

# Fluoroscopically Guided Sacroiliac Joint Injections: Comparison of the Effects of Intraarticular and Periarticular Injections on Immediate and Short-Term Pain Relief

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**OBJECTIVE.** The purpose of this study was to determine whether intraarticular sacroiliac joint injections provide greater immediate and short-term pain relief than periarticular sacroiliac joint injections do.

**MATERIALS AND METHODS.** The records of all fluoroscopically guided sacroiliac joint injections performed over a 4-year period were identified. Patients who received an injection of 0.5 mL of bupivacaine and 0.5 mL (20 mg) of triamcinolone and who had preinjection, immediate, and 1-week postinjection pain scores (0–10 numeric scale) were included. Images from the procedures were retrospectively reviewed by two musculoskeletal radiologists to determine intraarticular or periarticular administration of the injection with discrepancies resolved by consensus.

**RESULTS.** One hundred thirteen injections in 99 patients (65 women, 34 men; mean age, 59.4 years) met the inclusion criteria. There were 55 intraarticular and 58 periarticular injections. The mean preinjection, immediate, and 1-week postinjection pain scores for the intraarticular injections were 6.0, 1.6, and 4.1 and for the periarticular injections were 6.1, 2.0, and 4.2. The mean immediate and 1-week postinjection pain reduction were statistically significant in both groups ( $p < 0.001$ ). After adjustment for age, sex, preinjection pain score, time of year, and indication for injection, no significant difference in the preinjection to immediately postinjection change in pain between intraarticular and periarticular injections (mean change, 0.37;  $p = 0.319$ ) or in the preinjection to 1-week postinjection change in pain (mean change, 0.06;  $p = 0.888$ ) was noted. The mean fluoroscopy times were 42.4 seconds for intraarticular injections and 60.5 seconds for periarticular injections ( $p = 0.32$ ).

**CONCLUSION.** Although both intraarticular and periarticular sacroiliac joint injections provide statistically significant immediate and 1-week postinjection pain relief, no significant difference in the degree of pain relief achieved with intraarticular and periarticular injections was noted.

**Keywords:** bupivacaine, injection, intraarticular, pain, pain management, sacroiliac joint

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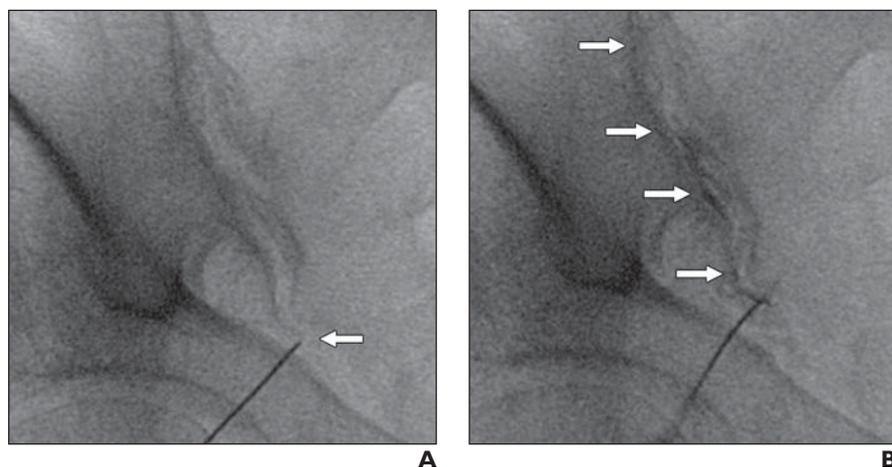
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**T**he cause of low back pain in as many as 20% of patients may be sacroiliac joint syndrome (SIJS) [1]. Patients with SIJS often present with pain near the posterior superior iliac spine. Both articular (osteoarthritis) and extraarticular (ligaments, tendons, or fascia) causes of SIJS have been described [2, 3]. However, the pain patterns associated with SIJS can overlap, with pain originating from the lumbar disks and the facet joints [4]. As a result, SIJS is probably underdiagnosed [4]. Radiographs of most patients with SIJS show either no radiologic abnormalities or only mild osteoarthritis, a common asymptomatic finding in adults older than 40 years [5, 6]. In addition, no reliable distinguishing CT features of SIJS have been reported [7].

