

INTERVENTIONAL PAIN & SPINE MEDICINE SECTION

Consensus practice guidelines on sacroiliac joint complex pain from a multispecialty, international working group

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Abstract

Background: The past two decades have witnessed tremendous growth in the appreciation and treatment of sacroiliac joint (SIJ) complex pain, including anatomical dissections that shed light on innervation, an appreciation for the contribution of extra-articular components to SIJ complex pain, the advent of radiofrequency ablation (RFA) and a host of minimally invasive surgical techniques. Yet, there is no standardization on diagnosis and treatment paradigms.

Methods: In February 2023, the Boards of Directors for the American Academy of Pain Medicine (AAPM) and American Society of Regional Anesthesia & Pain Medicine (ASRA-PM) approved the development of multispecialty guidelines on SIJ complex pain. Thirty partner organizations with clinical and scientific interests in SIJ complex pain were identified, and formal letters of request-for-participation were sent to each, along with a request for nominees to serve on the committee. Twenty five organizations agreed to participate in addition to the Departments of Defense and Veterans Affairs. A steering committee developed 21 questions, which spanned criteria for diagnosis, non-interventional and interventional treatments including surgery, technical parameters on how to optimize results, and what constitutes positive outcomes. Questions were methodically assigned to specialized modules comprising 4-5 members with complementary expertise, who collaborated with the Subcommittee Lead and one of three Committee Chairs to develop preliminary drafts. Following thorough revisions, these drafts were subsequently submitted to the full committee for comprehensive review. A modified Delphi method was used in which the answers to questions were sent to the committee *en bloc* and comments were returned in a non-blinded fashion to the Chairs, who incorporated the comments and sent out revised versions until consensus was achieved. During a committee meeting before commencement, it was agreed that recommendations would be noted when there was >50% agreement among committee members, but that a formal recommendation would require ≥75% consensus.

Results: Twenty-one organizations formally endorsed the guidelines. The American Society of Anesthesiologists, and American Academy of Physical Medicine & Rehabilitation, and the North American Spine Society affirmed the benefit of the guidelines but did not officially endorse them. The American Academy of Neurology declined to affirm the benefit of the guidelines citing "lack of relevance to their membership." Per policies, while the Departments of Defense and Veterans Affairs did not formally review the guidelines for endorsement, their representatives approved them. In addition to being endorsed or the benefit affirmed by all voting organizations, complete consensus from committee members was obtained on all 21 questions. On 2 recommendations, there were dissensions from 3 societies who thought that selecting patients for sacral lateral branch RFA and minimally invasive fusion should be based on ≥75% relief from 2 blocks instead of at least 50% relief from a single block before RFA, and greater than 50% pain relief with documented functional improvement after a single block before fusion. One additional society (Latin American Society of Regional Anesthesia) abstained on the statement that the evidence is stronger for extra-articular than intra-articular injections. The committee found that a battery of physical exam tests has reasonable sensitivity, but lower specificity, for identifying intra-articular but not extra-articular pathology, with negative tests having greater predictive value than positive ones. Intra-articular injections have diagnostic validity for SIJ intra-articular, but not extra-articular pain. There is unclear or negative evidence for imaging. The prevalence rates of intra-articular and extra-articular pathology are comparable, with both intra- and extra-articular steroid injections providing at least 4 weeks of relief in well-selected patients. However, the evidence is slightly stronger for extra-articular corticosteroid injections to provide short-term relief. The evidence base for non-interventional therapies is indirect, extrapolated mostly from low back pain studies. There is weak evidence supporting dextrose-based prolotherapy and platelet-rich plasma to provide at least 3 months of pain relief. There is strong evidence for sacral lateral branch RFA to provide relief for at least 6 months in individuals with extra-articular pathology, with face validity and indirect evidence from randomized trials supporting sacral lateral branch blocks as a prognostic tool. There is stronger evidence for larger lesions or more aggressive lesioning strategies than for less stringent techniques. There is weak evidence to support non-steroidal anti-inflammatory drugs to prevent neuritis after RFA, and in most cases anticoagulation does not require cessation in the periprocedural period. With an aggressive lesioning strategy, sensory stimulation provides minimal therapeutic benefit, with weak, extrapolated evidence that motor stimulation can provide safety benefit. The cutoff to designate diagnostic or prognostic blocks as positive is most commonly set at 50%, with higher values not shown to improve outcomes for more definitive procedures; for therapeutic treatment outcomes, the evidence supports a lower threshold of ≥30% pain relief or meaningful benefit on non-pain outcomes (eg, opioid cessation) for designation of a positive response. For carefully selected patients with intra-articular SIJ complex pain based on controlled blocks who have failed conservative therapies, there is weak or very weak evidence that minimally invasive SIJ fusion can provide benefit for at least one year.

Conclusions: SIJ complex pain remains an underappreciated source of chronic low back pain, affecting between 15% and 30% of patients with axial pain predominantly below L5. Answers to many questions were limited by low-quality evidence, indicating the need for better research. SIJ complex pain is a multifarious condition (ie, pain can be from different portions of both the intra- and extra-articular components of the joint) for which an interdisciplinary, multimodal treatment plan can optimize treatment outcomes.

Keywords: sacroiliac joint; radiofrequency; lateral branch; minimally-invasive fusion; corticosteroid injection; extra-articular; provocative test.

Introduction

The sacroiliac joint (SIJ) complex is a multiplex structure. The SIJ itself is composed of the lateral parts of the sacrum and medial portions of the iliac bones, which form the joint space enclosed by a fibrous capsule and synovial lining. The superior and dorsal portions of the joint itself are amphiarthrodial with the sacral and iliac surfaces separated by

fibrocartilage. The small antero-inferior portion of the joint is diarthrodial, more mobile, and contains hyaline cartilage on the bony articular surfaces. The SIJ is supported by an extensive network of posterior and anterior ligaments, which in combination with the joint itself, make up the SIJ complex, all of which contain nociceptors and can serve as pain generators.¹⁻⁴ Given this complexity, sacroiliac joint (SIJ) pain, or

more fittingly SIJ complex pain, remains one of the most challenging etiologies of axial low back pain (LBP) to understand and manage.

Data on the prevalence of SIJ complex pain vary widely, as there is no reference standard besides diagnostic injections, which are subject to false-positive and false-negative results. Nearly all diagnostic epidemiological studies evaluated intra-articular (IA) injections, which are associated with inherent diagnostic limitations related to capsular defects, structural communication with the S1 foramen, and anatomical variations presenting procedural challenges for consistent intra-articular access.⁵ The prevalence rate of extra-articular (EA) pathology is probably similar, perhaps even higher in younger individuals with post-traumatic pain.^{6,7} Prevalence data are further confounded by the thresholds used to classify diagnostic injections as positive or negative, with more stringent criteria (ie, multiple injections and higher cutoff thresholds) being associated with a lower prevalence (positive) rate.⁸ This conceptual framework categorizes SIJ complex pain as a dichotomous variable, whereas in clinical practice, pain originating from spinal structures may be more accurately conceptualized as existing on a continuum due to the presence of multiple concurrent pain generators. Similarly, prevalence rates derived from diagnostic injections are contingent upon clinical selection criteria, with the majority of studies employing diagnostic injections selecting patients based on suggestive clinical presentations (eg, positive provocative maneuvers or mechanical pain localized to the SIJ complex); more rigorous selection criteria invariably elevate the positive rate of diagnostic injections, resulting in higher prevalence estimates. In well-selected populations with mechanical back or buttock pain predominantly below L5 spinous process, SIJ complex pain appears to account for the index pain in about 15%-30% of patients.^{1,8}

Difficulties in diagnosis and discrepancies in prevalence rates have translated to a lack of standardization among clinical trials evaluating treatment interventions. There are very few placebo-controlled trials evaluating SIJ injections, with only one small trial ($n = 10$) evaluating IA injections and two small studies with less than 25 people each, by the same group of investigators, evaluating EA injections, with the longest study following blinded patients for two months.⁹⁻¹¹ There is only one large study that compared EA to IA injections in a randomized fashion,⁶ widespread disparities in injectate composition and technique in clinical studies, and no randomized-controlled trial(s) (RCT) investigating an IA corticosteroid injection that prescreened patients with diagnostic injections. For joint injections with other substances such as platelet rich plasma and hyaluronic acid, the extant studies are of poor quality and also contain widely divergent techniques, selection criteria and outcome measures.^{12,13}

The strongest evidence may be for radiofrequency ablation (RFA), which has shown superiority over sham RFA, standard of care, exercise therapy and IA corticosteroids. However, similar to joint injections, the results of these studies vary considerably, and there is no consensus on patient selection, technique and nerves targeted, or outcome measures.¹⁴⁻¹⁸ Clinical studies have evaluated pulsed radiofrequency, internally-cooled RFA (icRFA), bipolar RFA, conventional RFA (RFA) with a wide variety of methods, and combination RFA (eg, bipolar and unipolar or internally-cooled and conventional) strategies.¹⁷ In addition to branches of the dorsal rami, RFA has been performed inside of the

joint and in the posterior ligaments.^{19,20} Studies have used both IA and EA injections as well as sacral lateral branch injections (SLBBs) in isolation to select patients, with one case report describing the performance of SLBB in isolation before icRFA in a cancer patient.²¹⁻²⁵ Radiofrequency ablation studies have targeted nerves ranging from the L4 dorsal ramus to the S4 lateral branch, in multiple permutations including selecting nerve levels based only on sensory stimulation.^{17,21,25} These studies have used a variety of different cutoff thresholds ranging from ≥ 2 -points on an 11-point numerical rating (pain) scale (NRS) to $\geq 80\%$ relief for designating screening injections as positive,^{21,22,27} with a similar range from ≥ 2 -points or 30% to $>70\%$ for treatment outcomes.^{6,11,14,16,26,27}

There are discrepancies in the interpretation of the literature as well, with some reviews touting positive evidence for injections and RFA, while others have been more skeptical in their analysis.^{17,26} Collectively, this lack of standardization and consensus regarding procedural performance, evidence levels, what constitutes SIJ complex pain, which affects prevalence reports and selection for treatment, and even how to define procedural success, highlights the need for multispecialty guidelines. The charge of this committee was therefore to synthesize the evidence to develop pragmatic guidelines that can be used to inform clinical care with an emphasis on optimizing patient outcomes; identify evidence gaps that can be used to steer research; serve as a foundation for standardizing care of the patient with SIJ complex pain; and to assist regulators with developing authorization standards and clinical practice pathways.

Methods

The decision to convene a multispecialty and multinational Sacroiliac Joint Complex Pain Working Group (SIJ-WG) to develop SIJ complex intervention guidelines was approved by the American Academy of Pain Medicine (AAPM) and American Society of Regional Anesthesia and Pain Medicine (ASRA-PM) in July 2023. Thirty stakeholder academies and societies, as well as other organizations (eg, U.S. Departments of Defense and Veteran Affairs) with a vested interest in SIJ complex interventions were identified, and formal request-for-participation and member nomination letters were sent to those organizations in August 2023. Twenty-seven organizations agreed to participate, and three invited professional societies declined to participate (Lumbar Spine Research Society, LSRS; American Society for Interventional Pain Physicians, ASIPP; and American Society of Spine Radiologists, ASSR). Organizations were asked to consider a candidate's expertise, clinical experience, academic interests, and diversity in their nomination process. Each society nominated a single representative member (See [Appendix SA](#) for a list of participating academies, societies, and respective representatives). For the Departments of Defense and Veterans Affairs representatives, the Chairperson of the Department of Anesthesia at the Uniformed Services University of the Health Sciences and Director of the VA National Pain Management Program nominated individuals.

The SIJ-WG was charged with preparing guidelines on the use of IA SIJ injections, EA SIJ injections, SLBBs, sacral lateral branch radiofrequency ablation (SLBRFA), cryoablation, SIJ fusion, as well as conservative therapy that spanned the entire spectrum of care to include patient selection,

optimizing accuracy, interpreting results, and risk mitigation. Questions and formats were developed by the Working Group Committee Co-Chairs (Z.L.M., R.W.H., and S.P.C.) during iterative meetings. These questions and formats were refined based on feedback by the Executive Committee (D.T., A.C., L.K., and J.V.Z.). Once unanimous consensus was achieved by the Working Group Committee Co-Chairs and Executive Committee, input was gathered from the full Working Group Committee and further refined during the initial video-conference call. The resulting final unanimous consensus version was comprised of 21 distinct questions to be addressed within the guidelines.

The Working Group Committee was then divided into subcommittees composed of four to five members responsible for developing the answer(s) to each of the final 21 questions. One or two persons were designated as the “leads” responsible for task delegation. Once a subcommittee came to unanimous consensus on the answer to their assigned question, including the grade of evidence associated with relevant statements and recommendations, the Working Group Co-Chairs assisted with editing and provided feedback regarding content. Through iterative discussion of the supporting evidence, unanimous consensus was achieved amongst the subcommittee members and the Working Group Co-Chairs with regard to the content of the answer and the corresponding statements and recommendations. Next, the subcommittee’s work product was sent to the entire Working Group Committee for open-forum comments and revisions. A modified Delphi method was used to tabulate comments, incorporate changes, and converge the answers toward consensus over rounds of teleconference or electronic correspondence. At the initial conference call, the Working Group Committee decided that >50% panel agreement was sufficient to report a statement or recommendation, but ≥75% agreement was required for consensus, consistent with the Lumbar Facet Intervention and Cervical Facet Intervention Guidelines.^{28,29} After the Working Group Committee completed a draft of the guidelines, the document was sent to participating organizations’ Boards of Directors for approval, with only minor changes permitted at this stage. For organizational agreement, the Working Group Committee agreed that consensus required at least ≥75% agreement, consistent with the Lumbar Facet Intervention and Cervical Facet Intervention Guidelines.^{28,29} At both the committee and organizational levels, dissensions and abstentions were tabulated for each question.

Search engines used during composition of the various sections included PubMed, Embase, Medline, Google Scholar, SCOPUS, and Cochrane Database of Systematic Reviews, in addition to examination of the reference sections of all manuscripts. Additional peer-reviewed articles were identified by searching in topically-related new journals that are not yet indexed by Science Citation Index or found within PubMed. There were no limitations on language or types of articles used to develop the guidelines, such that experimental studies were considered for the sections on physical exam, anatomy and technical parameters, and case reports were considered for sections pertaining to risk mitigation and complications. Keywords used to address guideline topics were tailored to individual questions and included, for example, “sacroiliac”, “lateral branch”, “radiofrequency”, “pulsed radiofrequency”, “denervation”, “ablation”, and “arthritis” for questions pertaining to radiofrequency. Searches were comprehensive but a formal systematic review was outside of the scope of the

Table 1. Levels of evidence for guidelines and recommendations.

Certainty of net benefit	Magnitude of net benefit			
	Substantial	Moderate	Small	Zero/negative
High	A	B	C	D
Moderate	B	B	C	D
Low	Insufficient			

charter. Literature searches were performed through March 2025 to capture topical studies published following initial searches. In accordance with the Lumbar Facet Intervention and Cervical Facet Intervention guidelines,^{28,29} conclusions for each topic were graded on a scale from A to D, or as insufficient, according to modified US Preventative Services Task Force grading of evidence guidelines, with the level of certainty rated as high, medium or low (Tables 1-3).³⁰ The guidelines followed the recommended domains of the Appraisal of Guidelines for Research & Evaluation II (AGREE-II) checklist (see Appendix SB).³¹

This system, which has been modified for use in interventional pain and spine medicine guidelines drafted by the ASRA-PM, AAPM, American Society of Anesthesiologists (ASA), ASIPP, and the International Neuromodulation Society (INS),³²⁻³⁵ was chosen over others because of its flexibility,^{36,37} which permits high-grade recommendations in the absence of high-quality level I studies, which are challenging to conduct for invasive procedures.³⁸

Epidemiology

Q1. What is the prevalence of sacroiliac joint complex pain in individuals with chronic low back pain?

SIJ complex pain is commonly estimated to affect approximately 15%-30% of individuals with chronic, non-radicular LBP predominantly below L5.¹ In individuals with suspected SIJ complex pain based on history and physical exam, the prevalence of true SIJ complex pain is similar, estimated at 20%-30% based on the studies using diagnostic injections.⁸ Prevalence increases with older age, as chronic LBP is more common among older adults.³⁹ Radiologic imaging has been used to evaluate the SIJs; although it has high specificity, it has low sensitivity in identifying individuals with non-inflammatory, mechanical SIJ complex pain, making it a poor screening tool (see Question 3).⁴⁰ Despite their limitations, diagnostic injections with local anesthetic are currently the reference standard for estimating the true prevalence rate of SIJ complex pain.^{5,41}

It is important to note that while diagnostic IA injections are the current reference standard, this method is imperfect due to communication of the SIJ with the S1 foramen, the potential for dorsal leakage of injectate from the joint, and the presence of anterior capsular defects in a portion of individuals, which can result in anterior leakage of injectate.^{5,42,43} Therefore, a technically precise IA SIJ injection can still result in off-target anesthetic spread, with the potential for a false-positive test outcome. Recognizing these inherent limitations, research employing single IA SIJ injections suggests the prevalence of SIJ pain to be between 29% and 63%, whereas studies using two injections have recorded rates ranging from 10%- to 33%. However, these rates reflect the prevalence of SIJ pain in individuals already suspected to have this diagnosis

Table 2. What the grades of evidence mean and suggestions for practice.

Grade	Definition	Suggestions for practice
A	The committee recommends this treatment, test or strategy to improve outcomes. There is high certainty that the net benefit is substantial.	Offer or provide this service
B	The committee recommends this treatment, test or strategy to improve outcomes. There is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial.	Offer or provide this service
C	The committee recommends selectively offering or providing this treatment, test or strategy to improve outcomes to individual patients based on professional judgment and patient preferences. There is at least moderate certainty that the net benefit is small.	Offer or provide this service for selected patients depending on individual circumstances
D	The committee recommends against the test or intervention. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits.	Discourage the use of this service
I	The committee concludes that the current evidence is insufficient to assess the balance of benefits and harms of the intervention. Evidence is lacking, of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.	Read the clinical considerations section of the recommendation. If the treatment or service is offered, patients should understand the uncertainty about the balance of benefits and harms

Table 3. Levels of certainty regarding net benefit.^a

Level of certainty	Description
High	The available evidence usually includes consistent results from well-designed, well-conducted studies in representative populations with suspected SIJ complex pain and/or compelling evidence from non-randomized studies. The studies assess the effects of the treatment, test, or other intervention on treatment or other relevant outcomes. The conclusion is therefore unlikely to be strongly affected by the results of future studies.
Moderate	The available evidence is sufficient to determine the effects of the intervention on outcomes, but confidence in the estimate is constrained by such factors as: • The number, size, or quality of individual studies; • Inconsistency of findings across individual studies; • Limited generalizability of findings to individuals with suspected SIJ complex pain; • High likelihood of bias; • Lack of coherence in the chain of evidence. As more information becomes available, the magnitude or direction of the observed effect could change, and that change may be large enough to alter the conclusion.
Low	The available evidence is insufficient to assess effects on treatment and other outcomes of interest. Evidence is insufficient because of: • The limited number or size of studies; • Important flaws in study design or methods; • Inconsistency of findings across individual studies; • Gaps in the chain of evidence; • High likelihood of bias; • Findings not generalizable to individuals with suspected SIJ complex pain; • Lack of information on important outcome measures. More information may allow estimation of effects on treatment outcomes.

