pump*
		ASF L2-4/Rev. PSF L2-S1
		Rev. decompression L5-S1
20	0	None

PSF=posterior spinal fusion; ASF=anterior spinal fusion; Rev.=revision.
* Surgery performed at another institution.

Table 3
Comorbidities (in 10/20 patients)

Comorbidity	Number
Hypertension	3
Asthma	2
Hypothyroidism	2
Irritable bowel syndrome	2
Obesity	2
Coronary artery disease	1
Cardiomyopathy	1
Esophageal strictures	1
Gastritis	1
History of thyroid cancer	1
Hyperlipidemia	1
Osteoporosis	1
+HLA-B27	1
Sjögren's disease	1
Systemic lupus erythematosus	1
Total	21

Radiographic outcome assessment

All patients were evaluated radiographically in the preoperative period, postoperative period, and at the latest follow-up. Radiographic evaluation included an anteroposterior plain radiograph of the pelvis, specific views of the sacroiliac joint, and anteroposterior and lateral plain radiographs of the lumbosacral spine. Each postoperative radiograph was inspected for evidence of fusion, hardware loosening, and hardware failure.

Functional outcome assessment

In addition to the clinical and radiographic evaluations, functional outcome was assessed preoperatively at indication (that is, once surgery was decided) and at the latest follow-up via a standardized questionnaire in a prospective manner. Patients who did not fill out the preoperative or postoperative questionnaire during the office appointment were contacted by telephone and encouraged to mail in their surveys. Those who did not respond in a timely manner were contacted again, and surveys were completed over the telephone by an independent health-care worker. The questions were derived from the SF-36 Health Survey from the Medical Outcomes Trust and the AAOS Modems Instrument. The main purpose of the questionnaire was to assess the preoperative and current levels of function, pain, and patient satisfaction, but comorbidities and demographic information were also evaluated. The mean preoperative and postoperative scores derived from the SF-36 Health Survey (including Physical Function, Role Physical, Bodily Pain, General Health, Vitality, Social Function, Role Emotional, and Mental Health) and the AAOS Modems Instrument (including Comorbidity Scale, Satisfaction with Symptoms Index, Neurogenic Symptoms Index, and Pain/Disability Index) were recorded and compared using paired t tests with statistical significance set at $p<.05$.

Results

Clinical evaluation

On presentation, chief complaints were low back pain (10/20 patients, 50%), buttock pain (5/20 patients, 25%),

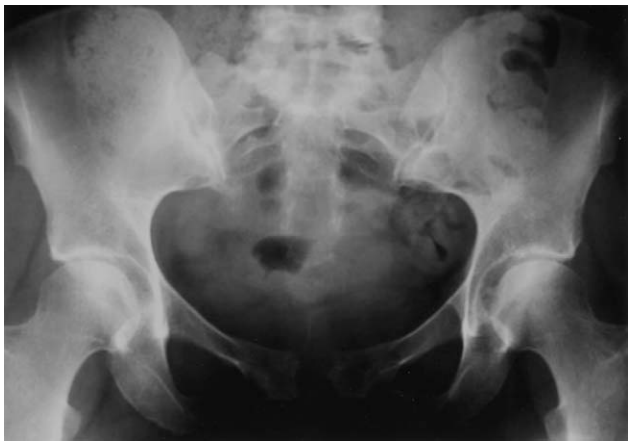

Fig. 1. Preoperative anteroposterior pelvis plain radiograph showing right sacroiliac joint narrowing and bony sclerosis.

pain localized to the sacroiliac joint (4/20 patients, 20%), hip pain (2/20 patients, 10%), and leg pain (1/20 patients, 5%). Some patients had more than one complaint. Clinical evaluation revealed that no single physical examination finding was able to diagnose predictably a disorder of the sacroiliac joint. Although some patients had more than one positive physical examination finding, tenderness to palpation over the sacral sulcus and posterior sacroiliac joint was seen most commonly and was positive in 8 patients (40%). The other tests were positive less often: Patrick's test (7/20 patients, 35%), Gaenslen's test (6/20 patients, 30%), compression test (2/20 patients, 10%), and hip abduction test (1/20 patients, 5%). Five of the 20 patients (25%) had nonspecific physical examination findings.

The conditions affecting the sacroiliac joint in the current study population included sacroiliac joint dysfunction, osteoarthritis, inflammatory arthritis, and postpartum instability (Table 4).