Both diagnostic and therapeutic intraarticular steroid injections have been suggested for the management of SIJS. Even though strict criteria for the degree of pain improvement to confirm a diagnosis of SIJS are lacking, greater than 50–75% reduction in postinjection pain has been suggested as a useful threshold [3]. Because intraarticular steroid injections may effectively reduce the pain associated with SIJS, low-grade synovial inflammation has been proposed as a potential cause [1, 8]. Fluoroscopy has been suggested as a fast and efficient way of performing injections into the sacroiliac joint, with the intraarticular placement reported in more than 90% of injections [9, 10]. This rate is much higher than the intraarticular placement rate of 12–22% reported for sacroiliac joint injec-



**Fig. 1**—78-year-old woman referred for sacroiliac joint injection for sacroiliac joint syndrome.

**A**, Fluoroscopic image obtained during sacroiliac joint injection shows placement of needle (arrow) within inferior aspect of sacroiliac joint.

**B**, Fluoroscopic image obtained after contrast injection shows linear contrast pattern (arrows) along course of sacroiliac joint extending away from needle tip, consistent with intraarticular injection.

tions without imaging guidance, that is, using palpable landmarks only [11, 12]. Many radiologists also prefer using CT guidance when performing sacroiliac joint injections given the complex sacroiliac joint anatomy [13–15]. However, use of CT guidance can increase radiation and utilization of resources.

We perform sacroiliac joint injections using fluoroscopic guidance, given previous reports of similar pain reduction for intraarticular and periarticular injections [16–18] and the limitations associated with CT-guided injections. In the event that intraarticular placement is not possible with fluoroscopy, we perform a periarticular injection. The purpose of this study was to retrospectively examine fluoroscopically guided sacroiliac injections to determine whether the degree of immediate and short-term (1 week after injection) pain relief is different in patients who receive periarticular rather than intraarticular injections.

## Materials and Methods

### Patient Selection

This study was approved by the University of Virginia institutional review board. A retrospective search was performed for sacroiliac joint injections performed between September 2009 and December 2013. Only patients who received 0.5 mL (20 mg) of triamcinolone acetonide (Kenalog, Bristol Myers Squibb) and 0.5 mL of bupivacaine 0.25% or 0.5% (Sensorcaine HCl, APP Pharmaceuticals) and who had preinjection, immediate (5–10 minutes), and 1-week postinjection pain scores recorded were included in the study. Images documenting needle placement using iodinated contrast medium either within or external to

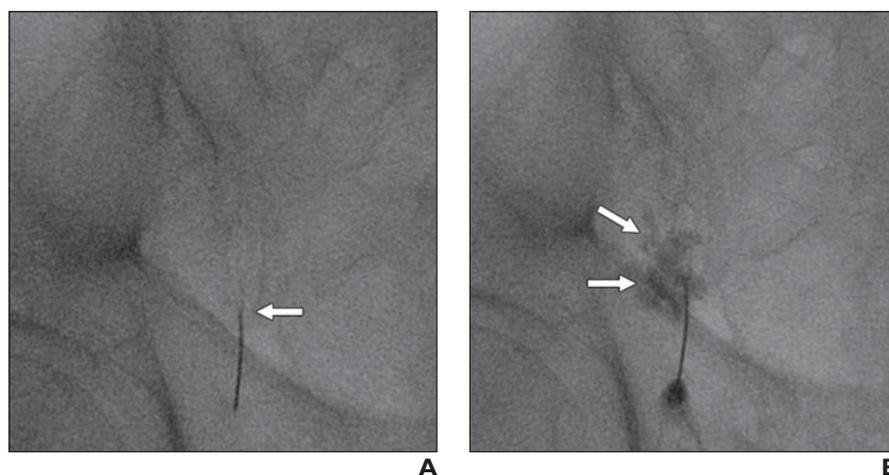
the sacroiliac joint also had to be available in the University of Virginia PACS (Carestream version 10.2, Carestream Health). Patient sex and age, side of procedure, referring department, and indication for injection were recorded. Patients who received bilateral injections were excluded.