^a Note, the levels of certainty described in the definitions for the grading of evidence in Table 2 refer solely to the magnitude of benefit attributed to the intervention, while the levels of certainty in Table 3 consider the basis of evidence for the recommendation and the likelihood the recommendation will be affected by future studies. Whereas the two are related, the grading of evidence and rating of certainty were considered separately.

based on history and physical examination that included positive SIJ provocation tests (Patrick's Gaenslen's, Yeoman's, distraction, compression, sacral pressure, and sacral thrust tests), and do not estimate the prevalence of SIJ pain in the overall population of patients with LBP. Furthermore, relaxing the criteria from $\geq 75\%$ to $\geq 50\%$ pain relief increases the prevalence estimates. The addition of corticosteroids to diagnostic injections also significantly increases the reported prevalence, with one systematic review finding that when corticosteroids are added to local anesthetic, the positive rate increased from 35% to 49% using a 75% index pain relief threshold.⁸ This is likely due mostly to greater potential for off-target spread of injectate, as adding corticosteroid to the IA injectate increases the total volume and therefore spread outside of the joint space itself though in some cases systemically absorbed

steroids can provide quick pain relief, and local steroids can also enhance the effects of local anesthetic. In studies using sedation, the estimated prevalence was higher, which is likely the result of a higher false-positive rate due to analgesia, anxiolysis, and muscle relaxation.⁴⁴

The prevalence of SIJ pain in the presence of concomitant pathology is less well-defined. In a 2020 study of individuals with lumbar disc herniations, the prevalence of SIJ dysfunction was estimated to be 33% based on three or more positive provocation tests, suggesting that SIJ pain may be present in one-third of individuals with lumbar radicular pain and MRI findings consistent with disc herniation.⁴⁵ However, these study results must be interpreted with caution given that the reference standard of anesthetic injections were not used to confirm "true" SIJ pain. In addition, SIJ provocation tests

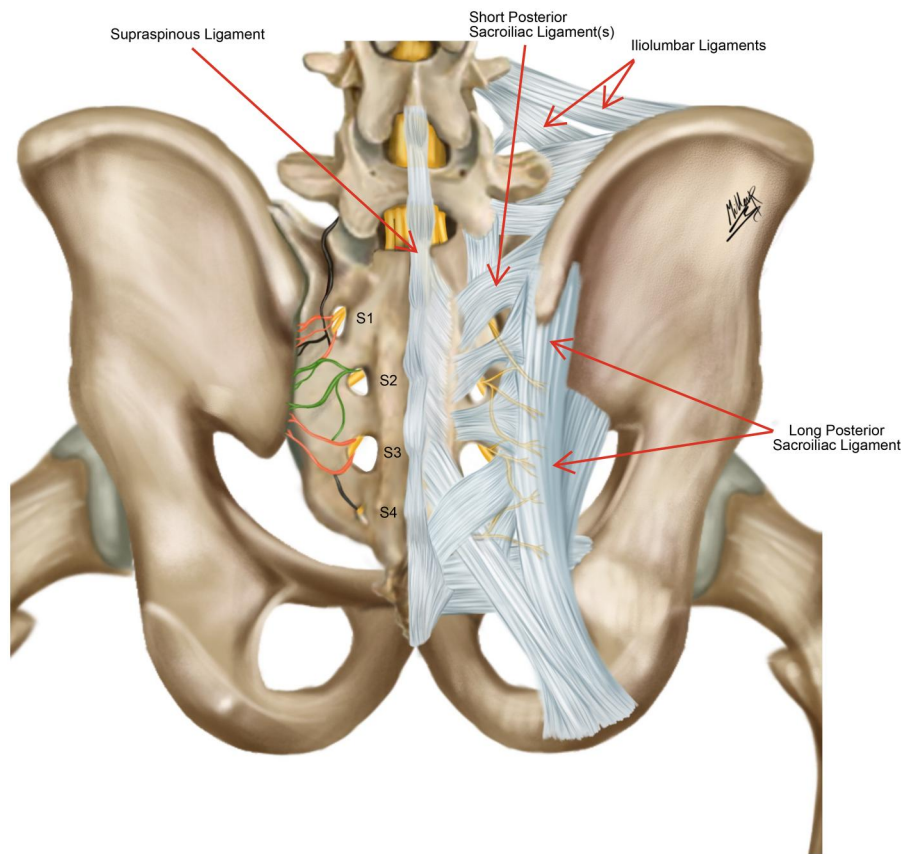


Figure 1. Animated illustration of the posterior sacroiliac joint complex showing ligamentous connections and sacral lateral branch nerve innervation. The left side of the sacrum demonstrates lateral branch nerve innervation of the articular joint, and the right side shows lateral branch nerve innervation of the ligaments.

may also exacerbate pain related to the herniated disc itself, thus resulting in a false-positive test for “true” SIJ pain. Nevertheless, it is likely that SIJ pain (and more comprehensively, sacroiliac joint complex pain) coexists with other sources of LBP in a subset of patients.

Dorsal ligament pain

The long dorsal sacroiliac ligament is anatomically connected to the erector spinae muscle, thoracolumbar fascia, and sacrotuberous ligament, potentially serving as a source of spinal pain.⁴⁶ The dorsal ligament associated with the SIJ has shared innervation with the lower portion of the posterior SIJ through the lateral branches of the dorsal rami of S1-3, with or without contributions from L5 and S4, via the nerve plexus termed the posterior sacral network (PSN)⁴⁷ (Figure 1). Given the shared innervation of the dorsal ligament, pain presentations could potentially vary from isolated dorsal ligament pain, dorsal ligament pain with concurrent SIJ-mediated pain, dorsal ligament pain with concurrent L5-S1 facet-mediated pain, and dorsal ligament pain with both concurrent SIJ- and L5-S1 facet-mediated pain. By employing diagnostic injections, it becomes possible to estimate the prevalence of isolated dorsal ligament pain. This estimation could theoretically be performed by identifying patients in a comparative-effectiveness study who exhibited a positive response to SLBBs, with or without subsequent SLBRFA, who showed little to no response to IA SIJ injection. This subset would likely exclude patients experiencing concurrent lumbar facet-mediated pain, and assumes that the IA SIJ injections were administered accurately, with no EA spread.

To date, no published studies provide an accurate estimation of the prevalence of pain exclusively from the dorsal ligament or the coexistence of dorsal ligament and IA SIJ pain, as per the theoretical framework described above. A study conducted by Salman et al. compared the effectiveness of SIJ injection to L4-5 dorsal rami and S1-3 RFA. However, little information regarding prevalence can be extrapolated from this study due to the fact that response to RFA, which is not 100% effective, cannot be used to estimate the prevalence of SIJ dorsal ligament pain, just as the response to an IA steroid injection cannot be used to estimate IA SIJ pain. Moreover, patients in both groups were selected based on response to a high-volume (3 mL) IA SIJ block, which theoretically should not relieve purely IA joint pain. Additionally, data were not presented for patients who transitioned to the RFA group.¹⁸ Another retrospective study by Yin et al.²⁵ reported the outcomes of SLBRFA in patients who responded positively to two deep interosseous ligamentous injections. However, the study did not provide information on the percentage of patients with respective positive responses to the first and second diagnostic injections, which would enable a more accurate estimate of the ligament-related pain prevalence as well as the incidence of false-positive blocks. Although this study does not offer the means to accurately estimate the prevalence of dorsal ligament pain, it does demonstrate that patients with such pain can respond to treatment with SLBRFA. Among the 14 patients included in this retrospective review, 9 (64%) experienced more than 50% pain relief, with 5 (36%) achieving complete pain relief at 6 months following RFA treatment. Given that prior studies evaluating outcomes

in SLBRFA had stringent inclusion criteria with positive diagnostic injections (some using IA SIJ injections), the outcomes in patients responding to SLBRFA (but showing a negative response to IA SIJ injection) remain unknown, necessitating further investigation.⁴⁸

Cohen et al. performed a randomized study in 125 patients with clinically suspected SIJ complex pain in which patients were allocated to fluoroscopically-guided or landmark-guided injections. Among the 60 patients in whom the 3 mL injection with local anesthetic and corticosteroid was limited to the EA dorsal ligaments, 57% experienced at least 50% pain relief lasting over 3 h vs 62% in those in for whom the injection was IA, and 69% in patients for whom injections were both IA and EA. Flaws in this study include the use of corticosteroids during uncontrolled single injections, and landmark-guided injections targeted to the area of maximal pain and tenderness rather distributed throughout the dorsal ligaments.⁶

Sacroiliac joint complex pain following lumbar or lumbosacral fusion surgery

Prior lumbar fusion may increase angular motion and stress across the SIJ complex, and pain may also result from adjacent level disease, increasing the prevalence of SIJ complex pain in individuals who have undergone prior spine surgery.^{49,50} Some patients may also experience positive diagnostic injections after lumbar fusion because a pre-surgical SIJ complex pain diagnosis was missed before fusion surgery.

In a computer simulation of a SIJ using a spine-pelvis model, the angular motion of the SIJ was modeled following L4-5, L4-S1, and L5-S1 fusion. The investigators found that motion increased steadily with each additional level fused and were especially substantial after an L5-S1 fusion (52% increased motion with flexion, 40% increase with extension, 28% increase with bending, and 51% increase with rotation). The most substantial increase in motion was observed with L4-S1 spinal fusion, with an estimated 168% increase in motion with flexion, 132% increase with extension, 95% increase with bending, and 69% increase with rotation.⁴⁹ Literature suggests the prevalence of SIJ complex pain to be between 33% and 59% in individuals who have undergone lumbar spinal fusion; thus, SIJ complex pain may be a contributor to the many etiologies of pain broadly categorized as “failed back surgery syndrome.”^{8,49}

Lumbosacral spinal fusion may also result in violation of both the synovial and ligamentous portions of the SIJ. In a CT study performed in 22 patients who underwent posterior iliac crest bone grafting and experienced persistent donor site pain, 16 were found to have violation of the posterior ligamentous structures, and three exhibited disruptions of the SIJ synovium. On imaging performed at least two years post-procedure, 10 of the 16 patients with ligamentous disruption had mild degeneration and six had severe degeneration vs 0 of 5 joints in patients who experienced no ligamentous or synovial violation. In the three patients who experienced synovial membrane breach, all experienced severe SIJ degeneration.⁵¹ These findings suggest that iliac crest bone grafting, for which the estimated prevalence of donor site pain ranges between 6% and 39%, may be associated with pain from the dorsal ligament, the IA joint, and the donor site adjacent to the SIJ.⁵²

Kennedy et al. described several studies evaluating SIJ pathology in individuals who have undergone lumbar/

lumbosacral spinal fusion.⁸ In a controlled study performed in patients with prior lumbar/lumbosacral spinal fusion, three of six positive provocation tests, and pain below L5 suggestive of SIJ complex pain who underwent two injections of local anesthetic (1 mL of 0.5% bupivacaine or 2% lidocaine) and corticosteroid (1 mL of 40 mg triamcinolone), $\geq 75\%$ relief of pain within 1-4 h was reported in 21 out of 52 (40%) of patients.⁵³ A positive response to the injectate was predicted by unilateral pain that was different from preoperative pain, and more than three positive provocation tests.⁵³ These procedures were performed using fluoroscopic guidance and IA needle location confirmed with contrast dye.

One retrospective study using a threshold of $>75\%$ relief of index pain after a single injection of local anesthetic and corticosteroid under fluoroscopic guidance confirmed by contrast dye reported a positive rate of 59% (20 out of 34 patients) in individuals with a spinal fusion to the sacrum.⁵⁴ Another retrospective review of individuals with LBP included 28 individuals with a history of spinal fusion who underwent diagnostic IA SIJ injection. Patients evaluated with IA SIJ injection included those with either at least three out of five positive SIJ provocation maneuvers, or two or fewer positive SIJ provocation maneuvers but a negative zygapophyseal joint injection. IA SIJ injection was considered positive if at least 75% of the patient’s pain was relieved after each injection with local anesthetic. The details regarding the number, type, and method of IA SIJ injection were not provided in this retrospective analysis. Among the 28 individuals with a history of spinal fusion identified in the analysis, 43% (12 out of 28) were identified to have SIJ complex pain, and 80% of those who had spinal fusion and SIJ complex pain had a history of spinal fusion to the sacrum, suggesting that spinal fusion to the sacrum is associated with higher rates of SIJ complex pain.⁵⁵

In a prospective study using local anesthetic IA SIJ injections in individuals with persistent LBP following successful lumbar spinal fusion, 35% of study participants experienced at least 75% relief from a single injection.⁵⁶ Patients who had unilateral pain >6 months in duration not extending below the knee, with tenderness at the sacral sulcus and no imaging evidence of a potential lumbar pain source were included. Injections were fluoroscopically guided using nonionic contrast to confirm IA placement, with 2 mL of 2% lidocaine used as the injectate. An injection was considered positive when contrast dye spread was contained within the joint and the patient experienced at least 75% pain relief within 15 min. The authors found that a pain-free interval of 3 months following surgery predicted a positive injection. This study also showed that L5-S1 spinal fusion patients had an increased frequency of positive injections, presumably because of the increased biomechanical load. Bone scintigraphy uptake in the SIJ was not associated with pain, when using IA SIJ injection as the reference standard.⁵⁶

Summary:

- The prevalence of SIJ-mediated chronic LBP is estimated to be 15%-30% in patients with axial pain predominantly below L5; Grade B evidence, moderate level of certainty.
- The prevalence of dorsal ligament-mediated pain is unknown but based on studies comparing IA and EA SIJ injection response, appears to be at least as common as exclusively IA pain; Grade I evidence.

- The prevalence of SIJ complex pain is suspected to be higher in patients with a prior history of lumbar or lumbosacral spinal fusion with estimated prevalence rates between 33% and 59%; Grade C evidence, low level of certainty.
- Chronic LBP following lumbar or lumbosacral spinal fusion surgery can be related to adjacent segment stress with increased loading and/or shear forces leading to accelerated degeneration, superimposed or missed SIJ-mediated pain prior to lumbar fusion, and/or violation of ligaments or synovial lining during iliac crest bone grafting; Grade C evidence, low level of certainty.

Recommendation:

- Further studies are needed to assess the prevalence of primarily dorsal ligament-mediated pain based on EA injections and SLBBs.

Diagnosis

Q2. Can history and physical exam identify a painful sacroiliac joint and can history and physical distinguish articular sacroiliac joint pain from dorsal ligament pain?

When assessing pain originating from the SIJ complex, it is important to distinguish between IA pain and dorsal ligament pain, as the treatments may differ (eg, IA injections and fusion for IA pain, EA injections and RFA for dorsal ligament pain). Some studies have identified historical and physical exam features that may help identify patients who will respond to IA diagnostic or therapeutic injections. However, no study has been designed using methodology that assesses the relative predictive value of elements of history and/or physical exam that help distinguish between IA SIJ vs dorsal ligament sources of SIJ complex pain. Since there are numerous parts of the SIJ complex that can be pain generators (eg, upper, middle, lower, dorsal and ventral ligaments, bony surfaces, synovial lining and fibrous capsule) with differences in referral patterns based on structure, location and stimulus intensity, the presentation of SIJ complex pain tends to be more variable than for individual facet joints, discs or muscles.

Historical features

There are some historical features that may help identify response to IA SIJ local anesthetic injection, suggesting IA pain, but studies have not typically distinguished between IA pain and dorsal ligament pain (see [Table 4](#)). The location of pain may have predictive value. Fortin et al. found that a point of maximal pain within 1 cm of a location just inferomedial to the posterior superior iliac spine (PSIS) correlated with response to IA SIJ injection in 16/16 subjects.⁵⁷ Another study found that tenderness within 2 cm of the PSIS was associated with positive response to EA (periarticular) injection⁵⁸; however, no IA SIJ injection was performed to assess the comparative response.

Pain patterns can be quite variable. Comparing SIJ IA responders vs non-responders, van der Wurff et al. found no major differences except 10% of the responders vs 100% of the non-responders had ischial tuberosity pain.⁵⁹ Some studies have reported pain in the buttock and thigh without

symptoms distal to the knee,⁶⁰ while others have reported a comparable proportion of patients who experienced these pain patterns between responders and non-responders to IA SIJ injection.⁴³ The presence of groin pain has been shown to predict a positive response to an IA SIJ injection, though groin pain was only present in 14% of responders in one study.⁴³ Alternatively, in two subsequent studies, pain in the groin was found to be associated with a positive response to a diagnostic EA injection.^{61,62} In another study, the positive correlation between response to an IA injection and pain in the posterolateral thigh and groin fell shy of statistical significance.⁶³

Characteristic painful activities and mechanisms of injury have been suggested as variables that may help distinguish different pain generators within the SIJ complex. In one retrospective cohort study, the authors identified several historical features that correlated with response to a therapeutic IA SIJ injection with local anesthetic and corticosteroid. These features were vehicle accidents, falls onto the buttock(s), postpartum state, American football injuries, and pelvis fracture.⁶⁴ Other inciting events included cumulative sports injuries such as lifting weights and running. Additional factors that may be associated with SIJ IA or ligamentous pain include leg length discrepancy, gait abnormalities, prolonged vigorous exercise, scoliosis, and spinal fusion.⁶⁵ Inflammation of the SIJ including a history of seronegative spondyloarthropathies with buttock pain suggests the presence of IA mediated pain. In one study, pain with rising from a chair was associated with IA SIJ pain but not lumbar facet joint pain.⁶⁶ However, none of these features have been shown to reliably distinguish between IA and EA sources of SIJ complex pain.⁶⁵

Features that are negative predictors for SIJ complex pain have also been described. In one study, only 4.4% of individuals with a positive diagnostic response to SIJ IA indicated that they had pain above L5 on a pain diagram that they completed at the time of baseline evaluation.⁶⁷ Several studies have also found that lumbar midline greater than paraspinal pain, or centralization of symptoms with provocation, is negatively associated with SIJ pain as diagnosed by IA SIJ injection as the reference standard.^{57,66,68}

Inflammatory arthritis represents a distinct variant of IA SIJ disease, being especially common in ankylosing spondyloarthritis and to a lesser degree rheumatoid arthritis. Distinctive features that may distinguish inflammatory arthritis from osteoarthritis include prolonged morning stiffness (>30 min), pain improved with activity and not improved with rest, nocturnal pain, the presence of uveitis and/or enthesitis, and onset before 40 years of age.⁶⁹

Physical examination

There is currently no evidence that the physical exam can distinguish IA pain from EA ligament pain (see [Table 5](#)). Provocative tests such as Patrick's or flexion-abduction-external rotation (FABER) and Gaenslen's generally focus on stressing the anterior joint structures, while motion tests such as Gillet (aka Stork test) purport to assess mobility and sometimes alignment; mobility tests may be particularly useful for the identification of early inflammatory arthritis. In contrast, exam maneuvers that rely on tenderness may be more likely to detect dysfunction of the more superficial and palpable posterior ligament complex. A biomechanical study using a 3-dimensional finite element model found the SIJ provocation

Table 4. Historical features associated with sacroiliac joint complex pain.