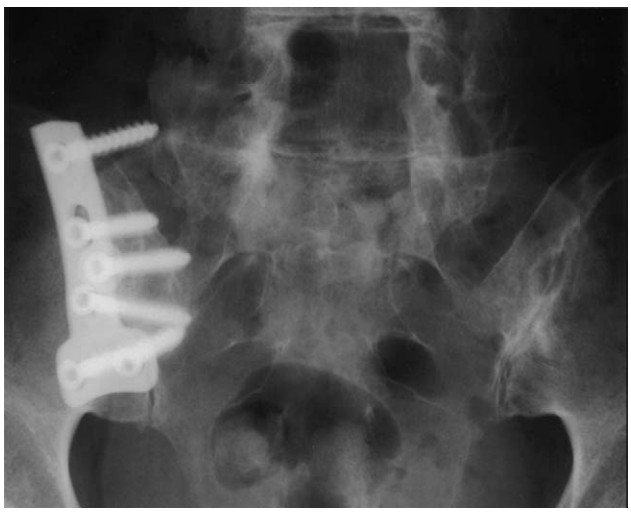

Fig. 2. Postoperative anteroposterior sacroiliac spine plain radiograph showing the use of T-plate to achieve arthrodesis of the sacroiliac joint using a modified Smith-Petersen technique.

Table 4
Sacroiliac joint disorders leading to sacroiliac joint arthrodesis

Diagnosis	Number of patients
Sacroiliac joint dyfunction	13 (65%)
Sacroiliac joint osteoarthritis	5 (25%)
Sacroiliac joint inflammatory arthritis (+HLAB-27)	1 (5%)
Sacroiliac joint postpartum instability	1 (5%)
Total	20 (100%)

Surgical results and radiographic outcome

All 20 patients underwent sacroiliac joint arthrodesis via a modified Smith-Petersen technique. The average estimated intraoperative blood loss was 290±186 mL, and the average length of stay was 5.2±3.8 days (Table 1). Evidence of fusion was seen on plain radiographs in 17 of 20 patients within 1 year of surgery, for an overall fusion rate of 85%. The procedure was associated with few complications (Table 5). Three of the 20 patients (15%) had nonunions that required revision surgery, which was performed through an anterior approach. Of those patients, one had no substantial comorbidities, one had a history of systemic lupus erythematosus, and one was a smoker. Although statistical analysis was performed to determine if smoking history was associated with a higher risk of subsequent nonunion, the power was too low to determine significance (data not shown). In two of these three patients, the postoperative course was complicated by a deep wound infection, which required subsequent irrigation and debridement. Once the infection was cleared, both patients initially did well, but in less than 1 year both patients had recurrence of the initial symptoms and were found to have a pseudarthrosis. Both underwent revision surgery through an anterior approach with an uneventful postoperative course and eventual solid fusion. The third patient presented with painful hardware, but symptoms improved with nonoperative intervention (Table 5). Overall, there was high satisfaction with results of the surgery (Table 6). Most patients (60%) indicated they would choose to have the surgery again, and only one patient—who had no evidence of pseudarthrosis or any other complications—definitely chose not to have the surgery again.

Functional outcome

Fifteen of the 20 patients (75%) returned their preoperative and postoperative functional outcome questionnaires. Despite multiple attempts to contact them, 3 of the 20

Table 5
Intraoperative and postoperative complications (in 4/20 patients)

Complication	Number
Pseudarthrosis	3
Deep wound infection	2
Painful hardware	1
Total	6

Table 6
Patient satisfaction

Would you do it again?	Number of patients
Definitely yes	8 (53.3%)
Probably yes	1 (6.7%)
Neutral	3 (20.0%)
Probably no	2 (13.3%)
Definitely no	1 (6.7%)

patients (15%) were lost to follow-up; the remaining 2 patients (10%) elected not to participate in the study. However, statistical analysis between the group of patients who completed the SF-36 Health Survey and AAOS Modems Instrument ("Responders") and the group of patients who did not complete the surveys ("Nonresponders") was undertaken and revealed no statistically significant differences between the two groups, although a trend was noted towards a greater percentage of women, shorter duration of symptoms, and shorter follow-up period in Nonresponders (Table 1).

Table 7 shows the mean preoperative and postoperative SF-36 Health Survey values. Statistically significant improvement ($p<.05$) occurred in all SF-36 outcome categories except for General Health and Mental Health; those categories showed improvement, but it was not statistically significant ($p<.4706$ and $<.0604$, respectively).