### Injection Technique

A radiology nurse asked patients to provide a preinjection pain score using a numeric rating system with 0 corresponding to no pain and 10 corresponding to the worst pain imaginable. All injections were performed by musculoskeletal radiology faculty members according to our institutional protocol or by musculoskeletal fellows with or without immediate faculty supervision accord-

ing to the technique set forth by Dussault et al. [9]. After giving written consent, patients were placed prone on the fluoroscopy table with the sacroiliac joints equally apart from the sacral midline. Under coned fluoroscopic guidance, a location approximately 10 mm immediately superior to the inferior edge of the sacroiliac joint was marked. The image intensifier was rotated 30° in a craniocaudal direction to better differentiate the posterior aspect of the sacroiliac joint from its anterior aspect, as described by Dussault et al. The image intensifier was typically not rotated in the transverse plane.

With the C-arm in neutral position and after induction of local subcutaneous analgesia, a 22-gauge straight spinal needle was directed perpendicular to the skin surface until the sacroiliac joint was reached. The needle was then advanced slightly ( $\approx 5$  mm) into the sacroiliac joint. Often the needle was directed slightly lateral to follow the natural contour of the joint. However, at the inferior aspect of the sacroiliac joint, the orientation of the joint is close to that of the sagittal plane; thus, the needle angulation was typically minimal. Once the needle was felt to be within the sacroiliac joint, a small amount ( $\sim 0.5$  mL) of iodinated contrast medium was administered to confirm the location of the needle tip. If the contrast agent spread was felt to be periarticular, the operator repositioned the needle in an attempt to obtain an intraarticular location. Once the operator was satisfied with the needle position, whether periarticular or intraarticular, an injection of 0.5 mL (20 mg) of 40 mg/mL triamcinolone and either 0.5 mL of bupivacaine 0.25% ( $n = 59$ ) or 0.5 mL of bupivacaine 0.50% ( $n = 54$ ) was administered. Radiology personnel telephoned the patients 1 week after injection to obtain a follow-up pain score, as is



**Fig. 2**—72-year-old man with sacroiliitis referred for sacroiliac joint injection.

**A**, Fluoroscopic image obtained during sacroiliac injection shows placement of needle tip (arrow) along inferior aspect of sacroiliac joint.

**B**, Fluoroscopic image obtained after contrast injection shows globular contrast pattern (arrows) near needle tip, consistent with periarticular injection.

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part of the standard clinical protocol after outpatient musculoskeletal procedures.

### Fluoroscopic Image Assessment

Two musculoskeletal radiologists (2 and 13 years of experience performing sacroiliac joint injections) retrospectively reviewed the fluoroscopic images using the department PACS. The reviewers were blinded to any events from the procedure and to the patient's pain scores. The reviewers independently determined whether each injection was intraarticular (Fig. 1) or periarticular (Fig. 2) on the basis of whether contrast medium coursed within the sacroiliac joint. If contrast material was present in both an intraarticular and a periarticular location, the injection was classified as intraarticular. This judgment was based on the assumption that the operator likely repositioned the needle until intraarticular access was achieved or the needle was intraarticular with periarticular leakage of contrast medium. Injections in which intraarticular contrast medium could not be definitively confirmed or those in which only periarticular contrast medium was seen were classified as periarticular given that retrograde extension of a substantial amount of periarticular injectant into the intraarticular space would be unlikely. When a discrepancy between the radiologists' classifications of a particular injection existed, the radiologists simultaneously rereviewed the injection images in question at a later date and made a final determination by consensus with both radiologists blinded to their initial interpretations.

### Statistical Analyses

**Data summarization**—Categoric data were summarized as frequencies and percentages, and continuous scaled data were generally summarized by the mean and SD of the distribution.

**Interreader agreement**—The concordance between the two readers' assessments of whether an injection placement was intraarticular or periarticular was evaluated by means of the kappa statistic and the McNemar test.

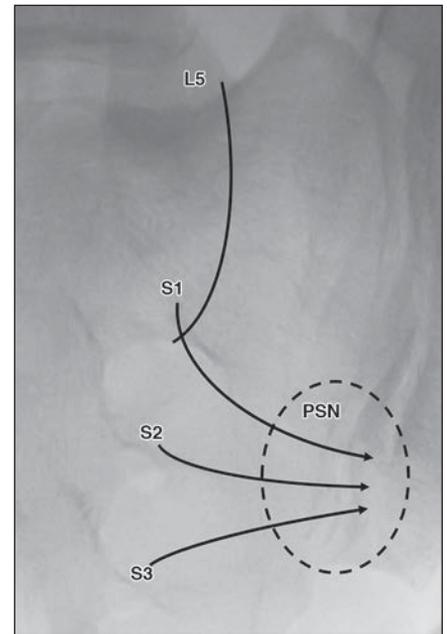
**Overview pain score analyses**—Three sets of pain score analyses were conducted. One set of analyses pertained to the preinjection pain scores; the second and third sets pertained to the change in pain scores immediately after (5–10 minutes) and 1 week after injection compared with the preinjection score, respectively.