Author, year, type of injection	Study design and diagnostic criteria	No. of patients	Test	Sensitivity	Specificity	Other
Schwarzer 1995 ⁴³ IA	Cross sectional study in patients with LBP below the L5-S1 spinal level and negative facet injections who responded to IA SIJ injections	43	Comparison of historical features			No historical or PE test offered predictive value of response to injection, but the presence of groin pain was more common in patients with positive diagnostic injection. Pain extending below knee showed comparable prevalence in those with and without SIJ complex pain.
Dreyfuss, 1996 ⁶⁷ IA	Prospective cohort study correlating 12 physical exam maneuvers with response to IA SIJ injection	85	Correlated PE & historical features with response to IA SIJ injection. These included pain drawings, maximal pain within 2 cm of posterior superior iliac spine, lifting buttock off chair while sitting.			No historical feature, none of the 12 SIJ tests, and no ensemble of these 12 variables demonstrated meaningful diagnostic value. Not able to distinguish between intra- and extra articular
Fortin, 1997 ⁵⁷ IA	Prospective cohort of patients with pain during arthrography	16	Maximal pain within 1cm infero-medial to the PSJs	100%		All patients had positive provocative joint injections validating SIJ abnormalities.
Slipman, 2000 ⁷⁹ IA	Retrospective study correlating response to an IA SIJ injection with pain referral patterns	50	Patrick's, Ganslen's, shear and Yeoman's test, and pain with pressure over the sacral sulcus. 2 of the 3 required positive responses had to include Patrick's test, and pressure over the sacral sulcus.			94 described buttock pain, 36 patients described LBP, 14% had groin pain, and 50% had lower extremity pain. Pain extended into the lower leg in 28% and into the foot in 14%.
Fukui, 2002 ⁶⁰ IA	Prospective cohort study in patients who responded to an IA SIJ injection and had pain provocation with exam tests.	28, 32 joints	Patrick's and Gaenslen's tests			All patients indicated pain over the SIJ, 68.7% had pain in the medial buttock, 37.5% experienced pain in the lateral thigh, 31.2% indicated the posterior thigh region as a pain site, and 9.3% reported groin pain.

(continued)

Table 4. (continued)

Author, year, type of injection	Study design and diagnostic criteria	No. of patients	Test	Sensitivity	Specificity	Other
Chou, 2004 ⁶⁴ IA	Retrospective study in patients with a negative EA injection with saline and a positive IA injection	194	Historical features, iliac compression test, Patrick's test, Yeoman's test, Gaenslen's test, midline sacral thrust and pressure to sacral sulcus Identified historical features of IA and EA sources of pain			44% had a traumatic event, 21% had cumulative injury, and 35% had spontaneous or idiopathic onset.
Cohen, 2005 ⁶⁵	Evidence-based review					Factors associated with SIJ pain included leg length discrepancy, gait abnormalities, prolonged vigorous exercise, scoliosis, and spinal fusion. Inflammation of the SIJ, especially in those with bilateral symptoms, suggests IA pathology. Pregnancy predisposes women to EA pain. Pain localized to buttock region was the only pattern associated with positive injections, with a diagnostic accuracy rate of 68.4%. Injections guided by pain provocation during 10% hypertonic saline injection. 22 (44%) patients complained of groin pain which was provoked in only 1 patient but relieved by local anesthetic in all patients When the cutoff point was increased to five, the sensitivity decreased to 85% and specificity increased to 93%
Jung, 2007 ⁶³ IA/ligamentous	Prospective cohort in patients with lumbar facet or SIJ complex pain confirmed by IA or ligamentous injection	419, 160 SIJ patients	Correlated pain drawings to injection and RFA outcomes			
Murakami, 2008 ⁵⁸ Ligamentous	Prospective study in patients with SIJ pain confirmed with placebo-controlled EA injections	46	Pain within 2cm of PSIS	78%	70%	
Kurosawa, 2015 ⁶¹ Ligamentous	Prospective study in patients with SIJ complex pain confirmed by positive response to EA injections and negative response to control injections	50	Worst pain divided into 4 regions: upper buttock, around the PSIS, middle buttock, and lower buttock.	Pain situated around the PSIS had the highest sensitivity (96%) with middle buttock pain having the lowest (69%).	Pain around the PSIS had the lowest specificity (82%) while lower buttock pain had the highest (99%).	
Kurosawa, 2017 ⁶² Ligamentous	Prospective study to determine distinguishing factors between SIJ ligament pain, lumbar disc herniation and lumbar spinal stenosis.	62 with SIJ complex pain, 59 with disc herniation or spinal stenosis	Two pain areas (PSIS detected by the one-finger test, ie, pointing to the most painful area, and groin pain), pain sitting on a chair, shear provocation test, and 4 tender points	90% sensitivity for a positivity cutoff point of 4 (out of a risk score of 0-9) based on regression analysis.	86% specificity	

EA, extra-articular; IA, intra-articular; PSIS, posterior superior iliac spine; SIJ, sacroiliac joint.

Table 5. Physical exam findings associated with sacroiliac joint complex pain.

First author, year	Study design	No. of patients	Tests	Sensitivity	Specificity	Other
Dreyfuss, 1996 ⁶⁷	Prospective cohort study correlating 12 physical exam maneuvers with response to IA SIJ injection	85	Various pain drawings, maximal pain within 2 cm of posterior superior iliac spine, lifting buttock off chair while sitting, Gillet test, thigh thrust test, FABER/Patrick test, sacral thrust test, Gaenslen's test, joint play			No historical feature, none of the 12 SIJ tests, and no ensemble of tests provided meaningful diagnostic value. Negative correlation noted between response to injections and pain cephalad to L5.
Maigne, 1996 ⁸⁰	Prospective study assessing prevalence of IA SIJ pain using dual injections	67	Distraction, compression, sacral pressure, Patrick's and Gaenslen's tests, pain with resisted external hip rotation and pain with pressure applied to the pubic symphysis			There was no association between any clinical variable or pain provocation test and a (+) response to injections.
Broadhurst, 1998 ⁸¹	Placebo-controlled double-blind study	40		77% for Patrick's, 80% for posterior shear and 87% for resisted abduction tests	100% for Patrick's, posterior shear and resisted abduction tests	No patient had $\geq 70\%$ pain relief after saline.
Slipman, 1998 ⁸² IA	Prospective cohort study examining tests associated with response to an IA SIJ injection	50	Patrick's, Gaenslen's, shear and Yeoman's tests, and pain with pressure over the sacral sulcus. 2 of the 3 required positive responses had to include Patrick's test, and pressure over the sacral sulcus.			SIJ injections were positive in 60% of patients with 3 positive tests.
Vleeming, 2002 ⁷⁵ IA/ Ligamentous	Cross sectional analysis in women with lumbopelvic pain that began during or right after pregnancy	178	Tenderness with palpation over the bilateral long dorsal sacroiliac ligament. Posterior pelvic pain provocation test and active straight leg raising test used as reference criteria.	76% for tenderness to palpation of long dorsal sacroiliac ligament for entire cohort, 86% in those diagnosed based on positive posterior pelvic pain provocation and active straight leg raising test, and 98% in those with severe pain on both tests.		Did not use injections as reference criteria, limited validity
Laslett, 2003 ⁶⁸ IA	Prospective, observational study evaluating physical exam tests associated with response to dual diagnostic IA SIJ injections	48 patients with lumbopelvic pain	Thigh thrust, Gaenslen's, distraction, compression and sacral thrust tests, as well as McKenzie assessments	91% for 3 positive tests	78% for 3 positive tests	9 subjects had peripheralization or centralization during the course of movements with none having positive response to injections.

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Table 5. (continued)

First author, year	Study design	No. of patients	Tests	Sensitivity	Specificity	Other
Young, 2003 ⁶⁶ IA	Prospective study evaluating physical exam tests associated with outcome in patients who experience pain provocation with capsular distension and relief with IA SIJ injection	102 with lumbopelvic pain	Distraction, compression, sacral thrust, thigh thrust (posterior shear) and Gaenslen's tests			3 positive tests, unilateral pain, and pain worsened when rising from sitting, strongly associated with response to injection. Negative relationship between midline lumbar pain and positive injection. Positive and negative predictive values were 77% and 87%, respectively, for 3 or more positive tests.
Van der Wurff, 2006 ⁵⁹ IA	Prospective study in patients who responded to a dual diagnostic SIJ injection	140	Distraction test, compression test, thigh thrust test, Patrick's test, Gaenslen's test	3 or more positive tests had 85% sensitivity	79% for 3 or more positive tests	No major differences between responders and non-responders except 10% of the responders vs 100% of the non-responders had ischial tuberosity pain. Using positive response to double-injections as the reference standard, the odds ratio of the thigh thrust test was 18.5, compression test was 3.9, and 3 or more positive stressor tests was 17.2.
Szadek, 2009 ⁸³	Systematic review of 18 studies		Various exam maneuvers, historical signs and pain patterns, and radiological studies			3 or more positive tests had 47% positive predictive value and 87% negative predictive value. Normalization of tests not predictive of injection response. 4 or more provocative tests predicted response to SIJ injections. Postoperative pain different from baseline pain and unilateral pain also associated with positive injections. No single physical exam maneuver is predictive of response to diagnostic injection, but when at least three physical exam findings are present, the sensitivity and specificity increases
Stanford & Burnham, 2010 ⁸⁴ IA	Prospective cohort study evaluating exam tests associated with positive response to IA SIJ injection	34	Patrick's, ipsilateral and contra-lateral Gaenslen's, thigh thrust, lateral compression and sacral thrust tests	3 or more positive tests had 82% sensitivity	3 or more positive tests had 57% specificity	
Liliang, 2011 ⁵³ IA	Prospective cohort study evaluating physical exam tests associated with response to dual IA SIJ injections	52 with prior lumbar fusion	Pain elicited with pressure over the sacroiliac ligaments, Patrick's, Gaenslen's, and shear (thigh thrust) tests, Yeoman maneuver, and standing-extension test			
Kennedy, 2015 ⁸ IA	Systematic Review	45 publications, 39 on exam findings				

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Table 5. (continued)

First author, year	Study design	No. of patients	Tests	Sensitivity	Specificity	Other
Nejati, 2020 ⁸⁵ IA	Cross-sectional study evaluating correlation between physical exam tests and response to dual diagnostic IA SIJ injections	48	Motion palpation tests: Gillet and forward flexion tests. Pain provocation tests: Patrick's, thigh thrust (posterior shear), Gaenslen's, Yeoman, compression, distraction and Newton's tests.	95% for 3 or more positive tests. Gillet and forward flexion tests had 100% sensitivity, but 0% specificity.	11% for 3 or more positive tests. Patrick's test had 67% specificity. Gillet and forward flexion tests had 0% specificity.	Positive and negative predictive values of 3 or more positive tests 82% and 33%, respectively.
Schneider, 2020 ⁷⁴ IA	Prospective cohort study evaluating whether physical exam maneuvers correlate with response to IA SIJ injection	35	Thigh thrust, Gaenslen's, Patrick's, distraction, compression and sacral thrust tests	Highest for Patrick's and sacral thrust tests (77%), 29% for Gaenslen's, 29% for thigh thrust, 35% for distraction tests	Highest for distraction (83%) and compression (78%) tests, 44% for Gaenslen's, 28% for Patrick's and 72% for thigh thrust tests	No association found between a single or combination of SIJ provocation maneuvers and response to an injection. Positive (67%) and negative (58%) predictive values highest for distraction test.
Mekhail, 2021 ⁷² IA	Prospective cohort study evaluating response to an IA SIJ injection	200	Patrick's, modified Gaenslen's alone and together	94% for combination	17% for combination	Patrick's and modified Gaenslen's tests had 81% positive predictive value, and 44% negative predictive value.
Saueressig, 2021 ⁷⁶ IA	Systematic review and meta-analysis of 5 studies		Clusters of pain provocation tests	80% for a cluster of positive tests	63% for a cluster of positive tests	Positive and negative predictive values 34.7% and 92.4%, respectively. Concluded a cluster of pain provocation tests provides 35% certainty of a painful SIJ. Negative tests are more predictive, providing 92% certainty an SIJ is not the primary pain generator.
Cohen, 2022 ⁷³ IA/ Ligament	Prospective multicenter cohort examining factors associated with 1-month outcome after SIJ injection	66	Patrick's test and Gaenslen's test	Patrick's test 59%, Gaenslen's test 71%, combined 53%	Patrick's test 26%, Gaenslen's 21%, combined 37%	Patrick's test positive predictive value 43%, negative predictive value 38%. Gaenslen's test positive predictive value 47%, negative predictive value 41%. Combined positive predictive value 41%, negative predictive value 38%.
Han, 2023 ⁷¹	Systematic review	168 415 319 213	Sacral thrust test Thigh thrust (posterior shear) test FABER/ Patrick's test Gaenslen's test	57.3% 54.1% 76.4% 47.9%	48.8% 53.7% 32.3% 47.9%	All included studies evaluated IA injections

IA, intra-articular; SIJ, sacroiliac joint; FABER, flexion-abduction-external rotation.

tests that provided the highest contact pressure across the joint (>10 MPa) were the compression, thigh thrust, Patrick's, and Gaenslen's tests, with Gaenslen's test resulting in the highest contact pressure (27.9 MPa).⁷⁰ The posterior and interosseous ligaments were stretched in the compression test; the anterior and interosseous ligaments were stretched in the distraction test; all ligaments were stretched in the sacral apex pressure test; the posterior ligaments were stretched in the thigh thrust test; the anterior ligaments were stretched in Patrick's and Gaenslen's tests.⁷⁰ Collectively, this study demonstrates that provocation tests likely stress both soft-tissue (EA) and IA structures, with significant overlap between maneuvers leading to a lack of specificity.

Some studies and systematic reviews suggest that a positive response to physical exam maneuvers may help identify IA pain as verified by a positive response to IA SIJ injections,^{59,68,71,72} while other studies have shown no significant correlation.^{67,73,74} Although it might seem self-evident that meaningful pain relief with an IA SIJ injection indicates IA pain, diagnostic injections are confounded by high false-positive and false-negative rates.⁸ Further muddling interpretation of these studies is the fact that $>50\%$ of attempted IA injections have been shown to extravasate injectate posteriorly into the dorsal ligaments.^{6,58} Another study found that IA injection was associated with a 27% incidence of aberrant flow to unintended neural elements,⁴² further undermining specificity and validity.

Vleeming et al. attempted to assess the prevalence of dorsal ligament pain in postpartum women with long dorsal sacroiliac ligament tenderness, but failed to use the widely-accepted criterion of pain relief following a diagnostic injection as the reference standard for identifying a painful SIJ complex.⁷⁵ In a systematic review involving five studies and 422 patients, all of whom received a battery of physical exam maneuvers and diagnostic IA injections, Saueressig et al. concluded that a positive cluster of SIJ provocation tests is associated with only 35% certainty of correctly identifying the joint as a pain generator, but that a negative cluster of tests can ascertain a non-painful joint 92% of the time.⁷⁶ Other studies evaluating McKenzie-based positional preferences have found those with centralization (reduction of referred pain from the axial spine toward an extremity) are unlikely to have SIJ complex pain based on response to injections.^{66,68}

Inter-rater reliability

The reliability of physical exam maneuvers is critical to assessing validity and has demonstrated mixed results in clinical studies. In a systematic review published in 2000 examining 11 studies that assessed inter- and intra-rater reliability for sacroiliac joint examination findings, van der Wurff et al. demonstrated poor reliability for joint mobility tests and inconsistent results for pain provocation tests, with an inverse relationship observed between study methodological quality and correlation coefficients.⁷⁷ In one prospective follow-up study using two independent examiners who performed exam maneuvers in 78 patients with back pain and asymptomatic controls, the weighted kappa was found to be 0.70 (95% CI = 0.45–0.95) for Gaenslen's, Patrick's, thigh thrust, compression and distraction tests, indicating substantial agreement.⁷⁸ In this study, the presence of three of five positive provocation tests was the threshold for a positive designation (see Table 6).⁷⁸

Summary:

- For assessing pain originating from the SIJ complex, there is low-quality evidence that a battery of historical (eg, groin pain) and physical exam (ie, provocative but not motion tests) features may help predict response to IA SIJ injection of local anesthetic with or without corticosteroids; Grade B evidence, moderate level of certainty
 - There are minimal available data regarding their ability to predict results in patients with primarily EA dorsal ligamentous pathology; Grade C evidence, low-to-moderate level of certainty.
- The specificity for individual and clusters of tests is lower than the sensitivity, with negative tests having greater predictive value than positive tests; Grade A evidence, high level of certainty.
- Inter-rater reliability for SIJ provocation tests demonstrates a wide range, with some of the most common tests (eg, FABER ("Patrick's") test) having the highest reliability; Grade C evidence, low level of certainty.
- Historical variables and physical exam signs can be used to select patients for diagnostic injections, but in individuals for whom there is a strong clinical suspicion (eg, negative workup for other causes) for SIJ complex pain, IA SIJ injections may be reasonable, even in the absence of positive provocation tests; Grade B evidence, moderate level of certainty

Q3. Can radiological imaging (including SPECT, radiographs, CT, MRI) identify a painful sacroiliac joint and aid in distinguishing articular sacroiliac joint pain from painful dorsal ligaments?

Imaging is the reference standard for identifying sacroiliitis [inflammation of the SIJ(s)], most commonly occurring in the context of systemic rheumatologic disorders, albeit with certain limitations. In contrast, there is a scarcity of studies designed to use imaging for identifying painful SIJs, detecting SIJ dysfunction, or differentiating between pain originating from the SIJ itself vs pain from the surrounding dorsal ligaments. Notably, few studies have compared the efficacy of imaging techniques to the reference standard of diagnostic anesthetic injection for these purposes.

Imaging the sacroiliac joint

SIJ dysfunction is typically associated with few abnormal imaging findings.⁹¹ Radiographs are the least costly imaging modality but are less sensitive than CT or MRI for detecting SIJ structural abnormalities, especially in early disease states. Besides anteroposterior (AP) radiographs, there is no consensus regarding the optimal additional radiographic views to best image the SIJ given its oblique orientation and sigmoid structure.⁹¹ In contrast to radiographs, cross-sectional imaging with CT, MRI, and single photon emission computed tomography (SPECT) create multiplanar images of the SIJ. CT can demonstrate sclerosis and bone erosions, while MRI can identify synovitis and bone marrow edema.⁹¹ MRI is the best modality for detection of early SIJ inflammation, as fluid-sensitive sequences can identify tissue changes such as subchondral bone marrow edema.⁹² Meanwhile, SPECT can detect metabolic disturbances in and around the SIJ and its dorsal ligaments.⁹³

Table 6. Inter-rater reliability of sacroiliac joint complex pain physical exam findings.