Preoperative and postoperative AAOS Modems Instrument scores are shown in Table 8. A significant improvement was found in the Neurogenic Symptoms Index, the Pain/Disability Index, and Satisfaction with Symptoms Index. No significant change was noted in the Comorbidiy Scale or any of the Comorbidity Subscales.

Discussion

Interest in the sacroiliac joint began many centuries ago when Hippocrates observed that a woman's pelvis separated during labor and remained so after birth [1]. Early studies since that time have focused mainly on the potential motion of the joint, changes during and after pregnancy, and changes during development and aging. Starting in the early twentieth century, however, investigators began to notice that the sacroiliac joint could also be a source of pain. Goldthwait and Osgood [2] first reported that the sacroiliac joint can be a source of unexplained low back and leg pain, even in women who were not pregnant. Soon, a significant percentage of low back pain was attributed to disorders of the sacroiliac joint [2,4,7]. However, in part because the sacroiliac joint is difficult to examine and even more difficult to localize as a source of pain, but also as other sources of low back and leg pain became better understood (in particular the mechanism by which herniated nucleus pulposus could cause pain), the hypothesis that the sacroiliac joint could lead to significant pain went out of favor. More recently, however, the hypothesis that disorders of the sacroiliac joint could cause low back, buttock, and leg pain has witnessed resurgence, and although controversial has been widely accepted [3–7]. The sacroiliac joint has been implicated as a cause of chronic low back pain in 13% to 30% of patients in one specialty spine care center [9,10], and perhaps in even a larger percentage of those with previous lumbosacral fusion [8].

Anatomically, the sacroiliac joint is a complex, synovial, diarthrodial joint that transmits forces from the pelvis to the spine and allows for 2 to 4° of motion in the sagittal plane. Because the joint contains hyaline cartilage, fibrocartilage, and synovium—and is therefore a true joint—it is subject to the same degenerative changes of any other synovial joint. Logically then, it should not be surprising that a disorder of the sacroiliac joint could lead to pain [4]. Many causes of sacroiliac joint pain have been described. Perhaps the most common—but also the most controversial—is sacroiliac joint dysfunction, which has been used to explain pain from the sacroiliac joint with no demonstrable lesion, but with a presumed underlying biomechanical disorder causing pain [11,12]. Diagnosis of sacroiliac joint dysfunction can be made by the appropriate clinical history and specific provocative sacroiliac joint stress tests, which aim to detect biomechanical abnormalities on physical examination [4,11,12]. Although the incidence of sacroiliac joint dysfunction in the general population is not known, Bernard and Kirkaldy-Willis [3] believed it to be the primary source of low back pain in 22.5% of their 1,293 patients. In the current study, 13 of 20 patients (65%) undergoing sacroiliac

Table 7
Comparison of the mean preoperative and postoperative SF-36 Health Survey Scores

SF-36 transformed scores	Preoperative (±SD)	Postoperative (±SD)	p value
Physical functioning	33.04±27.72	52.33±30.87	<0.0072
Role functioning physical	0.00±0.00	30.00±40.31	<0.0060
Bodily pain	14.33±11.11	36.87±23.84	<0.0009
General health	61.53±19.44	62.00±22.85	<0.4706
Vitality	33.00±20.85	49.00±24.14	<0.0047
Social functioning	34.17±20.84	59.17±28.92	<0.0032
Role functioning emotional	51.11±45.19	80.00±37.37	<0.0067
Mental health	55.47±23.17	64.27±25.63	<0.0604
Physical summary	26.37±7.35	33.53±11.72	<0.0252
Mental summary	42.45±12.08	49.46±13.07	<0.0105

Table 8
Comparison of the mean preoperative and postoperative AAOS Modems Instrument scores

AAOS lumber module scores	Preoperative (±SD)	Postoperative (±SD)	p value
Comorbidity scale	12.54±11.64	13.18±13.70	<0.3389
Comorbidity, subscale 1	17.14±14.74	18.57±18.86	<0.2121
Comorbidity, subscale 2	11.90±12.57	10.95±8.90	<0.6576
Comorbidity, subscale 3	9.52±8.82	10.95±15.48	<0.2908
Treatment expectation index	N/A	77.00±21.11	N/A
Satisfaction with symptoms	1.20±0.77	2.67±1.63	<0.0065
Would you do it again?	N/A	2.13±1.41	N/A
Neurogenic symptoms index	56.67±33.33	74.89±25.22	<0.0194
Pain/disability index	34.91±12.39	57.45±23.04	<0.0007

N/A=not applicable.

joint arthrodesis were thought to have sacroiliac joint dysfunction (Table 4).