**Preinjection pain score analyses**—ANOVA was used to compare the preinjection pain scores between the consensus intraarticular and periarticular injections. Linear contrast of the ANOVA least square means was used to test the null hypothesis that the mean of preinjection pain score distribution is the same for the intraarticular and

periarticular injections. A  $p < 0.05$  decision rule was used as the null hypothesis rejection rule.

**Analyses of preinjection to immediately postinjection change in pain**—The preinjection to immediately postinjection changes in pain scores were analyzed by analysis of covariance (ANCOVA). The primary sources of variation in the pain score changes examined were the consensus injection placement site (intraarticular or periarticular), the bupivacaine anesthetic dose (0.25% and 0.50%), and injection placement by anesthetic dose interaction. Preinjection pain, patient age and sex, time of academic year when the injection was performed, and the underlying reason for the injection were considered concomitant sources (i.e., adjustment factors) of pain score change variation. With regard to hypothesis testing, for each injection placement group (intraarticular and periarticular), linear contrasts of the least square means without concomitant variable adjustment were used to test the null hypothesis that the mean immediate change in pain is equal to zero. A two-sided  $p \leq 0.05$  decision rule was used as the null hypothesis rejection rule for the within injection placement group comparisons. A set of linear contrasts of the least square means with concomitant variable adjustment were used to compare the immediate changes in pain between the intraarticular and periarticular injection placements. This set of contrasts compared the mean immediate changes in pain per bupivacaine dose and overall. Two-sided  $p \leq 0.05$  decision rules were used as the null hypothesis rejection rule for these between injection placement comparisons. Chi-square analysis was used to evaluate the percentage of injections both immediately and 1 week after injection that had either 50% or 75% pain reduction.

**Analyses of preinjection to 1-week postinjection change in pain**—The preinjection to 1-week postinjection changes in pain scores were analyzed by ANCOVA. The primary source of variation in these changes in pain was consensus injection placement (intraarticular or periarticular). Preinjection pain, patient age and sex, time of the academic year when the injection was performed, and the underlying indication for the injection were considered concomitant sources (i.e., adjustment factors) of pain score change variation. With regard to hypothesis testing, for each injection placement group (intraarticular and periarticular), linear contrasts of the least square means without concomitant variable adjustment were used to test the null hypothesis that the mean 1-week postinjection change in pain is equal to zero. A two-sided  $p \leq 0.05$  decision rule was used as the null hypothesis rejection rule for the within injection placement group comparisons. A linear contrast of the least square means with concomitant variable adjustment was used to compare the



**Fig. 3**—34-year-old woman with pain in left hip and low back. Anteroposterior radiograph shows posterior sacral network (PSN) of nerves is primary innervation of sacroiliac joint. PSN is formed predominantly by lateral branches of S1–S3, which pass along inferoposterior aspect of sacroiliac joint. Schematic superimposed on radiograph shows that PSN is in same location as periarticular sacroiliac joint injections performed in this study. PSN is also intimately associated with long posterior sacroiliac ligament.

1-week postinjection changes in pain between the intraarticular and periarticular injection placements. Two-sided  $p \leq 0.05$  decision rules were used as the null hypothesis rejection rule for these comparisons. Chi-square analysis was used to evaluate the percentage of injections both immediately and 1 week after injection that had either 50% or 75% pain reduction.

**Analysis of fluoroscopy time**—The fluoroscopy time data were analyzed by ANCOVA. Because of the positive skewness of the fluoroscopy time measurement distributions, the fluoroscopy times were analyzed on the base 10 logarithmic scale. With regard to the ANCOVA model specification, injection placement (intraarticular or periarticular) was the primary source of variability in fluoroscopy time that was examined. The radiologist performing the procedure (musculoskeletal fellow or musculoskeletal fellow and attending radiologist) was considered a concomitant source of fluoroscopy time variability. Linear contrast of the linear mixed effects least square mean was used to test the null hypothesis that the geometric mean fluoroscopy time was the same for the intraarticular and periarticular injection placements. A  $p < 0.05$  decision rule was used as the null hypothesis rejection criterion. The

geometric mean is a location parameter—similar to the mean and median of the distribution—computed by antilog base 10 transformation of the mean of the logarithmic transformed distribution.