Author, Year	Design	No. of subjects	Reliability	Comments
McCombe, 1989 ⁸⁶	Prospective study assessing inter-rater reliability.	83	Kappa values for: Maitland test: 0.26-0.38 Compression test: 0.09-0.16 Distraction test: 0.11-0.36 Pain with hip flexion: 0.40-0.42 Pain on resisted hip external rotation: 0.38-0.63 Kappa values highest for thigh thrust (0.88) and distraction, compression and pelvic torsion (0.76), and lowest for sacral thrust (0.59) and cranial shear (0.69)	Concluded pain with hip flexion is reliable, pain elicited by external rotation is potentially reliable, and the others are unreliable.
Laslett, 1994 ⁸⁷	Prospective study assessing inter-rater reliability	51		All exams performed by the same 2 physical therapists.
Van der Wurff, 2000 ⁷⁷	Systematic review			Poor reliability for joint mobility tests. Mixed results for pain provocation tests, with an inverse correlation found between study quality and correlation. Strongest evidence for Gaenslen's and thigh thrust tests. 3 of 5 positive provocation tests was the threshold for a positive designation.
Kokmeyer, 2002 ⁷⁸	Prospective study	78	The weighted kappa was found to be 0.70 for Gaenslen's, Patrick's, thigh thrust, compression and distraction tests, indicating substantial agreement	
Potter & Rothstein, 1985 ⁸⁸	Prospective study	17	Compression and distraction tests had 76% and 95% agreement, respectively, with the other 11 tests having <70%.	Since the tests with high agreement were based on subjective metrics (pain report), the authors concluded all tests contained significant limitations.
Dreyfuss, 1996 ⁶⁷	Prospective study	85	Exam findings with kappa values >0.6 were thigh thrust, Patrick's and Gaenslen's tests	Historical findings (buttock, groin and SI joint pain) had higher kappa values (>0.67) than any exam finding.
Strender, 1997 ⁸⁹	Prospective study	71	SIJ provocation tests had good reliability: 96% agreement for Patrick's, 79% (kappa 0.26) for compression and 97% for internal hip rotation	50 pts examined by 2 physiotherapists and 21 by 2 physicians.
Bertilson, 2006 ⁹⁰	Prospective study	50	The 3 physical examination tests (SIJ compression, paravertebral tenderness, and iliopsoas tightness) had the lowest kappa values for all tests (0.6 to 0.33)	All exams done by 2 physical therapists using Kirkaldy-Willis back pain classification.

SIJ, sacroiliac joint.

Imaging sacroiliitis

Inflammatory sacroiliitis, which can be observed with ankylosing spondylitis, psoriatic arthritis, spondylitis associated with inflammatory bowel disease, and reactive arthritis,⁹² may be imaged with x-ray (XR), CT, and MRI commonly used in clinical practice. Radiographic features of sacroiliitis take longer to become detectable than other means of diagnosing the underlying condition, wherein approximately 33% of patients with symptoms <1 year and 50% of patients with symptoms for 2-3 years demonstrate perceptible radiographic findings.⁹⁴ Interpreting radiographs of the SIJ in suspected sacroiliitis can be challenging. Inter-observer and intra-observer variations are substantial, and sacroiliitis can be missed or incorrectly diagnosed using radiographs.⁹⁵

MRI is considered the reference standard for detecting SIJ involvement in patients with spondyloarthropathies. Studies have demonstrated that MRI has over 80% sensitivity in detecting chronic sacroiliitis, including sclerosis, joint space abnormalities, and ankylosis, with the highest sensitivity achieved through contrast-enhanced and short tau inverted recovery (STIR) techniques.^{96,97} Although MRI may be more sensitive in detecting active inflammation and associated structural changes, CT remains the preferred method for diseases involving bone destruction or ossification. When MRI is inappropriate or unavailable in the real world, visual scoring of SIJ to sacrum (SIS) ratios of SPECT/CT may serve to identify axial spondylarthritis (axSpA) with high sensitivity and a high negative predictive value. In one study, the sensitivity, specificity, and positive and negative predictive values of SIS ratio of SPECT/CT for axSpA were 87.5%, 56.5%, 16.6%, and 97.8%, respectively.⁹⁸

Identification of a painful sacroiliac joint with imaging

Imaging studies have not been found to be accurate in differentiating a painful from non-painful SIJ (see Table 7). In one prospective study performed in 364 patients evaluated in a neurosurgical clinic for mechanical LBP, the use of imaging added very little to the accuracy of an injection-confirmed SIJ complex pain diagnosis, with history alone identifying 85-86% of 150 cases, imaging added to history resulting in an 87% accuracy rate, and the combination of historical findings, physical exam, and advanced imaging increasing the accuracy rate to 96%.⁹⁹

Radionuclide bone scans

Slipman et al.¹⁰⁰ and Maigne et al.¹⁰¹ found that radionuclide bone scanning had sensitivities of 13% and 46%, respectively. In the study by Slipman et al., at least three SIJ provocation maneuvers were positive in included patients. The reference standard in this study was a single IA SIJ injection with either 2 mL of lidocaine mixed with 1 mL (6 mg) of betamethasone or 3 mL of lidocaine performed under fluoroscopic guidance. Iohexol 0.5 mL was injected to confirm IA needle placement, but rates of IA spread were not reported. A threshold of 80% pain relief was used to define a positive response. In the study by Maigne et al., patients were selected based on tenderness over the SIJ without use of SIJ provocation maneuvers. Needle placement was performed under fluoroscopic guidance with injection of iopamidol 1 mL followed by ~2 mL of lidocaine, with strictly IA spread reported in 32/39 patients. A threshold of 75% pain relief was used to define a positive injection. Although these studies showed specificities >90%, their low sensitivities indicate

that bone scan is not an effective screening tool for SIJ complex pain, as it fails to detect most cases.

CT scans

Elgafy et al.¹⁰² conducted a comparison of CT findings between 62 patients experiencing pain relief after SIJ injections and 50 age-matched controls without pelvic or back pain. Patient selection relied on limited criteria: Pain with pressure 1 inch below the posterior superior iliac spine, absence of pain with lumbar movements, and negative lumbar MRI. The injection protocol included a 5 mL subcutaneous lidocaine injection for local anesthesia followed by a large volume IA administration of 5 mL 1% lidocaine with 1 mL betamethasone. Notably, the authors neither used contrast to confirm IA placement nor defined quantitative criteria for positive response beyond subjective "pain relief." Results showed CT abnormalities in 57.5% of symptomatic patients vs 31% of controls, with 42.5% of symptomatic patients exhibiting no CT abnormalities. The calculated sensitivity (57.5%) and specificity (69%) indicate poor diagnostic utility, underscoring the methodological limitations of this investigation.

MRI

In a prospective observational study¹⁰³ performed in 60 patients with pain clinically suspected to originate from the SIJ who received MRIs, acute inflammatory arthropathy was found in 36.7%, nonspecific degenerative changes were found in 35%, stress fractures in 3.3%, and osteoid osteoma in 7%, with 23.3% having normal SIJs. The authors inadequately described the basis upon which patients were clinically suspected to have pain originating from the SIJs and did not report the use of physical exam maneuvers. Diagnostic injections were MRI-guided with 1 mL of a mixture of bupivacaine 1% and gadopentetate dimeglumine, with spread assessed using a fat-saturated T1-weighted spin echo sequence. SIJs were successfully accessed in 94.7% (108/114), of which 95.4% (103/108) of cases of spread were restricted to the IA joint on imaging. Thirty-two patients with nonspecific degenerative changes or normal SIJs underwent diagnostic IA SIJ injections; 46.9% had positive diagnostic injections and 53.1% had negative diagnostic injections. Among the 46.9% with positive diagnostic injections, 66.7% had normal MRIs and 33.3% had nonspecific degenerative changes. This study demonstrates that SIJ pain, as diagnosed by the reference standard of anesthetic injection, may not consistently correlate with MRI findings. However, due to the study design, it was not possible to determine the sensitivity and specificity of MRI in identifying painful SIJs.

SPECT

Cusi et al.⁹³ conducted a study examining the utility of single-photon emission computed tomography/computed tomography (SPECT/CT) in 100 patients (72 females, 28 males) with pelvic girdle pain—52% post-traumatic and 48% postpartum—compared to 80 asymptomatic controls undergoing SPECT/CT for non-pain indications. Imaging findings were compared to those in 80 control patients who received SPECT/CT for non-pain related reasons. Diagnostic injections were not used in this study; rather, the reference standard for the diagnosis of SIJ complex pain was clinical exam (3 of 4 positive exam maneuvers). Nuclear medicine physicians interpreted imaging studies in a blinded fashion. The results demonstrated that soft-tissue uptake posterior to the joint [area under the curve (AUC) = 0.99] or

Table 7. Accuracy of radiological tests to identify a painful sacroiliac joint complex.

First author, year, imaging modality	Study design and diagnostic criteria	No. of patients	Tests	Sensitivity	Specificity	Other
Elgafy, 2001 ¹⁰² CT	Retrospective case-control study evaluating the diagnostic value of CT in patients with SIJ complex pain. Diagnostic criteria were pain relief with CT-guided IA SIJ injection, exam consistent with SIJ complex pain, and negative L-spine MRI.	Cases: 62 Controls: 50	Compared CTs of 62 patients with pain relief after IA SIJ injections with local anesthetic (symptomatic group) to 50 age-matched patients who had CTs for reasons other than pelvic or back pain (control group)	57.5%	69%	
Slipman, 1996 ¹⁰⁰ Radionuclide bone scan	Prospective case-control study. 3 positive provocative maneuvers on exam, diagnostic IA SIJ injections were the reference standard.	N = 50 Cases: 31 Controls: 19	50 consecutive patients underwent nuclear scanning and IA SIJ injections	12.9%	100%	
Maigne, 1998 ¹⁰¹ Quantitative radionuclide bone scanning	Prospective case-control study. Patients with LBP underwent imaging followed by IA SIJ injection. Controls used to establish upper limits of normal for quantitative radionuclide bone scanning.	Patients: 32 underwent injection [Positive (75% benefit) injection: 13 Negative injection: 19] Controls: 34	Unilateral LBP with tenderness on palpation of the SIJ line without x-ray or CT findings suggestive of lumbar etiologies.	46.1%	89.5%	
Fritz, 2008 ¹⁰³	Prospective observational study. LBP clinically suspected to originate from SIJ, >12 weeks duration despite nonsteroidal anti-inflammatory drugs and/or physical therapy.	N = 60 Acute inflammatory arthropathy: 22/60 (36.7%) Nonspecific degenerative changes; 21/60 (35%) Stress fracture (2/60, 3.3%) osteoid osteoma (1/60, 1.7%) Normal in 14 of 60 (23.3%) patients.	All patients with suspected SIJ complex pain received MRI, and those with inflammatory changes received therapeutic IA corticosteroid SIJ injections while those without anesthetic SIJ injections and if positive received therapeutic IA SIJ injections.	Unable to calculate with provided information	Unable to calculate with provided information	Among 32 without inflammatory changes on MRI who received technically successful diagnostic IA SIJ injections, 15 (46.9%) were positive. Ten patients (66.7%) had normal imaging and 5 (33.3%) had nonspecific degenerative changes]. 17 (53.1%) had negative diagnostic IA SIJ injections.

(continued)

Table 7. (continued)

First author, year, imaging modality	Study design and diagnostic criteria	No. of patients	Tests	Sensitivity	Specificity	Other
Cusi, 2013 ⁹³ SPECT/CT	Prospective observational study Pelvic girdle pain with ≥ 3 positive SIJ provocation maneuvers	Cases: 100 with pelvic girdle pain with ≥ 3 positive SIJ provocation maneuvers Controls: 80 patients scanned for reasons other than LBP	All patients received SPECT/CT	Soft-tissue uptake: 0.93 Ligament enthesis uptake: 0.93 SIJ uptake: 0.93 SIJ sclerosis on CT: 0.75	Soft-tissue uptake: 1.0 Ligament enthesis uptake: 0.99 SIJ uptake: 0.60 SIJ sclerosis on CT: 0.60	The best diagnostic criterion for SIJ incompetence was either soft-tissue uptake posterior to the joint (AUC = 0.99) or uptake at the sacroiliac ligament insertions (AUC = 0.99). The combination of these two criteria yielded an AUC of 1.0. No diagnostic injections were performed. Sensitivity and specificity were determined based on clinical exam (3 of 4 positive exam maneuvers) as reference standard.
Tofuku, 2015 ¹⁰⁴	Prospective observational “Severe SIJ dysfunction” unresponsive to 1 year of conservative treatment and pain >4/10 Positive diagnostic IA SIJ injection defined as 75% pain relief	Patients: 32 Bilateral: 29 (19 lateralized) Unilateral: 3 (all lateralized)	All patients received SPECT/CT	Unable to calculate with provided information	Unable to calculate with provided information	Patients with lateralized pain had higher standardized uptake value (SUV) on symptom-dominant side (mean 5.3, range 3.6–9.9) vs nondominant (mean 4.1, range 2.2–6.9) side. In the 10 patients with bilateral pain without lateralization, the mean SUV difference between sides was small (0.22 [range 0.0–0.6]). In the 3 patients with unilateral symptoms, the affected side had tracer accumulation, with mean SUV 3.6 (range 3.0–4.8) Increased uptake in the upper SIJ (S1–S2) with extension into the dorsal interosseous ligament in 100% of patients. Mean counts were 168 (SD: 91) on the affected side and 109 (SD 60) on the unaffected side.
Saunders, 2018 ¹⁰⁵	Either referred from private clinical practice or prospectively recruited into an open-label trial of prolotherapy for physiotherapy-resistant SIJ complex pain. All had ≥ 3 positive exam maneuvers	Patients: 1200	All patients received SPECT/CT	Unable to calculate with provided information	Unable to calculate with provided information	

AUC, area under curve; CT, computed tomography; IA, intra-articular; LBP, lower back pain; MRI, magnetic resonance imaging; SIJ, sacroiliac joint; SUV, standardized uptake value; SPECT, single photon emission computed tomograph.

uptake at sacroiliac ligament insertions (AUC = 0.99)—with the combination yielding an AUC of 1.0—showed significant association with clinically diagnosed SIJ complex pain. However, the absence of confirmatory diagnostic intra-articular SIJ injections or sacroiliac lateral branch blocks necessitates cautious interpretation of these findings. This study indicates that SPECT/CT may hold promise as an imaging modality capable of identifying a painful SIJ complex, but future study will require use of diagnostic anesthetic injections as the reference standard.

Differentiating a painful sacroiliac joint from painful dorsal ligaments by imaging

We found no studies evaluating the ability of radionuclide bone scans, CT, MRI, or SPECT to differentiate a painful SIJ from painful dorsal ligaments.

Summary:

- The sensitivity of radionuclide bone scan (13%-46%) is inadequate for identifying a painful SIJ, though specificity is high (>90%); Grade D evidence for use as a diagnostic tool, moderate level of certainty.
- CT has inadequate sensitivity (57.5%) and specificity (69%) for identifying a painful SIJ; Grade D evidence for use as a diagnostic tool, low level of certainty.
- The evidence is insufficient to determine the sensitivity and specificity of MRI for identifying a painful SIJ; the available evidence suggests that MRI has low sensitivity and specificity for identifying a painful SIJ; Grade I evidence.
- SPECT/CT appears to have high sensitivity (95%) and specificity (99%) for identifying a painful SIJ complex based on one study, but these estimates are limited by using a reference standard of physical examination (rather than anesthetic injection) to diagnose SIJ complex pain; Grade I evidence for use as a diagnostic tool.
- SPECT/CT can identify EA and/or IA uptake but there is insufficient evidence to suggest that it can be used to differentiate IA SIJ pain from dorsal ligament pain; Grade I evidence.

Q4. Are intra-articular sacroiliac joint injections and sacral lateral branch injections diagnostic or prognostic?

The SIJ complex is a dual-structured joint where the sacrum meets the ilium. It features an amphiarthrodial superior/dorsal region with fibrocartilage and a smaller, more mobile diarthrodial antero-inferior portion with hyaline cartilage.¹⁻⁴ The joint is enclosed by a fibrous capsule with synovial lining and supported by extensive anterior and posterior ligaments, all containing nociceptors that can generate pain. The neuroanatomy of the SIJ complex remains incompletely characterized, with variability observed between independent cadaveric dissection studies. This anatomical complexity has led to debate regarding the diagnostic and prognostic validity of IA SIJ injections and sacroiliac lateral branch blocks (SLBBs) in clinical practice.^{3,25,106-118}

Are sacroiliac joint injections diagnostic?

There is no reference standard beyond diagnostic IA SIJ injection for confirming SIJ complex pain, creating an inherent challenge in assessing its diagnostic value. Current literature reports one or more IA SIJ injections as the reference

standard to evaluate other diagnostic methods (history, physical examination, imaging). Multiple factors can affect the sensitivity and specificity of these injections, including placebo effects, referred pain, neuroplasticity, central sensitization, expectation bias, systemic absorption of local anesthetic, and psychological factors.¹¹⁹ Furthermore, the SIJ may communicate with the S1 foramen, there is potential for dorsal leakage of injectate from the joint, and anterior capsular defects are present in approximately 40% of individuals with suspected SIJ complex pain.⁴³ As such, a technically sound IA SIJ injection may result in off-target anesthetic spread and the possibility of a false-positive test result.^{5,42,43} Despite these limitations, multiple systematic reviews and meta-analyses provide evidence that IA SIJ injections are diagnostic for SIJ-mediated pain with the false-positive rate of uncontrolled injections averaging around 20%.^{8,40,83,120} The Centers for Medicare and Medicaid Services (CMS) considers IA SIJ injections to have diagnostic value while acknowledging that the EA ligaments may be a pain generator.¹²⁰ A systematic review of 18 manuscripts by Simopoulos et al. found evidence that controlled comparative local anesthetic IA SIJ injections are the best means to diagnose SIJ-mediated pain.⁴⁰ Another systematic review by Kennedy et al. also supports the diagnostic validity of IA SIJ injections for SIJ-mediated pain.⁸ A systematic review by Szadek et al. partially supports the diagnostic validity of IA SIJ injections, but recommended that further studies should be conducted secondary to a paucity of sensitivity and specificity data.⁸³

Are sacroiliac joint injections prognostic?

Intra-articular SIJ injections may be prognostic for the outcome of SIJ immobilization by fusion (see Table 8). All clinical studies assessing the effect of SIJ fusion to date have used IA SIJ injections to select patients for surgery. However, it is unclear what prognostic value IA SIJ injections have for predicting response to SLBRFA. Although most clinical studies evaluating SLBRFA have used IA SIJ injections to select patients and reported favorable outcomes,^{14,21,27,119} SLBRFA targets nerves that innervate the posterior ligamentous complex and posterior aspect of the joint, but not the full capsule, synovium or most of the IA portion of the SIJ.^{111,117} The current literature suggests there are minimal differences in the prognostic value of an IA SIJ injection compared to SLBB in predicting SLBRFA treatment outcomes.¹²¹ The only randomized study that reported a negative result from SLBRFA used a single prognostic IA SIJ injection with 3 mL of 2% lidocaine, but also required only a 2-point decrease in pain to diagnose SIJ pain.²⁴ Because of the spread of local anesthetic (but not extension of an RFA lesion) to adjacent potential pain-generating structures, this cutoff is likely too lenient and results in a high rate of false-positive responses (low specificity). An additional confounding variable is that this study also used technology and a SLBRFA technique this is not anatomically valid.^{121,122} Anatomically valid SLBRFA techniques are described in Questions 13 and 17.