In patients with previous spine surgery, sacroiliac joint dysfunction can be an even more important source of pain and is one of the potential causes of failed back surgery syndrome [8,13,14]. Recently, Katz et al. [8], who used fluoroscopically guided sacroiliac joint injections for diagnostic purposes, identified sacroiliac joint dysfunction as the cause of low back pain after lumbosacral arthrodesis in 32% (and possibly in another 29%) of their 34 patients. Although older studies, such as that by Frymoyer et al. [42], have reported a similar incidence of low back pain after lumbosacral fusion, the etiology of low back pain was thought to be "referable to the iliac graft donor site" and not sacroiliac joint dysfunction. Unfortunately, in that study [42], sacroiliac joint injections were not used for diagnostic purposes, and therefore, it is quite likely that at least in some of his patients the source of symptoms was intraarticular in nature, as seen in the current population (where 9 patients had a history of prior ipsilateral iliac crest bone grafting). Although in the current study the incidence of sacroiliac joint dysfunction among patients with low back pain after lumbosacral fusion cannot be determined, the high number of previous surgeries (3.5±3.7 surgeries per patient in 15 patients [75%])—many of which included fusion to the sacrum (8 patients [40%])—certainly suggests that sacroiliac joint dysfunction may be relatively common after lumbosacral fusion (Table 2).

Inflammatory arthritides can also affect the sacroiliac joint, leading to sacroiliitis; perhaps the most common of these are spondyloarthropathies, such as ankylosing spondylitis and Reiter's syndrome, which are frequently associated with human leukocyte-associated antigen-B27 (HLA-B27) [4,15,17]. In ankylosing spondylitis (and to some extent in the other spondyloarthropathies), the sacroiliac joints are unilaterally or bilaterally affected with an intensity ranging from mild to severe often resulting in partial or complete ankylosis [17]. However, when spontaneous ankylosis does not develop, as has been described in at least one study [16], sacroiliac joints can sometimes cause long-lasting disabling pain. In at least two such cases, arthrodesis of the sacroiliac joint has been used with good success [16], Indeed, one of the patients included in that study, who was thought to possibly have ankylosing spondylitis and was HLA-B27 positive, had disabling sacroiliac pain secondary to sacroiliiitis with no evidence of sacroiliac ankylosis. He improved dramatically after sacroiliac joint arthrodesis.

Sacroiliac joint osteoarthritis can also lead to sacroiliac pain. As with other joints that are affected by osteoarthritis, evidence of joint space narrowing with bony sclerosis and osteophyte formation can be seen on plain radiographs. These degenerative findings are common in patients over 30 years of age and do not always correlate with symptoms [4,21]. However, in several reports, sacroiliac arthrodesis was used successfully in cases of overt osteoarthritis that failed to respond to nonoperative treatment [4,18–20,22,23]. In the current study, 5 of 20 patients (20%) had evidence of sacroiliac joint osteoarthritis and were treated with arthrodesis after failure of nonoperative treatment and confirmation of sacroiliac joint disease by fluoroscopically guided intraarticular injection.

Trauma [18,20,22], infection [18,19,24–26], and other, less common disorders of the sacroiliac joint, such as postpartum sacroiliac joint instability or diastasis [1,2,27] (1 patient in the current study), crystal arthropathy (gout or pseudogout) [4,28,29], osteitis condensans ilii [4], and tumor or tumor-like conditions [4] can all lead to sacroiliac joint pain. When these conditions are refractory to nonoperative treatment, they can—in the appropriate circumstances—be treated successfully with sacroiliac joint arthrodesis [18,20,22].

Pain originating from the sacroiliac joint may be difficult to diagnose and may mimic pain referred from lumbar herniated nucleus pulposus, lateral recess stenosis, facet joints, or even the hip [4,30–32]. Symptoms of sacroiliac joint disorders frequently include unilateral or bilateral low back pain, often with radiation to the groin, buttock, thigh, and even the foot or abdomen [8,9,31–33]. The current study population also displayed a variety of symptoms; the most common was back pain (10 patients, 50%). Results of the current study support earlier findings [8,9,11,34,35] that physical examination is not particularly useful: the current authors found no single test that was diagnostically reliable for a disorder of the sacroiliac joint, and 5 of 20 patients (25%) had only nonspecific physical examination findings.