*Statistical software*—The statistical software package SAS (version 9.4, SAS Institute) was used to conduct the statistical analyses.

**Results**

*Patient Characteristics*

One hundred thirteen injections were performed on 99 patients (65 women, 34 men; mean age, 59.4 years; range, 25–92 years) (Table 1). Twelve patients (10 women, two men) underwent multiple injections; 11 of these patients received two injections, and one patient received four injections. For the patients with multiple injections, the median and mean times between injections were 132 and 198 days (range, 43–553 days). There were 58 right and 55 left sacroiliac joint injections. The International Classification of Diseases, 9th revision (ICD-9), codes for the injections were low back pain for 34% of injections ( $n = 38$ ), sacral disorder for 34% ( $n = 38$ ), sacroiliitis for 17% ( $n = 19$ ), pelvic pain for 14% ( $n = 16$ ), and other for 2% ( $n = 2$ ). A distinct ICD-9 code for SIJS does not exist. The orthopedic spine service ordered 86% ( $n = 97$ ) of the procedures, followed by primary care with 12% ( $n = 14$ ), and rheumatology and physical medicine with 1% ( $n = 1$ ) each.

*Interobserver Agreement*

The interobserver agreement between the two musculoskeletal radiologists was assessed with the kappa statistic. The result ( $\kappa = 0.74$ ; 95% CI, 0.61–0.86;  $p < 0.05$ ) indicated substantial interobserver agreement. The two readers disagreed about 13% (15/113) of the injections; 12 injections were subsequently classified as periarticular and three as intraarticular. After the consensus interpretation, 49% (55/113) of injections were classified as intraarticular and 51% (58/113) as periarticular. Twenty-nine of the injections had both intraarticular and periarticular contrast patterns, which constituted 53% (29/55) of the total intraarticular injections. Most of these cases of both intraarticular and periarticular contrast patterns had only minimal contrast agent in a periarticular location.

*Preinjection Pain*

The mean preinjection pain scores were 6.1 (95% CI, 5.6–6.7) for the periarticular group and 6.0 (95% CI, 5.4–6.6) for the intraarticular group ( $p = 0.91$ ).

**TABLE 1: Total Number of Sacroiliac Joint Injections Included in the Study and Reasons for Exclusion of the Others**

No. of Injections	Starting No.	No. Excluded	No. Remaining
Total performed over 4-y period	324		
Excluded			
Lack of 1-wk postinjection pain score		139	185
Bilateral injections		30	155
Different volume of anesthetic used		26	129
Different dose of steroid used		15	114
No fluoroscopic image available		1	113
Included in study			113

**TABLE 2: Linear Mixed Model Unadjusted Estimates of Mean Change in Pain Immediately and 1 Week After Intraarticular and Periarticular Injections**

Time After Injection	Intraarticular			Periarticular		
	Value	95% CI	$p$	Value	95% CI	$p$
Immediate (5–10 min)	−4.4	−5.1 to −3.7	$\leq 0.001$	−4.2	−4.9 to −3.5	$\leq 0.001$
1 week	−1.9	−2.6 to −1.3	$\leq 0.001$	−1.9	−2.5 to −1.3	$\leq 0.001$

Note—Estimates not adjusted for preprocedural pain, age, sex, time of year, or reason for examination.

**TABLE 3: Results of Linear Mixed Model Analysis of Pain Reduction Between Intraarticular and Periarticular Sacroiliac Joint Injections**

Time After Injection	Mean Difference		Concomitant Variable Adjusted $p$
	Value	95% CI	
Immediate (5–10 min)	0.37	−0.36 to 1.11	0.32
1 week	0.06	−0.79 to 0.91	0.89

Note—Analysis was controlled for several concomitant variables: preprocedural pain, age, sex, time of year, and indication for injection. The degree of change in pain score was not significantly different between intraarticular and periarticular injections at either the immediate or the 1-week time points.