Prognostic value of local anesthetic injections on steroid injection outcomes

There are few studies examining the prognostic value of local anesthetic injections on outcomes from corticosteroid injections. In a small, prospective study performed in 26 patients, Schneider et al. reported a modest correlation between

Table 8. Systematic reviews and clinical studies discussing diagnostic and prognostic validity of sacroiliac joint injections and sacral lateral branch blocks for sacroiliac joint complex-mediated pain.

Author, year	Patients	Design	Results	Comments
Simopoulos, 2012 ⁴⁰	18 manuscripts reviewed	Systematic Review	False-positive rate for uncontrolled injections of approximately 20%. Evidence good for the diagnosis of SIJ complex pain using controlled comparative local anesthetic injections.	Fair to good support for diagnostic potential of dual local anesthetic injections in patients with positive SIJ provocation maneuvers.
Kennedy, 2015 ⁸	45 manuscripts reviewed, 39 manuscripts on diagnostic IA SIJ injections	Systematic Review	39 of 45 articles reviewed revealed evidence supporting diagnostic validity of IA SIJ injections	Systematic review did not comment on the prognostic validity of IA SIJ injections.
Szadek, 2009 ⁸³	30 manuscripts reviewed	Systematic Review	There is a paucity of sensitivity and specificity data. None of the manuscripts reviewed evaluated the diagnostic validity of SIJ injection	Authors note that because there is no reference standard for diagnosing SIJ pain, that while SIJ injections have face validity for diagnosing SIJ pain, they cannot be further validated.
Dreyfuss, 2009 ¹¹⁷	20 asymptomatic volunteers	Randomized, double-blind, placebo-controlled study	70% of active group had insensate interosseous and dorsal sacroiliac ligaments and inferior dorsal SIJ vs 0-10% of sham group. 86% of subjects who received verum injections retained sensation of repeat capsular distension despite insensate dorsal SIJ complex.	Multi-site, multi-depth SLBB are 70% effective at blocking sensation to interosseous and dorsal sacroiliac ligaments and dorsal SIJ but do not block sensation from the IA portion of SIJ.
Cohen, 2008 ²¹	28 patients with $\geq 75\%$ relief from IA SIJ injections	Randomized, sham-controlled study	1-, 3-, and 6-months after the procedure, 11 (79%), 9 (64%), and 8 (57%) RFA-treated patients experienced at least 50% pain relief and significant functional improvement.	First sham-controlled trial (high-level evidence) that L4 and L5 dorsal rami and S1-S3 sacral lateral branch RFA may provide pain relief and functional benefit for SIJ complex pain.
Mehta, 2018 ²⁷	30 enrolled patients, only 17 of whom were randomly assigned to active or sham treatment based on $\geq 80\%$ pain relief from dual IA SIJ injections	Randomized, double-blind, sham-controlled trial	At 3 months, the mean NRS pain score for the active group decreased significantly but the sham group did not experience a statistically significant decrease in pain.	Study demonstrated that RFA using a strip lesioning device may be an appropriate therapy to treat SIJ complex pain.
Cohen, 2009 ¹¹⁹	77 patients who underwent RFA using various selection criteria	Retrospective study evaluating factors associated with SLBRFA outcomes	Forty patients (52%) obtained a positive outcome. In multivariate analysis, preprocedural pain intensity, age older than 65 years, and pain radiating below the knee were significant predictors of failure.	Number of IA SIJ injections or performance of SLBBs not associated with RFA outcome. No single clinical variable reliably predicted treatment results.

(continued)

Table 8. (continued)

Author, year	Patients	Design	Results	Comments
Patel, 2012 ²²	51 pts with SIJ complex pain based on IA or ligamentous injections and $\geq 75\%$ pain relief to dual L5 dorsal ramus and S1-3 lateral branch blocks	Randomized, double-blind, sham-controlled study	3-months post-procedure, NRS pain scores were lower in the RFA group than the sham group.	Second sham-controlled trial (high-level evidence) that L5 dorsal ramus and S1-S3 sacral lateral branch RFA may provide pain relief and functional benefit for SIJ complex pain.
Cohen, 2023 ¹⁴	210 patients selected based on positive response to an undescribed SIJ injection and $\geq 50\%$ pain relief from SLBBs.	Randomized, multicenter comparative-effectiveness study	3 months post-treatment, the mean pain score for the RFA group decreased significantly vs no significant decrease in the standard medical management group.	First large, randomized, multicenter study to demonstrated effectiveness for RFA compared to standard medical management for subjects with chronic SIJ complex pain.
van Tilburg, 2016 ²⁴	60 patients enrolled based on ≥ 2 -point pain reduction after diagnostic SIJ injections. Included patients with “sciatica”, and did not describe the diagnostic SIJ injections.	Randomized, double-blind, sham-controlled, multicenter trial	No statistically significant difference in pain level over time between groups.	Only 11% had negative diagnostic injection. A non-anatomically valid SIJ RFA technique was used.
Juch, 2017 ¹⁶	226 patients enrolled based on $\geq 50\%$ pain relief from L5 dorsal ramus and S1-3 lateral branch blocks.	Randomized comparative-effectiveness study comparing exercise program alone to exercise and RFA. Included patients who responded to low-volume L5 dorsal ramus and S1-3 sacral lateral branch blocks.	Significant difference favoring RFA group at 3-month primary endpoint but not afterwards.	Patients could receive psychotherapy as indicated. Only 24% of patients had negative SLBBs. A non-anatomically valid SLBRFA technique was used in a subset of subjects.

IA, intra-articular; RFA, radiofrequency ablation; SIJ, sacroiliac joint; SLBB, sacral lateral branch block (injection); SLBRFA, sacral lateral branch radiofrequency ablation.

immediate pain relief from the local anesthetic in low-volume (2 mL) lidocaine-steroid injections, with the negative predictive value of immediate pain relief being higher for a negative response 2–4 weeks post-injection than the positive predictive value of a positive response, which is consistent with diagnostic blocks performed for other conditions.^{123,124} In two placebo-controlled trials evaluating IA facet steroid injections in which patients were selected based on a positive response to injections performed only with local anesthetic, neither reported positive outcomes.^{125,126} In addition to the questionable prognostic value of local anesthetic blocks, differences in technique (ie, needle location) and injectate spread between injections limit reproducibility.

Are sacral lateral branch blocks diagnostic?

Randomized, double-blinded, placebo-controlled studies reveal that SLBBs are not diagnostic for IA SIJ-mediated pain.¹¹⁷ There is anatomical evidence that the IA portion of the SIJ is innervated from both ventral and dorsal sources.^{107,113,127} A randomized double-blind, placebo-controlled study in 20 asymptomatic subjects by Dreyfuss et al. revealed that multi-site, multi-depth SLBBs are approximately 70% effective in blocking nociception arising from the interosseous (IO) and dorsal sacroiliac (DSI) ligaments, as well as the inferior dorsal capsule of the joint, but do not effectively block pain associated with distension of the full SIJ capsule.¹¹⁷ Although this study did not assess the ability of SLBBs to block nociception from the articular surfaces of the SIJ (ie, no noxious stimulus to the articular surfaces was applied), it is very unlikely that the full IA portion of the SIJ is innervated by sacral lateral branches when taking into account these results and those of anatomical studies.^{117,121,122}

Are sacral lateral branch blocks prognostic?

SLBBs have face-validity for predicting the outcome of SLBRFA given that the same nerves blocked are those targeted by SLBRFA; however, the current literature suggests that they may not provide meaningful additional predictive value beyond using historical and physical exam criteria (ie, provocative tests) and a prognostic injection of any type (IA SIJ injection, SLBB or even a large-volume injection into the dorsal ligaments)^{25,121} (see Table 8). Pragmatic trials directly comparing selection pathways and protocols are needed to increase confidence in our understanding of the prognostic value of IA, EA, and SLBBs. It will be important that such trials use anatomically-valid SLBRFA techniques^{121,122} as discussed in Question 13 of these guidelines.

Summary:

- IA SIJ injections are diagnostically valid for IA SIJ-mediated pain; Grade B evidence, moderate level of certainty.
- IA SIJ injections with local anesthetic have unreliable predictive value for IA injections with steroids; Grade I.
- IA SIJ injections have unreliable prognostic value for SLBRFA—Grade C, low level of certainty.
- SLBBs are diagnostic for pain arising from the interosseous ligament, dorsal sacroiliac ligament, and inferior dorsal SIJ joint; Grade B evidence, low-to-moderate level of certainty.

- There is insufficient evidence to assess the relative prognostic validity of SLBBs compared to other selection criteria for SLBRFA; Grade I evidence.

Recommendations:

- Multiple systematic reviews partially support the diagnostic validity of SIJ injections, but further study is needed to address the variability in sensitivity and specificity data.
- Further pragmatic trials directly comparing selection criteria (history, physical examination, and SLBBs) are needed to increase confidence in the relative prognostic values of different means of optimally selecting SLBRFA candidates.

Q5. What volume should be used for intra-articular sacroiliac joint injections? Should diagnostic injections include corticosteroid?

History and physical examination can suggest the SIJ complex as the pain generator in patients with LBP, but with undetermined specificity and sensitivity. Pain relief following IA SIJ injections of local anesthetic (LA), with or without corticosteroids, is considered a more reliable diagnostic indicator of the SIJ being the pain-generator in patients with LBP than history and physical exam alone. Only 15–30% of patients with suspected SIJ complex-related pain based on history and examination experience analgesic benefit with IA injections of LA, which is likely attributable to a combination of incorrect diagnosis, lack of spread to the pain-generating area(s), and other technical failures.^{8,80,128} Intra-articular SIJ injections are characterized by high false-positive rates, with needle position and the volume of injectate playing key roles in specificity.

Capacity of the sacroiliac joint

The SIJ has a surface area of around 17.5 cm², but the synovial portion has small capacity. The capacity of the SIJ has been measured by injecting contrast medium into the joint until either resistance was met or spillage into EA structures was observed. The reported volumes for retained IA injectates range from 0.8 to 2.5 mL in asymptomatic individuals and 1.0–2.7 mL in symptomatic individuals.^{129,130} Considering bony overgrowth (eg, osteophytes) in individuals with osteoarthritis, it is possible that healthy joints can accommodate a greater volume of injectate without capsular tears. It has been proposed that injectate volumes exceeding 2.5 mL are likely to be non-specific for diagnosing the articular portion of the SIJ as the pain generator in patients with mechanical LBP due to EA spillage.¹³¹

The SIJ is covered dorsally by four layers of sacroiliac ligaments and muscles that can also be pain generators. Extra-articular causes of pain from the SIJ are likely as common as IA causes,^{6,132} and the false-positive rate of single diagnostic IA SIJ injections is approximately 20%.⁸⁰ Therefore, target specificity is an essential criterion in assessing the validity of a diagnostic injection and, for IA LA injections into the SIJ, false-positive rates of 19%–22% have been reported in various studies synthesized in a systematic review.⁸

Intra-articular sacroiliac joint injections

Presence of IA spread of a small volume of injected contrast (up to 0.5 mL) without spillage into anatomical structures

Table 9. Data on injectate volumes from studies evaluating sacroiliac joint complex interventions.

First author, year, study type	Study population	Intervention	Implications for SI joint volume	Comments
Schwarzer, 1995 ⁴³ Prospective	43 patients with LBP below the L5-S1 spinal level investigated with SIJ injections	1 mL of contrast and 1 mL of LA	2 mL injected	30% patients reported pain relief with 19 (44%) patients exhibiting tears in the ventral capsule
Laslett, 2005 ¹⁴⁰ Prospective	48 patients with suspected SIJ complex pain	1 mL of contrast and 1 mL of LA	2 mL injected	33% patients had pain relief with SIJ injections
Fortin, 2003 ¹³³ Prospective	74 SIJ injections in 43 patients (age 20-48 years)	63.5% subjects had a positive injection provocation test (reproduction of pain)	Mean injected volume: 1.08 mL (range: 0.5-1.8 mL)	Direct relationship between volume injected and pain reproduction, but not between reproduction of pain with injection and CT or x-ray findings of pathology.
Waisbrod, 1987 ¹⁴⁸ Retrospective	21 patients	Injections to prognosticate outcome of SIJ fusion	1-2 mL of saline to provoke pain and 1-2 mL of LA to relieve it	11 patients had 50% pain relief at a mean follow-up of 2.5 years after SIJ fusion
Schütz, 2006 ¹⁴⁹ Retrospective	14 patients	Injections to prognosticate outcome of bilateral SIJ fusion	5 mL of LA	Only 18% patients were satisfied with the outcome at a mean follow-up of 39 months
Fortin, 1999 ⁴² Prospective	76 SIJ injections in 43 patients with LBP (age range 24-48 years)	Injections with contrast to evaluate the pattern of spread	Mean injected volume: 1.08 mL (range: 0.5-1.8 mL)	61% of injections resulted in EA spread - posterior spread into the dorsal sacral foramina, superior spread to the fifth lumbar nerve root, and ventral spread to the lumbosacral plexus
Stelzer, 2019 ¹⁵⁰ Prospective	40 SIJ injections in 20 cadavers	Injections with contrast to evaluate the pattern of spread	0.5 mL of contrast injected followed by 2 mL of colored latex	Significantly higher success rate of IA injection with fluoroscopy compared to US
Luukkainen, 1999 ⁹ RCT	20 patients	Therapeutic EA injections of LA and corticosteroid vs LA only	3 mL of injectate	Better clinical outcomes in LA and corticosteroid group
Luukkainen, 2002 ¹⁰ RCT	24 patients	Therapeutic EA injections of LA and corticosteroid vs LA only	3 mL of injectate	Better clinical outcomes in LA and corticosteroid group
Cohen, 2019 ⁶ RCT	125 patients	Therapeutic fluoroscopically-guided IA SIJ and palpation-guided injections in proximity to the SIJ	3 mL of injectate	No difference at 1 month after the injections but better relief with fluoroscopically-guided injections at 3 months. In the fluoroscopy group, 44% of injections were only IA, 47% were IA and EA and 9% were EA.

(continued)

Table 9. (continued)

First author, year, study type	Study population	Intervention	Implications for SI joint volume	Comments
Maigne, 1996 ⁸⁰ Prospective	19 patients	Dual diagnostic injections into the SIJ in patients with LBP—first injection with lidocaine and second injection with bupivacaine	1 mL of contrast injected followed by 2 mL of lidocaine 2% for first injection and bupivacaine 0.5% for second injection	35% patients after 1 st injection and 18.5% after 2 nd injection had their VAS pain score reduced by $\geq 75\%$
Maigne, 2005 ⁵⁶ Prospective	45 patients	Diagnostic injection into SIJ in patients with pain over the SIJ following lumbar spinal fusion	1 mL of contrast injected followed by 2 mL of lidocaine 2%	40 patients had IA injections – 35% (95% CI: 20.2–49.8%) of these had $>75\%$ reduction in pain 15 min after injection
Yin, 2003 ²⁵ CS-R	14 patients	2 separate EA SIJ (deep interosseous ligamentous) injections with LA and corticosteroids to target pain arising from the SIJ and the posterior ligaments covering the joint	5 mL of 0.5% bupivacaine containing 4 mg/mL of triamcinolone	Injections used to select patients for RFA, of which 60% experienced $\geq 60\%$ subjective relief and $\geq 50\%$ pain score reduction maintained for at least 6 months.
Murakami, 2007 ¹³⁷ RCT	50 patients	Diagnostic injection with LA: IA vs EA	2 mL of 2% lidocaine	EA injections effective in all 25 patients but IA injections effective in only 9 of 25 patients. EA injections administered in one or more sections of the posterior EA area of the SIJ and to another section in the extracranial portion.
Murakami, 2018 ¹³⁶ Prospective	85 patients	Diagnostic injection with LA close to the posterior superior iliac spine: EA first; IA if EA was unsuccessful	2 mL of 2% lidocaine	58 out of 85 patients had pain relief with EA injection; 14 out of remainder had pain relief with IA injection

CI, confidence intervals; EA, extra-articular; IA, intra-articular; LA, local anesthetic; LBP, low back pain; PA, periarticular; RCT, randomized controlled trial; RFA, radiofrequency ablation; SIJ, sacroiliac joint; US, ultrasound; VAS, visual analog scale.

Table 10. Data on use of corticosteroids in diagnostic injections from studies on sacroiliac joint complex interventions.

First author, year, study type	Study population	Intervention	Implications for use of corticosteroids in injectates	Comments
Dreyfuss, 1996 ⁶⁷ Prospective	85 patients with suspected SIJ complex pain who received IA injections to determine the validity of historical and physical exam signs for diagnosis	0.2-0.5 mL of contrast, 1.5 mL of LA, 0.5 mL of corticosteroid injected into SIJ	Increase in volume of the injectate by 25% due to use of corticosteroids	52 patients (61%) reported $\geq 50\%$ pain relief 20 min after the injection
Borowsky, 2008 ¹³⁹ Retrospective	120 patients with suspected SIJ complex pain ($n = 40$ who received IA and 80 who received IA + EA injection)	IA-only injection consisted of 1.5 mL of 0.5% bupivacaine + 80 mg MP; Combination injection consisted of 2 mL 0.5% bupivacaine + 40 mg MP injected IA, and 2 mL bupivacaine and 40 mg MP injected into dorsal SIJ ligaments bathing lateral branches	Increase in volume of the injectate by 100% due to deliberate EA injection	At 3 months after injection, 12.5% patients in IA group and 31.25% patients in IA+EA group reported $\geq 50\%$ reduction in pain score
Soneji, 2016 ¹⁵¹ RCT	40 patients with suspected SIJ complex pain based on physical exam who underwent ultrasound-guided or fluoroscopically-guided IA SIJ injections	4 mL of injectate (3 mL of LA (bupivacaine 0.5%) and 1 mL of MP) as a diagnostic and therapeutic intervention	Increase in volume of the injectate by 33% due to use of corticosteroids	50% of ultrasound vs 65% of fluoroscopically-guided injections were IA. Similar outcomes in both groups.
Liliang, 2011 ⁵³ Prospective	52 patients (out of 130) who had lumbar/lumbosacral spinal fusion and had ≥ 3 positive provocation tests for SIJ complex pain	Dual diagnostic IA SIJ injections with 0.5 mL contrast, 1 mL of LA (lidocaine 2% or bupivacaine 0.5%) with 1 mL of corticosteroid (40 mg triamcinolone)	Increase in volume of the injectate by 100% due to use of corticosteroids	40% patients had $\geq 75\%$ reduction in pain with both diagnostic injections
Chou, 2004 ⁶⁴ Prospective	54 patients with (+) provocation tests who experienced $\geq 80\%$ pain relief with diagnostic IA SIJ injection using only LA. 2 additional therapeutic injections with LA and corticosteroid were scheduled but cancelled if the first injection conferred $\geq 80\%$ pain relief 2 weeks post-injection. Those who failed to obtain relief from therapeutic injections were scheduled for controlled dual injections (EA injections with saline and IA injections with LA).	0.5 mL contrast, 0.5 mL of LA (lidocaine 2%) with 2 mL of corticosteroid (12 mg betamethasone)	All 27 patients who did not report pain relief with IA SIJ injection with LA and corticosteroid also did not report pain relief with subsequent dual diagnostic injections with saline and LA.	A mean of 2.5 (range: 1-4) therapeutic SIJ injections were administered to study participants

(continued)

Table 10. (continued)

First author, year, study type	Study population	Intervention	Implications for use of corticosteroids in injectates	Comments
Maugars, 1992 ¹⁴³ Prospective	42 SIJ injections in 22 patients with sacroiliitis	0.5 mL contrast followed by 1.5 mL of Cortivazol (equivalent to 62.5 mg of prednisolone) injected into SIJ without any LA	LA not injected because authors concerned about “transient anesthesia of the pelvis”	79% of patients (81% of joints) reported $\geq 70\%$ pain reduction for at least 1 month
Maugars, 1996 ¹¹ RCT	13 SIJ injections in 10 patients with sacroiliitis	1–3 mL contrast followed by 1.5 mL of Cortivazol (equivalent to 62.5 mg of prednisolone) or saline injected into SIJ without any LA	Enrollment stopped at 1 year when only 1/3 rd of required number of participants enrolled	At 1 month, 5 of 6 SIJs in patients injected with corticosteroid reported $> 70\%$ pain relief compared to 0 out of 7 in the placebo group
Karabacakoglu, 2002 ¹⁴² Prospective	22 SIJ injections in 17 patients with ankylosing spondylitis and sacroiliitis	0.2–0.5 mL contrast followed by 1 mL (14 mg) of betamethasone injected into SIJ without LA		At 1 month, 15 out of 17 patients reported good improvement and 2 of 17 reported fair improvement
Visser, 2013 ¹³⁴ RCT	51 patients with SIJ and leg pain randomized to physiotherapy ($n = 15$), manual therapy ($n = 18$), and IA injection ($n = 18$)	0.6–2 mL of a mixture of 30 mg of lidocaine and 20 mg triamcinolone injected	Mean IA injectate volume: 1.1 mL	20% of patients in physiotherapy group, 72% of patients in manual therapy group, and 50% of patients in IA injection group reported some reduction in pain 6–12 weeks after injections

EA, extra-articular; IA, intra-articular; LA, local anesthetic; MP, depo-methylprednisolone; RCT, randomized controlled trial; SIJ, sacroiliac joint; VAS, visual analog scale.

adjacent to the SIJ or evidence of intravascular uptake confirms target specificity. In a systematic review by Kennedy et al., the synthesis of literature suggested that 0.2–0.5 mL of contrast was needed to confirm IA placement of the needle tip, followed by the injection of 0.5–2 mL of local anesthetics (depending on the dose and concentration), and 1–2 mL of corticosteroids (depending on the dose and concentration) into the SIJ for therapeutic effect.⁸ The total volume of the injectate for IA injection in the SIJ has varied from 1.5 to 4 mL in clinical studies (Table 9). The mean volume of retained IA contrast injectate for the SIJ, prior to EA spread being observed, was reported to be 1.1 mL in two studies.^{133,134} The median volume of injectate when only LA is used is approximately 2 mL but increases to 3 mL when a combination of LA and corticosteroids is injected into the SIJ (Tables 9 and 10).