Although plain radiographs, nuclear medicine imaging studies, computed tomography, and magnetic resonance imaging can all be useful and serve as an adjunct in diagnosis of sacroiliac joint disorders, none have proven to be both sensitive and specific enough to be relied upon for diagnosis (except perhaps in spondyloarthropathies for which the studies have proven to be more beneficial) [4,8,12,33]. In the current study, all patients underwent plain radiography of the pelvis, the sacroiliac joints, and lumbosacral spine, but some patients underwent other studies as well. However these tests were used not as diagnostics but to rule out other potential causes, which may mimic sacroiliac joint pain.

All patients in the current study underwent multiple fluoroscopically guided intraarticular sacroiliac joint injections as described previously [10,11,31,32]. In the past, such injections were thought to be of questionable utility because they were done "blindly" with no fluoroscopic guidance and in effect anesthetized only the interosseous sacroiliac ligament [11]. However, the advent of fluoroscopy has made intraarticular sacroiliac joint injections a key in diagnosing (and treating) disorders of the sacroiliac joint [8,10,12,31,32,34,36–38,43]. It is now commonly accepted that if there is >75% reduction of pain within 15 to 45 minutes of local anesthetic injection, the diagnosis is highly probable; if glucocorticosteroids are used in addition to the local anesthetic, and relief lasts more than 1 week, the diagnosis may be even more likely [8,33]. Fluoroscopically guided intraarticular injection appears to be the most stringent and useful test in diagnosing sacroiliac joint pathology, and the current authors believe that success of sacroiliac arthrodesis depends on careful patient selection. Therefore, the current authors emphasize the importance of using this procedure to document that the sacroiliac joint is the pain generator.

As mentioned above, sacroiliac joint arthrodesis has been recommended for, and successfully used to treat, a wide variety of etiologies affecting the sacroiliac joint [16,18,19,20,22–24,26]; however, the number of patients in these reports has always been small and results have typically been anecdotal in nature. Similarly, various techniques have been proposed to achieve sacroiliac joint arthrodesis, including the Smith-Petersen technique (also referred to as the posterior approach) [16,18,22,23,44], the anterior approach [20,40,45], percutaneous fixation [46–49], and a posterior midline fascial splitting approach [39]. The current authors used a modified Smith-Petersen technique in which an additional T- or L-shaped plate and screws were used to secure the fixation. Postoperatively, the patients were kept nonweightbearing for 3 months, but postoperative immobilization with a hip spica cast was deemed unnecessary. With this technique, solid fusion was obtained in 17 of 20 patients (85%); there were few complications (Table 5) and a high patient satisfaction rate (Table 6). Most importantly, however, the current study represents the first documentation of validated (via SF-36 Health Survey and AAOS Modems Instrument measures) significant postoperative improvement in functional outcome.

This study has limitations. First, despite the fact that strict criteria were used to determine the presence of fusion on plain radiographs, the 85% fusion rate may be an overestimation because more precise methods (such as a computed tomography scan) were not used to confirm successful arthrodesis. Second, the described procedure is performed relatively infrequently, so the number of patients available for study was limited (20 patients). This small number precluded additional statistical analysis (eg, to determine if smoking history was associated with a higher risk of pseudarthorsis) because of inadequate power, and comparisons with a nonoperative control group. Lastly, despite multiple attempts at contact, the current authors were able to gather information on only 15 of the 20 patients. However, even though a 75% response rate is not ideal, there were no statistically signficant differences between responders and nonresponders, and the authors believe that the overwhelming improvement in most functional outcome categories indicates that the procedure can be successful in carefully selected patients. To that end, the authors believe that sacroiliac joint arthrodesis should be recommended only in the presence of a documented positive response to the injection, failure of all nonoperative treatment modalities, and recurrent symptoms despite initial positive response to the injection.

Conclusions

Disorders of the sacroiliac joint are challenging to diagnose and treat. Patients who do not respond to nonoperative measures can be successfully treated with sacroiliac joint arthrodesis, which can be expected to yield a high fusion rate with few complications and lead to improvement in functional outcome. Success of surgery, however, depends on careful patient selection.