*Preprocedure to Postprocedure Changes in Pain*

The mean pain score immediately after the intraarticular injections was 1.6 and that after the periarticular injections was 2.0. The mean reduction in pain score immediately after the procedure was 4.2 units (95% CI, 3.5–4.9 units;  $p < 0.001$ ) for the periarticular group and 4.4 units (95% CI, 3.7–5.1 units;  $p < 0.001$ ) for the intraarticular group. Immediate changes in pain were not dependent on the dose of bupivacaine ( $p = 0.53$ ). The mean 1-week postinjection pain score for the intraarticular injections was 4.1 and for the periarticular injections was 4.2. The mean reductions in pain scores 1 week after injection were 1.9 units (95% CI, 1.3–2.5;  $p < 0.001$ ) for the periarticular group and 1.9 units (95% CI, 1.3–2.6, units;  $p < 0.001$ ) for the intraarticular group (Table 2).

With regard to the set of concomitant variables, there was a significant association be-

tween postinjection pain relief and preinjection pain score; higher preinjection pain scores were associated with greater reductions in immediate ( $p < 0.001$ ) and 1-week ( $p = 0.004$ ) pain scores. Older patients reported greater pain relief immediately after injection ( $p < 0.001$ ), but this association was not present 1 week later ( $p = 0.246$ ). There was no association between the indication for the injection and either the immediate changes in pain ( $p = 0.247$ ) or the changes 1 week after injection ( $p = 0.636$ ). Likewise, sex did not affect the degree of pain relief reported either immediately ( $p = 0.277$ ) or 1 week ( $p = 0.226$ ) after injection.

After adjustment of concomitant variables for preinjection pain score, age, sex, time of year of the injection, and indication for the injection, there was no significant difference in the immediate pain relief provided by the intraarticular and the periarticular injections

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(difference in concomitant variable adjusted mean change in pain, 0.37; 95% CI, -0.36 to 1.11;  $p = 0.319$ ). Similarly, after adjustment for preinjection pain score, age, sex, time of year of the injection, and indication for injection, no significant difference was found in 1-week postinjection pain relief provided by the intraarticular and the periarticular injections (difference in concomitant variable adjusted change in pain, 0.06; 95% CI, -0.79 to 0.91;  $p = 0.888$ ) (Table 3).

The postinjection pain scores were also categorized as to number of patients who had either 50% or 75% reduction in pain score. Chi-square analysis showed no statistically significant difference between intraarticular and periarticular injections (Table 4).

### Fluoroscopy Time Analysis

The mean fluoroscopy time was 42.2 seconds for the intraarticular group and 60.5 seconds for the periarticular group ( $p = 0.32$ ). The geometric mean fluoroscopy times were 29.1 seconds (95% CI, 22.6–37.6 seconds; range, 3–187 seconds) for the intraarticular group and 39.8 seconds (95% CI, 31.1–51.0 seconds; range, 4–341 seconds) for the periarticular group ( $p = 0.11$ ).

### Discussion

Despite the findings of a 2012 systematic review that the evidence is limited for using either intraarticular or periarticular injections to manage SIJS-related pain [19], the number of sacroiliac joint interventions performed in the United States has increased. A lack of understanding of the precise cause of SIJS has limited the usefulness of results of previous studies evaluating SIJS, making it more difficult to select patients for whom treatment is most appropriate solely on the basis of history and physical examination findings [20]. Nevertheless, our retrospective study evaluating patients referred for sacroiliac joint pain showed that periarticular and intraarticular sacroiliac joint injections resulted in similar pain relief.

Periarticular and intraarticular steroid and anesthetic injections may produce similar pain relief because of the underlying anatomy. The innervation pattern of the sacroiliac joint is predominantly from the lateral branches of S1–S3, which form a sacral neural network along the posterior aspect of the sacroiliac joint (Fig. 3) with the lateral branches of L4 and L5 also probably contributing to the innervation [21, 22]. There is little, if any, anterior contribution to sacroiliac joint innervation

**TABLE 4: Percentage of Patients in the Intraarticular and Periarticular Injection Groups With 50% or 75% Pain Relief Compared With Preprocedure Pain Score**

Reduction in Pain After Injection	Immediately After Injection			1 Wk After Injection		
	Intraarticular (n=55)	Periarticular (n=58)	p	Intraarticular (n=55)	Periarticular (n=58)	p
≥ 50%	78 (43)	72 (42)	0.48	40 (22)	29 (17)	0.13
≥ 75%	64 (35)	50 (29)	0.24	22 (12)	10 (6)	0.53

Note—Values in parentheses are numbers of injections.