Extra-articular sacroiliac joint injections

Pain arising from the SIJ can be due to stimulation of the nerve endings that exist not only in the articular cartilage but also in the SIJ capsule, synovial lining and the ligaments covering the posterior (and anterior) aspect of the joint.^{3,135} An EA injection of LA into the posterior ligaments can often provide effective relief of SIJ-related pain.^{136,137} This may be more relevant when soft tissue dysfunction of the SIJ is presumed to be the main cause of pain, such as in the non-elderly population with LBP.¹³⁸ Other studies have reported analgesic benefit when a combination of LA and corticosteroid was injected in the EA tissue in close proximity to the SIJ.^{9,10,25,139} However, these studies have several limitations: (1) none pre-screened patients with diagnostic injections; (2) follow-ups were short-term; and (3) functional capacity was not sufficiently evaluated.¹ Irrespective of the composition of the injectate, the volume for injection into the EA space around the SIJ is usually 2–3 mL.

Should diagnostic sacroiliac joint injections include corticosteroids?

Corticosteroids are usually injected into the SIJ to confer therapeutic benefit, especially if a preceding injection with LA results in substantial (usually $\geq 50\%$) but short-lasting pain relief.^{68,140} Ideally, the injection of a combination of LA and corticosteroids would confer a biphasic response with the LA providing the initial analgesic benefit and the corticosteroid conferring delayed but sustained pain relief.

A sustained analgesic response after an SIJ injection with LA and corticosteroids may indicate the SIJ is indeed responsible for a patient's pain but could also reflect a discordant (prolonged) response to injection of the LA, which may be a placebo effect. Further, the addition of corticosteroids often increases the volume of the injectate (Table 10) and the utility of including corticosteroids in diagnostic injections into the SIJ is unclear. In a systematic review, when local anesthetic alone was injected, 35% (95% CI: 29–41%) of 246 patients experienced $\geq 75\%$ relief, but when corticosteroid was added to the injectate, 49% (95% CI: 47%–51%) of 685 patients had $\geq 75\%$ relief, suggesting corticosteroids may undermine specificity.⁸ The timing of evaluation is important when determining whether a diagnostic injection is positive or negative, as systemic effects from injectable corticosteroids may be apparent within 6 h depending on intravascular uptake and the corticosteroid injected, which is often the timeframe for evaluating pain diaries.

Although a systematic review found that corticosteroids provide added relief to local anesthetic in only a small percentage of patients undergoing IA injections and nerve blocks,¹⁴¹ in some cases, it may be appropriate to inject corticosteroids in the IA space in patients with suspected sacroiliitis because inflammation of the articular surfaces is a key driver of pain in these patients. Injection of corticosteroids in the IA space in these patients is often associated with pain relief lasting for one to six months.^{11,142,143}

Goals of the injections

SIJ injections serve multiple purposes beyond diagnosing or confirming SIJ complex pain in patients with LBP. These injections can also predict responses to more definitive interventions, such as surgical joint fusion or SLBRFA. There are no studies evaluating the predictive value of SIJ injections before fusion, but for lumbar fusion, the results are decidedly mixed, with discography rarely used nowadays to select patients.¹⁴⁴ Logically, when using IA SIJ injections as prognostic indicators for SIJ fusion outcomes, it would be crucial to ensure the injectate remains within the IA space. However, studies evaluating SIJ fusion typically do not report the volume of injectate used.^{145,146}

RFA of the nerves supplying the SIJ complex targets the innervation to the posterior sacroiliac ligaments and posterior aspect of the SIJ. Hence, inadvertent EA spread during an intended IA injection that results in analgesic benefit may be more predictive of the analgesic benefit following RFA of the posterior SIJ complex innervation, though it would be impossible to separate the contributions of IA and EA spread.

Another important issue to consider when treating patients with SIJ complex pain is whether the pain is purely IA, purely EA, or from a combination of IA and EA pathology. Even in patients with spondyloarthropathy, controlled trials evaluating EA corticosteroid injections have shown efficacy.⁹ Suspecting the latter would justify an injection approach that involves intentional extravasation of LA into both the IA space as well as the posterior ligaments of the SIJ. In a retrospective study that compared outcomes in 120 patients who received only IA vs a combination of IA and EA injections, Borowsky et al. reported a higher incidence of analgesic benefit in the combination group. At 3 months after the injections, 12.5% patients in IA SIJ injection group and 31.3% patients in the combination group reported 50% or more reduction in their pain intensity scores.¹³⁹

Sacral lateral branch blocks

Prognostic injections of the lateral branches innervating the posterior SIJ have been recommended prior to SLBRFA, with the total cumulative volume for S1–3 ranging between 1.5–2 mL in controlled trials.^{14,16,22} When S4 is targeted, slightly higher volumes may be necessary. For the L5 dorsal ramus, consistent with facet injections, most studies have used volumes ≤ 0.5 mL. In a pilot study performed in healthy volunteers that found that multi-depth (but not single-depth) SLBBs prevented pain from ligamentous probing but not capsular distension, Dreyfuss et al. performed injections at the L5 dorsal ramus and from S1–2 at the 2:30, 4:00, and 5:00 positions on the face of a clock for right-sided injections (mirror image locations on the left) 8–10 mm from the lateral margin of the posterior foramina, using 0.2 mL per site. At S3, nerves were targeted at the 2:30 and 4:00 positions, while S4 was only injected at the 3:00 position on the right in the single-site,

single-depth study (it was not targeted in the multi-site, multi-depth study). In the multi-depth study, the authors injected first at sacral periosteum, then repeated the injection after pulling back the needles 1 bevel length (approximately 3 mm). This resulted in a volume of 1.2 mL at each peri-foraminal region, injected at two different depths and at three different points at each sacral level.^{117,118} SLBBs are performed purely as predictive tests before SLBRFA and there is no evidence supporting lateral branch nerve entrapment or inflammation as the etiology of SIJ complex pain. There is currently no basis to add corticosteroids to the local anesthetic. Given the variability in anatomy and techniques, more research is required to evaluate the impact of the volume of injectate in predicting outcomes of definitive therapies for relieving SIJ complex pain.

Communication between the sacroiliac joint and proximal neural structures

The lumbosacral plexus runs directly across the anterior joint capsule of the SIJ. Defects in the capsule of the SIJ can result in the spread of the injectate to neural and other pain-generating structures through the following pathways: (1) dorsal spread to the first three dorsal sacral foramina, (2) superior spread to the fifth lumbar nerve root, and (3) ventral spread to the lumbosacral plexus. Various patterns of neural spread were observed in over 60% of joints injected with contrast by Fortin et al.⁴² In a study evaluating landmark-based SIJ injections (no imaging guidance), Rosenberg reported a 44% incidence of spread into the sacral neural foramina (predominantly S1) and a 24% incidence of epidural spread.¹⁴⁷ In another study evaluating the arthrographic patterns of IA SIJ injections, nine of the 13 patients (69%) with pain relief following the injection exhibited tears in the ventral capsule of the joint.⁴³ In this study, the authors found a positive but weak association between capsular tears and analgesic benefit. In a study that enrolled patients with suspected SIJ complex pain after lumbar or lumbosacral spinal fusion surgery, four of the 52 patients (7.7%) patients experienced transient weakness of the lower extremities after IA SIJ injections with LA and corticosteroids.⁵³ The authors attributed this to leakage of the injectate from the ventral aspect of the SIJ.

It is difficult to interpret these findings because while capsular tears may raise the likelihood of an SIJ being painful, they can also result in false-positive responses to IA diagnostic injections with LA. Presence of sensorimotor neural blockade in the ipsilateral lower limb following IA SIJ injection of LA suggests spread of LA to the lumbosacral plexus through a tear in the ventral capsule of the SIJ. However, absence of this finding cannot rule out spread to neural structures adjacent to the joint.

Summary:

- IA injections into the SIJ should be performed with a maximum of 2.5 mL of total injectate to prevent capsular rupture and to reduce spread to adjacent structures; if an increase in resistance to the injection is perceived at lower volumes (eg, 2.0 mL), the injection may be halted to avoid tears in the capsule of the joint; Grade B recommendation, moderate level of certainty.
- In patients with suspected IA and EA pain arising from the SIJ itself and the ligaments overlying the posterior aspect of the joint, a total injectate volume higher than 2 mL may be required to block pain generators and treat

dysfunction. Up to and sometimes exceeding 3 mL (depending on the extent of pain and pathology) of injectate can be used to achieve this goal; Grade C recommendation, low level of certainty.

- The response to diagnostic IA SIJ injections can be used to select patients for surgical fusion of the SIJ; Grade B recommendation, moderate level of certainty.
- The addition of corticosteroids to LA for IA SIJ injections for diagnosing pain arising from the SIJ does not confer any clear diagnostic benefit while potentially increasing the volume of injectate, thereby increasing the chance of extra-articular spread. Corticosteroids should not be routinely added to LA during purely diagnostic IA injections; Grade D recommendation against the intervention; low level of certainty.
- The volume of LA for SLBBs should range between 0.67 and 1.2 mL per foraminal region to account for variable neuroanatomy and for the possibility of multiple nerves per level, and should be performed at different depths; Grade C recommendation, very low level of certainty.

O6. How accurate are the use of anatomical landmarks, ultrasound, and CT scan for obtaining intra-articular spread during a sacroiliac joint injection?

Landmark-guided sacroiliac joint injections

Randomized trials

A single randomized multicenter study by Cohen et al.⁶ evaluated the accuracy of landmark-based injections and compared clinical outcomes between landmark-guided and fluoroscopy-guided SIJ injections. The study randomized 125 patients with clinically suspected non-inflammatory SIJ complex pain supported by positive SIJ provocative maneuvers; 61 received landmark-guided injections, and 64 received fluoroscopy-guided injections. Following final needle placement based on randomization (eg, landmark vs fluoroscopy), contrast was injected under fluoroscopy for both groups prior to administration of LA and corticosteroid. In the landmark group, 8% of injections were either IA or IA and EA, whereas in the fluoroscopy group, 44% injections were IA and 47% were IA and EA. In the landmark-guided group, the remaining 92% of injections did not have any IA SIJ contrast spread. For the landmark-guided group, six injections were noted to have contrast spread in the piriformis muscle; one injection had contrast spread over the L5-S1 facet joint; three injections had contrast spread inside a sacral foramen; one injection had contrast spread within 3 cm of the hip; and one injection had contrast spread in the pelvic outlet. Regarding clinical outcomes, no significant difference in pain reduction was observed at 1 month between groups [−2.3 points change in pain numerical rating scale (NRS) in the fluoroscopy group vs −1.7 points in the landmark group; $P = .23$]. Although the reductions in average pain and worst pain were greater in the fluoroscopy group than in the landmark group at 3 months (−1.8 and −2.2 points in the fluoroscopy group vs −0.9 and −1.4 points in the landmark group; $P = .049$ and $.02$, respectively), these clinical differences were modest and accompanied by a higher cost for fluoroscopically guided injections (see Table 11).

Non-randomized trials

Three observational studies prospectively assessed the accuracy of landmark-guided SIJ injections. One study by Hansen

Table 11. Clinical studies evaluating accuracy of image or landmark guidance for sacroiliac joint complex injections.

Author, year	Patient population	Design	Results	Comments
Landmark guidance Rosenberg, 2000 ¹⁴⁷	37 SIJ injections in 33 pts with positive SIJ provocation maneuvers were performed.	A prospective study assessing the accuracy of landmark-guided SIJ injections with confirmation using CT scan.	IA SIJ injection was accomplished in 8 of 37 (22%) patients. Clinically-guided needle placement was based on palpation of the posterior superior iliac spines and identification of the midline.	Injected material was identified within 1 cm of the joint 68% of the time. Epidural contrast was observed 24% of the time and foraminal spread in 44% of injections.
Hansen, 2003 ¹⁵²	60 pts with positive SIJ provocation maneuvers underwent landmark-guided SIJ injection.	An observational study assessing the accuracy of landmark-guided SIJ injections with confirmation using FL.	Only 5 of 60 pts (12%) had IA SIJ needle placement.	The posterior superior iliac spine as the landmark was found to be a poor indicator of IA SIJ anatomic access.
Cohen, 2019 ⁶	125 pts with positive SIJ provocation maneuvers were randomized to receive landmark-guided injections or FL-guided injections.	A multicenter randomized comparative-effectiveness study to assess the accuracy of landmark-guided and FL-guided SIJ injections and compare outcomes.	In the landmark group, 8% of injections were either IA or EA and EA. In the FL group, 44% of injections were IA, 47% were IA and EA, and 9% were EA only.	No significant differences in pain reduction were observed between groups at 1 month. At 3 months, the improvement in average pain (−1.8 vs −0.9 points) and worst pain (−2.2 vs −1.4 points) were greater in the FL group than in the landmark group. No differences in clinical outcomes were observed between IA and other types of injections.
Fluoroscopy guidance Maigne, 1996 ⁸⁰	67 pts with chronic LBP referred for diagnostic IA SIJ injections.	Observational study assessing the diagnostic accuracy of clinical examination in identifying symptomatic SIJ complex pain.	Penetration of joint not possible in 10.4% of pts, sciatic palsy indicating extravasation occurred in 4.5%.	Used double injections
Stelzer, 2019 ¹⁵⁰	Cadaveric study with 20 subjects (40 joints).	A prospective study comparing the accuracy of lower US-guided SIJ injection with FL-guided SIJ injection using confirmation with dissection of injected colored latex.	US-guided injections were IA in 1/20 (5%), and EA in 19/20 (95%) with intra-ligamentous spread of latex. FL-guided injections were IA injection in 10/20 (50%) cases, 8/20 (40%) showed intra-ligamentous spread, and 2/20 (10%) revealed vascular spread.	With US, there was good structural visibility in 11 of 20 (55%) cadavers and perception of the needle being IA in 10 of 20 (50%). With FL, good structure visibility occurred in 9 of 20 (45%) cadavers and perception of the needle being IA occurred in 17 of 20 (85%) specimens.
Ultrasound guidance Pekkafahli, 2003 ¹⁵⁷	34 consecutive pts with SIJ complex pain diagnosed radiologically or based on physical exam.	A prospective study assessing the accuracy of US-guided SIJ injections with confirmation using FL.	Among 60 US SIJ injections, 46 (76.7%) were IA. The IA injection rate was 60% for the first 30 injections, 93.5% in the last 30 injections, with the last 20 US-guided injections all being IA.	The mean US-guided procedure time was 9 min (range, 4–18 min). Pain outcomes not assessed.

(continued)

Table 11. (continued)

Author, year	Patient population	Design	Results	Comments
Klauser, 2008 ¹⁶⁰	Cadaver study in 10 subjects (20 joints).	A prospective study comparing the accuracy of upper-level and lower-level SIJ injection with CT confirmation.	US-guided IA needle placement at the upper level occurred in 7 out of 10 (70%) specimens, and at the lower level in 9 of 10 (90%).	The mean procedure time was 3.09 min and was longer in the first cadavers than in the last cadavers. In 4 cases that were not IA, attempts at another level resulted in IA injection.
Hartung, 2010 ¹⁵⁸	14 pts (20 joints) with acute sacroiliitis.	A prospective study comparing US-guided SIJ injections with 1 mL corticosteroid in those with IA (40%) vs EA (60%) spread based on MRI.	8 SIJ injections (40%) were IA whereas the other 12 injections (60%) were EA. Similar pain relief was observed in both groups.	Study underpowered to detect a difference in outcomes. 1 mL corticosteroid mixed with contrast, without LA.
Je, 2014 ¹⁵⁴	120 pts with noninflammatory SIJ arthritis.	RCT comparing outcomes with US-guided vs FL-guided SIJ injections up to 12 weeks following injection.	No differences were observed in the ODI and NRS pain scores between groups. The US-guided SIJ was IA in 48 of 55 87.3% of pts and in 54 of 55 (98.2%) pts in the FL-guided group.	Vascularization around the SIJ was seen in 34 of 55 pts in the US group. 3 cases of intravascular injection occurred in the FL group.
Perry, 2016 ¹⁶¹	Cadaver study with nine subjects (17 joints).	A prospective study assessing the accuracy of US-guided SIJ injection with confirmation by dissection of injected paint marker.	Among 17 SIJ joints, 15 (88.2%) were injected with paint marker. Among the 15 joints with IA placement, 5 joints (33.3%) showed partial EA spread and required redirection of the needle. 3 joints (20%) had EA spread not seen during US.	One of the joints with no IA spread was found to be partially frozen at the time of dissection; the second joint was considered an unsuccessful injection because of osteophytes at the joint line.
Soneji, 2016 ¹⁵¹	40 pts with unilateral SIJ pain diagnosed by physical exam (eg, SIJ provocation maneuvers).	RCT comparing outcomes with US-guided vs FL-guided SIJ injections up to 3 months following injection.	The US-guided SIJ injections were IA in 10 of 20 (50%) vs 13 of 20 (65%) in the FL-guided group.	Reduction from pain scores observed in both groups at 1 month but no difference between groups.
De Luigi, 2019 ¹⁵⁵	50 pts with SIJ-mediated LBP diagnosed by physical exam (eg, SIJ provocation maneuvers).	A prospective study assessing the accuracy of US-guided SIJ injections with confirmation using FL.	In 48 out of 50 (96%) pts, IA contrast spread was seen on FL.	The 2 pts w/o IA spread both had a BMI >40. Of the 48 joints with IA spread, one had vascular uptake in addition to an IA arthrogram.
Fouad, 2021 ¹⁵⁶	34 pts with acute or chronic SIJ complex pain diagnosed by physical exam (eg, SIJ provocation maneuvers).	A prospective study assessing the accuracy of US-guided SIJ injections with confirmation using FL after final needle position.	33 of 39 (84.6%) injections were IA while 6 of 39 (15.4%) injections were EA.	Both groups improved with no difference between groups.