References

[1] Lynch FW. The pelvic articulations during pregnancy, labor, and the puerperium: an x-ray study. Surg Gynecol Obstet 1920;30:575–80.
[2] Goldthwait JE, Osgood RB. A consideration of the pelvic articulations from an anatomical, pathological and clinical standpoint. Boston Med Surg J 1905;152:593–601.
[3] Bernard TN Jr, Kirkaldy-Willis WH. Recognizing specific characteristics of nonspecific low back pain. Clin Orthop 1987;217:266–80.
[4] Bernard TN Jr, Cassidy JD. The sacroiliac joint syndrome: pathophysiology, diagnosis, and management. In: Frymoyer JW, ed. The adult spine: principles and practice. New York: Raven Press, 1991:2107–30.
[5] Bradley KC. The anatomy of backache. Aust N Z J Surg 1974;44:227–32.
[6] McGregor M, Cassidy JD. Post-surgical sacroiliac joint syndrome. J Manipulative Physiol Ther 1983;6:1–11.
[7] Schuchmann JA, Cannon CL. Sacroiliac strain syndrome: diagnosis and treatment. Tex Med 1986;82:33–6.
[8] Katz V, Schofferman J, Reynolds J. The sacroiliac joint: a potential cause of pain after lumbar fusion to the sacrum. J Spinal Disord Tech 2003;16:96–9.