[23]. Ligamentous structures along the posterior sacroiliac joint have also been implicated as potential pain generators, particularly the long posterior sacroiliac ligament, which courses vertically along the sacroiliac joint and is intimately associated with the posterior sacral nerve network [24]. Although most radiologists perform sacral lateral branch blocks and radiofrequency ablation near the neural foramina, some prefer a more lateral approach closer to the sacroiliac joint targeting the more distal branches of the posterior sacral network [21]. We target the inferior 1 cm of the sacroiliac joint for our injections; thus, any periarticular injection would be in the region of the posterior sacral nerve network and long posterior sacroiliac ligament. In our study the 1-mL injected volume in the inferior sacroiliac joint location would not be expected to spread superiorly to the level of lumbar nerve roots or to the lumbosacral epidural space. Although periarticular injections appear to benefit some patients with SIJS, the precise target for a periarticular injection remains unclear. Dreyfuss et al. [25, 26] suggested that injections at multiple depths may be necessary because of the variable course of the nerves [6].

We report a 49% success rate for intraarticular placement under fluoroscopic guidance. One factor contributing to our lower intraarticular percentage, compared with the greater than 90% intraarticular rate reported in the literature, is that we classified injections as being intraarticular only when contrast medium was clearly present within the sacroiliac joint [9, 10]. A contrast pattern that was not clearly intraarticular was considered periarticular, possibly resulting in an underestimation of true intraarticular injections. Although deciphering intraarticular from periarticular injections was difficult in some cases, our low rate of interobserver disagreement (13%) and high kappa value (0.74) confirm the high likelihood that the reviewers identified intraarticular contrast medium when present.

The included procedures were performed by 30 different providers with the fellows supervised by six musculoskeletal faculty members. Philosophical differences among musculoskeletal faculty members also contributed to the lower intraarticular percentage. Some believed that intraarticular placement was required for maximal benefit. Others believed that periarticular injections were as effective as intraarticular injections and that repeated attempts to access the sacroiliac joint may be counterproductive. These varying opinions resulted in a spectrum among faculty as to the length of time spent trying to obtain intraarticular access and the intraarticular success rate of each provider. In addition, many of the procedures were performed by musculoskeletal radiology fellows with the general instruction by some faculty that performing a periarticular injection was permissible if intraarticular access could not be obtained. This instruction may have resulted in a lower intraarticular rate.

The effectiveness of periarticular sacroiliac joint injection has been compared with that of intraarticular injection in several studies. Borowsky and Fagen [18] evaluated 120 patients. They reported that 3 weeks after injection, patients receiving simultaneous intraarticular and periarticular steroid injections of 2 mL bupivacaine and 40 mg methylprednisolone near the posterior superior iliac spine fared better—42.5% (34/80) versus 27.5% (11/40) positive response rate—than patients who received only an intraarticular injection. Similarly, after evaluating 50 patients, Murakami et al. [16] reported that periarticular injections of 1–2.5 mL lidocaine 1% were more effective—100% (25/25) versus 36% (9/25)—in improving the activities of daily living score than was intraarticular injection alone. Unlike those investigators, we directly compared intraarticular and periarticular injections. We also used a different periarticular steroid and anesthetic injection location (inferior sacroiliac joint

in our study as opposed to posterior superior iliac spine in the study by Borowsky and Fagen.) and assessed pain scores as opposed to activities of daily living, as in the study by Murakami et al. The findings and methods in our study were similar to those in an ultrasound study by Hartung et al. [27], who had a 40% intraarticular success rate and no clinically significant difference in pain relief 24 hours or 4 weeks after injection; however, that study was much smaller with only 20 injections. We included a larger number of injections than have most previous studies, the largest of which was that of Borowsky and Fagen, which included 120 patients.

Although periarticular and intraarticular injections may result in similar pain relief, intraarticular injections have been extensively used to verify a diagnosis of SIJS and to guide more advanced therapies, such as radiofrequency ablation [6, 22]. Other investigators have used periarticular lateral branch block to select patients for radiofrequency denervation; however, neither intraarticular sacroiliac joint injections nor lateral branch blocks have been found to be successful predictors of which patients' conditions will improve with denervation treatment [28–30]. Sacroiliac joint fusion and débridement of the posterior sacroiliac soft tissues and nerves have been suggested as possible therapies. The success rate of these interventions is approximately 50% [31].