(continued)

Table 11. (continued)

Author, year	Patient population	Design	Results	Comments
CT guidance Artnr, 2012 ¹⁶³	30 pts with LBP and positive SIJ provocation testing who underwent bilateral SIJ injections.	Prospective study assessing outcomes with low-dose CT-guided injections and retrospective comparison of radiation dose to standard CT- and FL-guided injections.	100% of low-dose CT injections were IA with radiation dose (4.57 mGycm2) lower than FL-guided injections (3.73 mGycm2) and standard CT (76.27 mGycm2)	The accuracy of historical standard CT- and FL-guided injections was not reported. Clinical outcomes not reported.
Althoff, 2015 ¹⁶⁴	29 pts (21 bilateral, 8 unilateral) with inflammatory back pain and active SIJ inflammation confirmed by MRI.	A prospective study evaluating clinical outcomes 6 months after treatment.	23 pts (76%) had IA injection and 7 (24%) pts had EA injection. One patient with bilateral injections had one IA and the other EA.	At 3 and 6 months, greater improvement in the IA group than the EA group.
Paik, 2016 ¹⁶⁶	34 pts with presumed spondyloarthropathy or nonspondyloarthropathic SIJ dysfunction.	Retrospective study assessing outcomes after CT- with intermittent FL-guided SIJ injections.	All injections were IA (100%) with median procedural times of 5.28 min for unilateral and 6.72 min for bilateral SIJ injections and a median radiation dose of 0.11 mSv	When compared to reported procedural times in the literature, time was > FL-guided, but < standard CT-guided, US-guided, and MRI-guided SIJ injections
Bronsard, 2020 ¹⁶⁵	94 pts with SIJ complex pain with positive Fortin finger sign who underwent prior lumbosacral spinal fusion.	A retrospective study comparing outcomes two days after 1-3 IA and EA injections.	Of 146 SIJ injections, 61% were IA vs 100% of 34 3-dimensional injections.	41% of 2-dimensional injections were effective vs 73% of 3-dimensional injections. Long-term outcomes not assessed.
Bessar, 2021 ¹⁶²	52 pts with clinically-suspected SIJ complex pain.	RCT comparing outcomes with CT-guided vs FL-guided SIJ injections up to 12 months following injection.	Difficult localization of the SIJ space in 5 pts in the FL group. Improvement in pain score and function from baseline in both groups. Significant difference between groups favoring CT for both pain and function at 6 months, but only pain at 12 months.	Blinding was not noted. Improvement in both groups with non-significant difference favoring CT-guided group. No difference in radiation dose.
Oren, 2021 ¹⁶⁷	17 pts with suspected SIJ-related lower back or buttock pain.	Retrospective study assessing outcomes after CT with fused FL-guided SIJ injections.	All injections were IA (100%).	Of 23 injections, 100% pain relief was achieved 2 h after SIJ injection in 18 of 23 (78%). Long-term outcomes not assessed.

CT, computerized tomography; EA, extra-articular; FL, fluoroscopy; F/U, follow-up; IA, intra-articular; LA, local anesthetic; LBP, low back pain, NRS, pain numeric rating score, ODI, Oswestry Disability Index; RCT, randomized controlled trial; SIJ, sacroiliac joint; US, ultrasound; VAS, visual analog scale.

et al.¹⁵² included 60 patients with positive SIJ provocative maneuvers who underwent a SIJ injection using a landmark-guided technique performed by a single experienced physician. The posterior superior iliac spine was used as the landmark, with no imaging to guide injection. Based on fluoroscopic confirmation, only five of 60 patients (12%) had IA needle placement. The authors concluded that because blind placement of the needle infrequently results in IA spread, SIJ injections should be performed under fluoroscopic visualization.

A recent retrospective study by Hasoon et al. compared 2-week outcomes in 10 patients with clinically-suspected SIJ pain, 5 of whom underwent landmark-guided injections by inserting a needle slightly inferior to the PSIS, and 5 of whom underwent fluoroscopically-guided injections. Each group received 3 mL injections containing 2 mL of bupivacaine 0.25% and 40 mg of triamcinolone. Two weeks post-injection, the average pain relief was 76% in the image-guided group, which favorably compared to the mean 56% pain relief in the landmark-guided patients.¹⁵³

The inaugural study evaluating the accuracy of blind injections was conducted by Rosenberg et al.¹⁴⁷ The authors performed 37 SIJ injections in 33 patients who had positive SIJ provocation maneuvers. This study assessed the accuracy of landmark-guided SIJ injections based on palpation of the posterior superior iliac spine and identification of the midline, with position confirmed by CT scan. The final needle location was observed within the SIJ in only eight of 37 (22%) patients, with foraminal and epidural spread noted in 44% and 24% of injections, respectively. The authors concluded that the low accuracy rates for landmark-guided SIJ injections limit their use for injection therapy.

Fluoroscopically-guided sacroiliac joint injections

Randomized trials

As noted above, the accuracy rate in the randomized multicenter study by Cohen et al.⁶ comparing fluoroscopy-guided and landmark-guided SIJ injections found that 91% of fluoroscopically-guided injections were either IA or that the injectate spread within both the joint and to the posterior ligaments.

Non-randomized Studies

In a cadaveric study by Stelzer et al.¹⁵⁰ the accuracy of fluoroscopically guided SIJ injections was assessed, and joint spread was confirmed with dissection after injection of colored latex. The fluoroscopy guided SIJ injections showed IA spread in 50% of specimens, 40% of injections were within the posterior ligaments, and 10% demonstrated intravascular spread; it is noteworthy that for obvious reasons, readjustment was not performed after contrast injection.

There are several observational studies that assessed analgesic benefit with fluoroscopically-guided SIJ injections.^{68,80,140} These studies prospectively assessed the diagnostic utility of clinical examination in identifying SIJ complex pain based on the outcomes of fluoroscopically-guided IA SIJ injections. In the study by Maigne et al., 1 mL of contrast was injected into the SIJ, followed by 2 mL of lidocaine 2% for the first injection and bupivacaine 0.5% for the second injection. The authors reported that 35% of patients after the first injection and 18.5% after the second injection experienced $\geq 75\%$ pain reduction.⁸⁰ In the study published in 2005 by Laslett et al., 1 mL of contrast and 1 mL

of LA was injected into the SIJ, and 33% of patients reported pain relief.¹⁴⁰ In the 2003 publication by Laslett et al., 35% responded positively to the first injection; among these, 18.5% experienced temporarily relief from the confirmatory SIJ injection. However, no attempt was made to interpret the accuracy of fluoroscopic guidance for IA SIJ injections in these studies, and pain relief following injection was used as a surrogate.

Ultrasound-guided sacroiliac joint injections

Randomized trials

Two randomized trials compared clinical outcomes between ultrasound-guided and fluoroscopically-guided SIJ injections. In a study by Jee et al.,¹⁵⁴ 120 patients with non-inflammatory SIJ arthritis were randomized either to ultrasound-guided SIJ injections or fluoroscopically-guided injections. The spread of contrast was assessed by a blinded radiologist. The ultrasound-guided injections were IA in 87.3% of patients, and the fluoroscopy-guided injections were IA in 98.2% of patients ($P < .05$). Vascular injection was observed in 34 of 55 (62%) of ultrasound-guided injections while three cases of intravascular injection were found in the fluoroscopy group. No differences were observed in NRS pain and Oswestry Disability Index (ODI) scores up to 12 weeks following injections. Another study by Soneji et al.¹⁵¹ randomized 40 patients with unilateral SIJ arthritis to receive either ultrasound-guided or fluoroscopically guided SIJ injections, with participants followed for 3 months. In the ultrasound-guided group, contrast spread was assessed with fluoroscopy. Blinding was not reported. The ultrasound-guided SIJ injections were IA in 50% of patients, and fluoroscopically-guided injections were IA in 65% of patients. No significant differences in NRS pain or ODI scores were observed between groups.

Non-randomized trials

Several studies prospectively assessed the accuracy of ultrasound-guided SIJ injections using fluoroscopy as the reference standard.¹⁵⁵⁻¹⁵⁷ In the study by Pekkaflahli et al.,¹⁵⁷ 34 consecutive patients with SIJ complex pain underwent 60 ultrasound-guided SIJ injections, with 76.7% found to be IA. The IA injection rate appeared related to proceduralist experience, with an accuracy rate of 60% for the first 30 injections, which increased to 93.5% in the subsequent 30. A study by De Luigi et al.¹⁵⁵ reported a higher rate (96%) of IA injection in 50 patients with SIJ-mediated LBP who underwent ultrasound-guided SIJ injection. Only one injection resulted in vascular uptake of contrast. The two patients who had undergone ultrasound-guided SIJ injections without IA contrast spread had a body mass index over 40 kg/m². In 34 patients, Fouad et al.¹⁵⁶ found that 84.6% of injections were IA while 15.4% of injections were EA. Using MRI confirmation after ultrasound-guided SIJ injections in 14 patients (20 injections), Hartung et al.¹⁵⁸ observed IA spread in eight (40%) injections and EA spread in 60%. Lastly, a large retrospective review of 8,226 patients who underwent musculoskeletal injections by Hynes et al.¹⁵⁹ observed no difference in the complication rate between ultrasound- and fluoroscopically-guided musculoskeletal injections (SIJ injections were included with other injections).

Three studies assessed the accuracy of ultrasound-guided SIJ injections in cadaver models, with conflicting results. In a study by Klauser et al.,¹⁶⁰ the accuracy of upper-level and

lower-level ultrasound-guided SIJ injections was confirmed using CT. In a total of 20 joint injections, the authors observed IA needle placement at the upper level in 70% vs 90% at the lower level. The overall success rate for ultrasound-guided IA needle placement was 80% (16 of 20 SIJs). Another cadaver study by Perry et al.¹⁶¹ assessed the accuracy of ultrasound-guided SIJ injections through the dissection of injected paint markers. Out of 17 SIJ injections, 15 (88.2%) were injected in the IA space, but five (33.3%) also showed partial EA spread on ultrasound during initial injection, necessitating redirection of the needle. Three of the 15 IA joint injections exhibited partial EA spread not observed during ultrasound-guided needle placement. Finally, as above, a study by Stelzer et al.¹⁵⁰ compared the accuracy of ultrasound-guided SIJ injections to fluoroscopically-guided SIJ injections, evaluating joint spread by dissection after injection of colored latex. With ultrasound-guided SIJ injections, the IA spread was observed in 5% of injections, with 95% of injections being EA. In contrast, the fluoroscopy-guided SIJ injections showed IA spread in 50%, 40% showed intra-ligamentous spread, and 10% resulted in intravascular uptake.

CT-guided sacroiliac joint injections

Randomized trial

A single RCT compared clinical outcomes with low-dose CT-guided IA SIJ injections to fluoroscopically-guided IA SIJ injections. In a study by Bessar et al.,¹⁶² 52 patients with SIJ complex pain were randomized to either low-dose CT-guided IA SIJ injection or fluoroscopically-guided IA SIJ injection and followed for 12 months. In both groups, significant improvements in pain and function were observed through 12 months, with results generally being more favorable in the CT group. In this study, blinding was not reported. Difficulty in localization of the SIJ space was reported in five patients who underwent fluoroscopically-guided injections. More patients were satisfied in the CT group, with no significant difference in the radiation dose between groups.

Non-randomized studies

Two prospective studies assessed the accuracy and clinical outcomes of CT-guided IA SIJ injections. In a study by Artner et al.,¹⁶³ 30 patients with LBP and positive SIJ provocation testing underwent low-dose CT-guided bilateral IA SIJ injections, with 100% of injections being IA. The authors also found no significant difference in radiation dose when compared to fluoroscopically-guided IA SIJ injections performed the previous month (4.57 mGycm² with low dose CT-guided injections vs 3.73 mGycm² with pulsed fluoroscopically-guided injections). The authors did not delineate how accuracy was determined. When the accuracy was assessed using confirmation by a blinded evaluator in a later study by Althoff et al.,¹⁶⁴ CT-guided SIJ injections were observed to be IA in 76% of procedures.

Three studies retrospectively assessed the accuracy of CT-guided injections. In a study by Bronsard et al.,¹⁶⁵ 94 patients with SIJ complex pain after previous lumbosacral spinal fusion surgery underwent up to three CT-guided IA SIJ injections confirmed with arthrography. Out of 146 SIJ injections, 61 were IA, and 41% were effective (>70% pain improvement) two days after injection. It should be noted that patients received repeat injections only if prior injections were ineffective (up to three injections), and the third

injection was performed with 3-dimensional surgical navigation. In retrospective studies by Paik et al.¹⁶⁶ and Oren et al.,¹⁶⁷ combined CT-guidance with fluoroscopy was used, with both studies reporting 100% IA spread confirmed by arthrography. In the study by Paik et al., the authors found that the time required for combined CT-fluoroscopy procedures was greater than the reported times for fluoroscopically-guided IA SIJ injections, but less than for standard CT-guided, ultrasound-guided, and MRI-guided IA SIJ injections.

Summary:

- In those with suspected IA SIJ pathology, accuracy for intra-articular injectate spread is greater with fluoroscopically-guided SIJ injections compared to landmark-guided SIJ injections; Grade B evidence, moderate level of certainty.
- IA SIJ injections without imaging guidance (such as landmark or palpation-guided injections) should not be used when performing IA SIJ injections; Grade A recommendation, high level of certainty.
- The use of image guidance should be strongly considered when performing SIJ complex injections when extra-articular involvement is suspected to delineate needle position; Grade B recommendation, moderate-to-high level of certainty.
- The use of fluoroscopic image guidance should be coupled with contrast injection (if no contraindication) to confirm intra-articular placement; Grade C recommendation, low level of certainty.
- Ultrasound guidance should be considered in patients where radiation exposure (eg, pregnancy, children) and/or contrast (eg, anaphylactic reaction) is contraindicated; Grade C-B recommendation, moderate level of certainty.
- The evidence is insufficient to determine the non-inferiority of ultrasound-guided compared to fluoroscopically-guided SIJ injections for accuracy of IA placement; Grade I.
- The accuracy of ultrasound-guided injections depends on the experience of the proceduralist and patient characteristics (eg, body mass index); Grade C evidence, low level of certainty.
- The evidence is insufficient to compare the accuracy of CT-guided to fluoroscopically-guided SIJ injections; Grade I evidence.
- In patients with advanced degenerative changes of the SIJ noted on preprocedural imaging or who have had prior unsuccessful fluoroscopically-guided SIJ injections, low-dose CT guidance with or without fluoroscopy can be considered; Grade C recommendation, low level of certainty.

Q7. Which is more effective for the treatment of sacroiliac joint complex pain, intra- or extra-articular sacroiliac joint complex injections?

The SIJ complex is a sophisticated structure composed of the sacral and iliac bones, which form the joint space enclosed by a fibrous capsule and synovial lining. This complex is supported by an extensive network of posterior and anterior ligaments, as well as a diverse group of muscles that contribute to its stability and function. These muscles include the erector spinae, multifidus, gluteal group, psoas, quadratus lumborum, piriformis, obliques, hamstrings, and pelvic floor muscles. The intricate interplay of these osseous, articular,

ligamentous, and muscular components ensures the structural integrity and proper biomechanical function of the SIJ complex. Nociceptors are abundantly present throughout these structures, and researchers have used pain provocation techniques and anesthetic studies on both patients and healthy volunteers to develop comprehensive pain referral maps for IA and EA SIJ complex pain.^{3,4,59–61,79,129}

The probability of EA or IA sources being the primary SIJ complex pain generator depends on many factors. Extra-articular pathology is more likely to be predominant in a young individual with unilateral pain who reports a specific inciting event, and injections into the dorsal ligaments typically require a higher volume than for IA injections.¹ Extra-articular SIJ pain is often associated with exquisite tenderness, and normal or near-normal imaging, although certain MRI sequences such as short tau inversion recovery (STIR) can detect acute inflammatory processes. In contrast, IA pathology is more likely to occur insidiously in an older person with bilateral pain, and is generally associated with radiological abnormalities.¹ Some patients also have IA and EA pathology occurring simultaneously, as suggested by controlled trials demonstrating efficacy for EA injections in patients with spondyloarthropathies,⁹ and a trend toward a higher responder rate and greater pain relief when a combination of IA and EA spread was observed (60%) compared to when only IA (48%) or EA (54%) spread occurred ($P = .25$) in injection-based outcome studies.⁶ In a retrospective study conducted in 120 patients, Borowsky and Fagen reported a higher proportion of responders following combination IA/EA injections than for IA injections alone.¹³⁹ In a recent randomized trial by Tantawy and Nazim in which the same dose and volume of corticosteroid and local anesthetic was injected either into or both into (IA) and outside (EA) the joint, the authors found no difference in pain scores at 1 week, but superiority for the combination group at 1- and 6-months (see Table 12).¹⁶⁸

Clinical studies

Randomized trials

Direct comparisons

In a double-blind study, Cohen et al. randomized 125 patients with clinically-diagnosed SIJ complex pain to landmark-guided injections with sham fluoroscopy or fluoroscopically-guided injections in which the target was IA.⁶ Only 8% of the landmark-guided injections were IA, which is consistent with the low rate of IA spread without image guidance found in other studies.^{147,152} Although greater immediate pain relief and a higher short-term responder rate (69% for combination spread, 62% for IA-only spread, 57% for only EA) was found for combination injections, the differences between groups were not significant. Whereas no significant differences were observed between groups at the 1-month primary endpoint, at 3-month follow-up some outcome measures favored IA over EA spread, which is consistent with the short duration of benefit for soft tissue injections.