[9] Maigne JY, Aivaliklis A, Pfefer F. Results of sacroiliac joint double block and value of sacroiliac pain provocation tests in 54 patients with low back pain. Spine 1996;21:1889–92.
[10] Schwarzer AC, Aprill CN, Bogduk N. The sacroiliac joint in chronic low back pain. Spine 1995;20:31–7.
[11] Dreyfuss P, Michaelsen M, Pauza K, McLarty J, Bogduk N. The value of medical history and physical examination in diagnosing sacroiliac joint pain. Spine 1996;21:2594–602.
[12] Elgafy H, Semaan HB, Ebraheim NA, Coombs RJ. Computed tomography findings in patients with sacroiliac pain. Clin Orthop 2001; 382:112–8.
[13] Slipman CW, Shin CH, Patel RK, et al. Etiologies of failed back surgery syndrome. Pain Med 2002;3:200–7.
[14] Waguespack A, Schofferman J, Slosar P, Reynolds J. Etiology of long-term failures of lumbar spine surgery. Pain Med 2002;3:18–22.
[15] Bellamy N, Park W, Rooney PJ. What do we know about the sacroiliac joint? Semin Arthritis Rheum 1983;12:282–313.
[16] Berthelot JM, Gouin F, Glemarec J, Maugars Y, Prost A. Possible use of arthrodesis for intractable sacroiliitis in spondylarthropathy: report of two cases. Spine 2001;26:2297–9.
[17] Braun J, Sieper J, Bollow M. Imaging of sacroiliitis. Clin Rheumatol 2000;19:51–7.
[18] Gaenslen FJ. Sacro-iliac arthrodesis: indications, author's technic and end-results. JAMA 1927;89:2031–5.
[19] Langlais F, Apoil A, Moinet P. [Surgery in sacro-iliac arthritis]. J Chir (Paris) 1974;107:303–12.
[20] Rand JA. Anterior sacro-iliac arthrodesis for post-traumatic sacroiliac arthritis. A case report. J Bone Joint Surg 1985;67A:157–9.
[21] Resnick D, Niwayama G, Goergen TG. Degenerative disease of the sacroiliac joint. Invest Radiol 1975;10:608–21.
[22] Smith-Petersen MN, Rogers WA. End-result study of arthrodesis of the sacroiliac joint for arthritis—traumatic and nontraumatic. J Bone Joint Surg 1926;8:118–36.
[23] Waisbrod H, Krainick JU, Gerbershagen HU. Sacroiliac joint arthrodesis for chronic lower back pain. Arch Orthop Trauma Surg 1987;106:238–40.
[24] Bakalim G. Results of radical evacuation and arthrodesis in sacroiliac tuberculosis. Acta Orthop Scand 1966;37:375–86.
[25] Coy JT III, Wolf CR, Brower TD, Winter WG Jr. Pyogenic arthritis of the sacro-iliac joint: long-term follow-up. J Bone Joint Surg 1976; 58A:845–9.
[26] Grace JN, Sim FH, Shives TC, Coventry MB. Wedge resection of the symphysis pubis for the treatment of osteitis pubis. J Bone Joint Surg 1989;71A:358–64.
[27] Goldthwait JE. The pelvic articulations: a consideration of their anatomic, physiologic, obstetric and general surgical importance. JAMA 1907;49:768–74.
[28] Kerr R. Radiologic case study. Sacroiliac joint involvement by gout and hyperparathyroidism. Orthopedics 1988;11:185, 187–90.
[29] Malawista SE, Seegmiller JE, Hathaway BE, Sokoloff L. Sacroiliac gout. JAMA 1965;194:954–6.
[30] Calvillo O, Esses SI, Ponder C, D'Agostino C, Tanhui E. Neuroaugmentation in the management of sacroiliac joint pain: report of two cases. Spine 1998;23:1069–72.
[31] Fortin JD, Dwyer AP, West S, Pier J. Sacroiliac joint: pain referral maps upon applying new injection/arthrography technique. Part I: Asymptomatic volunteers. Spine 1994;19:1475–82.
[32] Fortin JD, Aprill CN, Ponthieux B, Pier J. Sacroiliac joint: pain referral maps upon applying a new injection/arthrography technique. Part II: Clinical evaluation. Spine 1994;19:1483–9.
[33] Slipman CW, Patel RK, Whyte WS II, et al. Diagnosing and managing sacroiliac pain. J Musculoskelet Med 2001;18:325–32.
[34] Dreyfuss P, Dreyer S, Griffin J, Hoffman J, Walsh N. Positive sacroiliac screening tests in asymptomatic adults. Spine 1994;19:1138–43.
[35] Potter NA, Rothstein JM. Intertester reliability for selected clinical tests of the sacroiliac joint. Phys Ther 1985;65:1671–5.
[36] Bollow M, Braun J, Taupitz M, et al. CT-guided intraarticular corticosteroid injection into the sacroiliac joints in patients with spondyloarthropathy: indication and follow-up with contrast-enhanced MRI. J Comput Assist Tomogr 1996;20:512–21.
[37] Dussault RG, Kaplan PA, Anderson MW. Fluoroscopy-guided sacroiliac joint injections. Radiology 2000;214:273–7.
[38] Karabacakoglu A, Karakose S, Ozerbil OM, Odev K. Fluoroscopy-guided intraarticular corticosteroid injection into the sacroiliac joints in patients with ankylosing spondylitis. Acta Radiol 2002;43:425–7.
[39] Belanger TA, Dall BE. Sacroiliac arthrodesis using a posterior midline fascial splitting approach and pedicle screw instrumentation: a new technique. J Spinal Disord 2001;14:118–24.
[40] Guner G, Gurer S, Elmali N, Ertem K. Anterior sacroiliac fusion: a new video-assisted endoscopic technique. Surg Laparosc Endosc 1998;8:233–6.
[41] Renfrew DL. Sacroiliac joint injection. In: Renfrew DL, ed. Atlas of spine injection. Philadelphia: WB Saunders, 2004:67–71.
[42] Frymoyer JW, Howe J, Kuhlmann D. The long-term effects of spinal fusion on the sacroiliac joints and ilium. Clin Orthop 1978;134: 196–201.
[43] Maugars Y, Mathis C, Berthelot JM, Charlier C, Prost A. Assessment of the efficacy of sacroiliac corticosteroid injections in spondylarthropathies: a double-blind study. Br J Rheumatol 1996;35:767–70.
[44] Ebraheim NA, Lu J, Biyani A, Yeasting RA. Anatomic considerations for posterior approach to the sacroiliac joint. Spine 1996;21:2709–12.
[45] Ebraheim NA, Lu J, Biyani A, Yeasting RA. Anatomic considerations of an anterior approach to the sacroiliac joint. Am J Orthop 1996;25: 697–700.
[46] Van den Bosch EW, van Zwienen CM, Van Vugt AB. Fluoroscopic positioning of sacroiliac screws in 88 patients. J Trauma 2002;53:44–8.
[47] Routt ML Jr, Nork SE, Mills WJ. Percutaneous fixation of pelvic ring disruptions. Clin Orthop 2000;375:15–29.
[48] Tonetti J, Carrat L, Lavallee S, Pittet L, Merloz P, Chirossel JP. Percutaneous iliosacral screw placement using image guided techniques. Clin Orthop 1998;354:103–10.
[49] Routt MLC Jr, Kregor PJ, Simonian PT, Mayo KA. Early results of percutaneous iliosacral screws placed with the patient in the supine position. J Orthop Trauma 1995;9:207–14.