Longer fluoroscopy time was used to perform the periarticular injections than the intraarticular injections. This is presumably related to multiple attempts occasionally made to access the sacroiliac joint before the operating musculoskeletal radiologist decided to administer the steroid-anesthetic mixture in a periarticular location. Even though many radiologists perform sacroiliac joint injections under CT guidance [13–15], we prefer fluoroscopic guidance because CT guidance can increase the use of scarce resources and increase the radiation dose. CT- and fluoroscopy-guided sacroiliac injections have the same billing code (CPT 27096), and the charge is the same for both modalities. However, when the expense of the imaging suite and equipment is considered, the cost to the institution is likely higher for performing the procedure with CT guidance [32]. Many institutions have limited CT scanner availability for injection procedures given the high rate of use of CT for diagnostic imaging and other, more complex interventional procedures. In contrast, fluoroscopy

may be more readily available at many institutions. The radiation dose associated with CT guidance can be as high as 76.67 mGy · cm with standard technique and a preprocedural topogram, whereas the radiation dose with fluoroscopic guidance is reported to be 3.73 mGy · cm on average [2, 33]. Artner et al. [33] described a low-dose protocol for CT-guided sacroiliac injections, although it remains unclear whether such a protocol is widely used throughout the imaging community. The success rate of intraarticular access is probably higher with CT than the 49% rate found with fluoroscopy among the procedures in this study. This may be of lesser importance, however, given that our patients had similar degrees of pain relief whether the injection was in an intraarticular or a periarticular location.

Our findings suggest that inability to access the joint under fluoroscopic guidance with subsequent performance of periarticular injection does not result in any difference in pain relief. Thus, modality choice may be based on factors aside from success rate of intraarticular access. Injecting into the sacroiliac joint without imaging guidance, using only anatomic landmarks, is not recommended because of the risk of injection near a lumbar nerve root and into the epidural space, sacral foramina, or even the pelvis [11].

Our study had limitations. First, whether the injection was intraarticular or periarticular was based on retrospective interpretation of available fluoroscopic images. Second, most patients were considered to have SIJS by their referring clinician; however, there is no ICD-9 code for SIJS, and patient charts were not retrospectively reviewed as part of this study, leaving some uncertainty as to the diagnosis. Third, some patients did not respond to 1-week telephone calls for assessment of pain score, and these patients were excluded from the study, potentially resulting in sampling bias. Fourth, the assumption that intraarticular injections remain confined solely to the sacroiliac joint may not be accurate. Fortin et al. [34] reported CT evidence of extraarticular contrast extravasation in 61% of patients after fluoroscopically confirmed intraarticular injections. The contrast agent extravasated most frequently into the dorsal subligamentous tissues and sometimes extended to the neural structures at the level of the dorsal sacral foramina, L5 nerve root, or anteriorly to the lumbosacral plexus. Thus, discontinuity of the posterior joint capsule as reported by several authors may po-

tentially blur the line between intraarticular and periarticular injections [23, 34]. Finally, the age-related phenomenon of fibrous ankylosis across the sacroiliac joint could result in underfilling of contrast medium and medication along any residual joint space and extravasation of injectant into the surrounding soft tissues [35, 36]. Visualization of intraarticular contrast flow in elderly patients with fibrous ankylosis may be difficult given the potential lack of a normal joint space.

In summary, our results indicate that both intraarticular and periarticular sacroiliac joint injections result in clinically significant reduction in pain both immediately and 1 week after injection and that there is no significant difference in the degree of pain relief between the two groups. Our results suggest that fluoroscopic guidance is an acceptable method for performing sacroiliac joint injections in most patients. Although the findings of this study were that both intraarticular and periarticular injections were beneficial for pain relief, it remains unclear whether the effect of these two injection locations could be additive such that injecting in both locations would be advantageous for pain relief. The ideal location or depth for periarticular injection is an additional potential topic for further study. It also remains unclear whether periarticular injections can be used to select patients for sacroiliac radiofrequency ablation, which has traditionally been done solely with intraarticular injections. Perhaps in these cases, CT will remain the modality of choice for the time being and fluoroscopic guidance will be reserved for patients who need pain relief therapy.

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