Khalil et al. performed a quasi-randomized (based on laterality) trial in which 96 patients with severe clinically-identified SIJ pain were allocated based on their most painful side to receive fluoroscopically-guided right-sided IA injections with a 3 mL mixture of methylprednisolone and 2 mL of 2% lidocaine injected into the center of the joint without contrast to confirm placement ($n = 46$), or left-sided EA injections administered in the upper, middle and lower regions

containing the same injectate ($n = 50$).⁷ The authors found statistically significant differences favoring EA injections immediately after the injection (3.0 vs 4.3 and 0.4 vs 1.3 at each of the 2 hospitals), at 1-week (2.2 vs 4.3 and 1.3 vs 2.3), 1-month (1.9 vs 4.6 and 0.4 vs 2.2) and 3-month (1.7 vs 4.7 and 0.3 vs 2.8) follow-ups. This study included only individuals with baseline scores of at least 8 on a 0-10 NRS, did not provide combined data, and incorrectly stated that the blind injections outside of the joint were into different parts of the joint capsule.

Indirect comparisons from randomized trials

There are three placebo-controlled trials that have evaluated outcomes following SIJ injections. In the first one by Maugars et al., 10 patients (13 joints) with spondyloarthropathy and active sacroiliitis were randomized to receive IA corticosteroids or saline following joint arthrography in a double-blind fashion.¹¹ At 1-month follow-up, five of the six joints injected with corticosteroid were deemed to have $\geq 50\%$ pain relief vs one of seven in the saline group. At 1 month, six of the seven control joints were reinjected with corticosteroid. At 3- and 6-month follow-ups, 62% and 58% of participants continued to report pain reduction, respectively.

In the two randomized, double-blind placebo-controlled trials by the same group of investigators that evaluated EA injections, the authors compared depo-corticosteroid and local anesthetic injections to saline and local anesthetic injections in 20 patients with seronegative spondyloarthropathy in their initial study,⁹ and in 24 patients without spondyloarthropathy in a follow-up study.¹⁰ At both 1- and 2-month follow-up, the treatment group experienced a greater reduction in pain than the control group. In addition to the short follow-up periods, another flaw in these two studies is that the local anesthetic used in both treatment groups is not a true placebo.¹⁴¹

Non-randomized comparative-effectiveness studies

In the first study to compare IA to EA SIJ injections, Murakami et al.¹³⁷ performed a non-randomized, evaluator-blinded, prospective study in 50 patients comparing immediate-term (5-min post-injection) outcomes for lidocaine IA injections and EA injections performed in four locations along the SIJ. The EA injections were performed with 0.5-1 mL aliquots of lidocaine in areas where hypertonic saline provoked pain. The authors reported significant improvement in six activities of daily living in 100% of the EA injections vs 36% of the IA injections. They then performed EA injections on the IA non-responders, again reporting a 100% response rate. In addition to the unrealistic 100% response rate, other flaws include selection bias and the outcome measure, which was immediate and did not involve pain relief.

In an observational study by the same group, the authors performed EA injections in 85 patients with pain around the posterior superior iliac spine. The injectate consisted of 0.5 mL aliquots of 2% lidocaine mixed with contrast in individuals whose pain was reproduced by needle irritation.¹³⁶ In those who failed to experience a positive outcome, defined as $\geq 70\%$ pain relief 15- to 30-min post-injection, a fluoroscopically-guided IA injection was performed with a 50:50 mixture containing betamethasone and bupivacaine 0.5%. Seventy-two (85%) patients experienced a positive response,

Table 12. Clinical studies comparing extra-articular and intra-articular sacroiliac joint complex injections.

Author, year	Patients	Design	Results	Comments
Murakami, 2007 ¹³⁷	50 pts with axial LBP and >1 (+) SIJ provocation test	Prospective study comparing IA SIJ injections with 1–2.5 mL LA or 0.5–1 mL EA injections in pts who experienced pain with hypertonic saline provocation in multiple areas	EA injection effective (attainment of predefined functional endpoints) in 100% of pts vs 36% for IA after 5 min.	Non-randomized, blinded evaluation. All non-responders to IA injections responded to EA injections, with 100% response rate raising questions of validity.
Borowsky & Fagen, 2008 ¹³⁹	120 pts with LBP below the L4 spinal level and radiation into buttock, thigh, groin or calf	Retrospective study comparing fluoroscopically guided IA to IA + EA SIJ injections medial to joint line from S1–3	Combination > IA-only injections through 3 mos.	Unclear why the authors only analyzed data on 120 of 164 eligible pts. Equivalent total corticosteroid dose, but higher volume of LA in the combination group.
Hartung, 2010 ¹⁵⁸	14 pts (20 joints) in pts with acute sacroiliitis	Prospective study comparing ultra-sound-guided SIJ injections with 1 mL corticosteroid in those with IA (40%) vs EA (60%) spread based on MRI	No significant differences between IA & EA group at 24 hrs. At 4 wks, there was a non-significant trend toward IA > EA (3.3 vs 2.5 points on a 0–10 scale)	Study underpowered to detect difference. 1 mL corticosteroid mixed with contrast, without LA.
Nacey, 2016 ¹⁶⁹	99 pts (113 joints) who underwent SIJ injections by radiologists (unclear selection criteria)	Retrospective study comparing outcomes with IA (49%) vs EA (51%) SIJ injections with 1 mL corticosteroid + LA	No significant differences immediately or at 1 week, though non-significantly higher responder rates in IA group at 1 week.	Evaluators blinded to outcome. 13% of cases in which there was disagreement regarding spread pattern resolved by consensus discussion.
Murakami, 2018 ¹³⁶	85 pts with pain around the posterior superior iliac spine	Non-randomized, observational study evaluating EA injections, and in non-responders, IA injections	Among the 72 pts with a positive response ($\geq 70\%$ pain relief 15–30-min post-injection), 81% were in the EA group vs 19% in the IA group.	Higher proportion of placebo responders were likely included in the EA group. Total volumes administered not described.
Cohen, 2019 ⁶	125 pts with clinically-diagnosed SIJ pain	Randomized, double-blind study evaluating fluoroscopically-guided vs landmark-guided injections	<10% of landmark-guided injections IA. No differences between fluoroscopically-guided or landmark-guided, or IA vs EA injections at 1 month. At 3 mo, some outcome measures favored fluoroscopically-guided injections (mean reduction in avg. pain 1.8 vs 0.9).	Very small, non-significant difference in mean change in avg. pain score 1 month stratified by injection location. At 3 months, mean reduction in avg. pain score in IA, EA and combination group 1.9, 1.0 and 1.4, respectively ($P = .18$). For worst pain, mean reductions 2.6, 1.5, 1.7, respectively ($P = 0.12$).
Khalil, 2022 ⁷	96 pts with severe clinically diagnosed SIJ complex pain	Quasi-randomized, non-blinded study evaluating fluoroscopically-guided IA injections (right-sided pain predominance) vs landmark-guided left-side EA injections	Statistically significant differences favoring the EA group at all time points through 3 months.	Incorrectly asserted that the EA injections were in the joint capsule. Did not combine data for both hospitals, and the statistical analysis was flawed.

EA, extra-articular; IA, Intra-articular; LA, local anesthetic; SIJ, sacroiliac joint.

with the successful group comprised of 81% ($n = 58$) EA and 19% ($n = 14$) IA injections. In addition to the non-randomized design, a disproportionate percentage of placebo responders were likely included in the positive EA group.

As alluded to above, in a retrospective study in which the authors compared IA corticosteroid and local anesthetic injections ($n = 40$) to IA and EA injections ($n = 80$), the proportion of patients who obtained $\geq 50\%$ pain relief at 3 weeks (42.5% vs 27.5%) and 3 months (31.3% vs 12.5%) was higher in the combination group.¹³⁹ Although the total dose of corticosteroid was the same in the two groups, the combination group received a higher volume of bupivacaine (4 mL vs 1.5 mL). The authors also did not provide a basis as to why data were only analyzed on 120 of the 164 eligible patients. Hartung et al.¹⁵⁸ performed a prospective study in 14 patients (20 joints) to determine the accuracy of ultrasound-guided IA SIJ injections, finding only a 40% success rate using MRI as the reference standard. Although there was no difference in pain reduction at 24 h between those patients with IA spread and those with only EA spread, at 4 weeks there was a trend toward greater pain relief in the IA group (3.3 vs 2.5 points on a 0-10 numerical rating scale).

Nacey et al.¹⁶⁹ retrospectively reviewed the records of 113 fluoroscopically-guided SIJ injections performed with 1 mL of corticosteroid and local anesthetic in 99 patients. The injection location was stratified based on a review of images by two musculoskeletal radiologists. For the 55 (49%) of injections deemed to be IA, the mean immediate reduction in pain was 4.4 vs 4.2 for the 58 patients whose injections were EA. One-week post-injection, both groups reported an average pain reduction of 1.9 points on a 0-10 scale. The responder rates immediately post-injection (prevalence rate) and at 1 week in the IA and EA groups were 43% vs 42%, and 22% vs 17%, respectively using $\geq 50\%$ pain relief as the threshold, and 35% vs 29% and 12% vs 6%, respectively, using $\geq 75\%$ relief. One limitation in studies evaluating the effectiveness of EA injections is that there is little standardization on selection, location of injections and the injectate composition.

Summary:

- There is slightly stronger evidence for the efficacy of extra-articular (periarticular) than intra-articular SIJ injections with corticosteroid for at least one month in patients clinically diagnosed with SIJ complex pain; Grade C evidence, low level of certainty.
- There is conflicting evidence that extra-articular injections may be more effective at three months; Grade C evidence, low level of certainty.

Q8. Is there an optimal technique for performing intra-articular sacroiliac joint injections and sacral lateral branch blocks?

Anatomical considerations

When determining the optimal technique for performing IA and EA SIJ injections as well as SLBBs, it is important to consider the anatomy relevant to each procedure. The SIJ, a combination diarthrodial and amphiarthrodial joint, typically consists of the sacral segments S1 (largest component), S2, S3, and the ilium.¹³² The SIJ consists of both IA and EA portions. The IA and EA portions consist of a synovial joint

(infero-anteriorly) and syndesmosis (ie, fibrous linkage), respectively.

The synovial portion of the SIJ typically involves the inferior half of the joint with the articular cartilage on the sacral side being thicker in comparison to that of the iliac side (~ 3 -5 mm vs ~ 1 -2 mm).¹⁷⁰ Multiple ligaments support the SIJ including ventral, dorsal, transverse and interosseous ligaments. The interosseous ligaments are also supported by the short and long dorsal sacroiliac ligaments.^{132,171} The volume of the joint has been estimated to range from 0.5-2.5 mL.^{41,117,118,130,133}

The innervation to the SIJ and surrounding structures (posterior EA elements) is complex, and our understanding continues to evolve.^{113,132,171,172} The IA portion of the SIJ is mainly innervated by anterior sources with a small contribution from posterior sources.¹⁷¹ Both myelinated and unmyelinated fibers exist within the articulation of the SIJ.^{3,109} The anterior aspect of the joint is innervated by branches from the lumbosacral trunk, as well as direct branches from the anterior ramus of L4 and the anterior ramus of L5.¹⁷¹ Dissection and histology has not confirmed innervation from the anterior rami of S1-S3 and sacral plexus.^{109,171} The posterior aspect of the SIJ capsule and posterior EA ligaments are innervated by the posterior sacral network (PSN), which predominantly consists of lateral branches of the posterior rami from S1 to S3.¹⁷¹ Figure 1 demonstrates the location of the posterior interosseous ligaments and sacral lateral branches. The L4, L5, and S4 lateral branches inconsistently innervate the posterior SIJ complex. One study demonstrated contributions from S1 and S2 in 100%, S3 in 88%, L5 in 8% and S4 in 4% of specimens, though other studies have reported greater contributions from L5 and S4.^{108,112,113,115,132} The lateral branches are small with mean diameters < 1 mm (range 0.21-1.51 mm).¹¹³ When the L5 lateral branch is involved in the innervation it may anastomose with the lateral branch of S1 or innervate the posterior aspect of the joint directly.^{108,113} The lateral branches emerge from the foramina, with the number of lateral branches from each foramen ranging from one to four and most levels having one to two.^{108,171}

Defining optimal technique of each injection procedure depends on its purpose (diagnostic, prognostic, and/or therapeutic) and the relevant structures to be targeted. The following text will focus on diagnostic and/or therapeutic IA SIJ injection and diagnostic/prognostic SLBBs. Optimal technique for therapeutic dorsal ligament complex injection will not be discussed, as its therapeutic value has not yet been well defined (addressed in other sections of this article). Similarly, diagnostic injections of the innervation of the anterior aspect of the SIJ complex will not be discussed here, as viable technique(s) have yet to be validated.

Intra-articular sacroiliac joint injections

Multiple techniques have been described for IA SIJ injections. For all IA SIJ injections, image guidance is mandatory to assist with accurate needle placement, prevent deposition of the diagnostic and/or therapeutic injectate into vasculature, and to determine if there is IA and/or EA spread. Placement without image guidance results in a high technical failure rate ranging from 78%-100%.⁴¹ Although ultrasound guidance can be used for placement, the use of this imaging modality may be associated with lower accuracy rates in some contexts and long learning curves for IA placement.^{154,157,158,173}

Therefore, this section will focus on fluoroscopy-guided injections.

For fluoroscopy-guided injections, multiple technical aspects need to be considered including the location of SIJ access, use of contrast medium, and volume of therapeutic and/or therapeutic injectate. First, injection of contrast medium is recommended to delineate the eventual spread of the diagnostic and/or therapeutic injectate and to assist with target specificity. Contrast injection allows for the determination of intravascular spread, EA spread into and onto surrounding structures and the existence of ventral and dorsal capsule tears.⁸ SIJ contrast flow patterns may have predictive value for short-term outcomes, although their utility for long-term prognosis appears limited. Scholten et al.¹⁷⁴ conducted a retrospective review of 54 subjects who underwent therapeutic SIJ corticosteroid injections, with 49 patients included in the final analysis. Their findings revealed that arthrographic contrast patterns demonstrating injectate delivery to the superior portion of the SIJ were associated with greater pain reduction at 2 weeks post-injection. However, this differential effect was not observed at the 8-week follow-up when compared to subjects whose contrast did not reach the superior portion of the SIJ.

A second variable to consider when performing IA SIJ injections is the volume of injectate. When performing SIJ injections into the inferior portion of the joint, the capacity is <2.7 mL with capsular distention occurring at volumes ≤1.6 mL.^{8,130,133} Therefore, it is recommended that volume of injections be <2.5 mL including the volume of contrast deposited prior to any diagnostic and/or therapeutic injectate. This is addressed in additional detail within Question 5 (What volume should be used for SIJ injections? Should diagnostic injections include corticosteroid?) of this article.

Traditionally, IA SIJ injections are performed by accessing the lower portion of the joint since the synovial portion of the SIJ involves the inferior half of the joint. However, successfully entering the joint at times can be challenging.⁸ Successfully gaining IA SIJ access may be more difficult in male patients.¹⁷⁷ Injections may also be more difficult in individuals who demonstrate osteophytes and the presence of substantial vacuum phenomena on preprocedural CT scans.¹⁷⁷ In general, review of pre-procedural axial imaging may provide insight regarding the most feasible angle of approach for obtaining access to the SIJ. In individuals for whom access is challenging (eg, obesity or severe joint narrowing), the use of CT-guidance may improve technical success and possibly outcomes.¹⁶² If entering the lower portion of the joint is challenging with fluoroscopy and alternatives are not available, other points of access in the middle and superior portions of the SIJ have been suggested.^{175,176,178} In an observational study of 69 consecutive patients in whom the middle portion of 100 separate SIJs was targeted, the success rate was 80%.¹⁷⁶ Notably, in three of the 20 cases of failed SIJ access using the middle part of the SIJ, the traditional inferior SIJ access technique was successful. Conversely, in four patients, attempts to access the inferior aspect of the joint were unsuccessful, with successful injections achieved by accessing the middle portion of the joint. This suggests the need for adaptability. In a prospective randomized noninferiority study examining 181 patients who were randomized to undergo injection using a point of SIJ access at either the upper or lower one-third of the joint, the IA injection success rates were 93.3% and 95.6%,

respectively.¹⁷⁵ The authors concluded that accessing the upper one-third of the SIJ resulted in a similar success rate compared to the traditional point of access at the lower one-third of the SIJ.¹⁷⁵

Sacral lateral branch blocks

SLBBs are used to select patients for RFA techniques that target the posterior sacral network (PSN) associated with EA SIJ complex pain including the short posterior sacroiliac ligament (SPSL), long posterior sacroiliac ligament (LPSL), interosseous sacroiliac ligament (ISL), and superficial lamina of the sacrotuberous ligament (STL).¹⁷¹ Both single-site, single-depth SLBBs and multi-site, multi-depth SLBBs have been examined for their ability to effectively anesthetize the posterior SIJ complex.^{117,118} In a randomized, controlled, double-blinded study, single-site, single depth SLBBs were found to be physiologically ineffective on a consistent basis with 60% of volunteers in the active group maintaining sensation with both repeated SIJ capsular distention as well as probing of the dorsal ligaments of the SIJ complex.¹¹⁸ Furthermore, in a parallel anatomic study examining S1 and S2 lateral branch injections with green dye, only 36% of lateral branches were successfully captured using the single-site, single-depth technique.¹¹⁸ Based on this study, it was determined that single-site, single-depth SLBBs are associated with a high false-negative rate and may fail to identify patients with pain arising from portions of the posterior SIJ complex innervated by the PSN. In a follow-up, double-blind, placebo-controlled study performed in 20 asymptomatic volunteers, multi-site, multi-depth SLBBs produced a much lower false-negative rate in comparison to the single-site, single-depth SLBBs.¹¹⁷ For the multi-site, multi-depth SLBB technique described by Dreyfuss et al.,¹¹⁷ needles were placed 8-10 mm lateral to the posterior sacral foramina at multiple locations based on clock face positions around the S1 and S2 foramina (Right: 2:30, 4:00, and 5:30; Left: 9:30, 8:00, and 6:30) and S3 foramina (Right: 2:30, 4:00; Left: 9:30 and 8:00). After ruling out vascular needle tip position with injection of contrast medium at each target area, 0.2 mL of local anesthetic was injected. A second injection at each target area was then performed after withdrawing the needle by one bevel length, for a total volume of 1.2 mL at the S1 and S2 foramina, and 0.8 at S3.

When using this multi-site, multi-depth SLBB protocol, 70% of the active group did not respond to posterior ligamentous probing after receiving injections compared to 0-10% of the sham group. Furthermore, a parallel cadaver study revealed a 91% accuracy rate for multi-site, multi-depth SLBBs to capture the S1 to S3 lateral branch nerves. Notably, in the human subject portion of the study, 86% of participants retained the ability to sense capsular distention; thus, the ventral articular portion of the SIJ is not effectively anesthetized by blocking the PSN.¹¹⁷ One study has validated an ultrasound-guided technique for SLBBs using the Dreyfuss et al. multi-site, multi-depth SLBB protocol.¹⁷⁹ In this randomized-controlled trial, the investigators probed the dorsal aspect of the sacroiliac ligament, the dorsal aspect of the SIJ, and the SIJ interosseous ligament both before and after implementing two different SLBB protocols in order to establish the ability of participants to perceive pain in these regions and then to evaluate the degree to which pain to probing was reduced or completely eliminated by each of the two SLBB protocols. The investigators reported a similar degree of ability to block nociception caused by probing these three SIJ

complex structures when using the previously validated fluoroscopically-guided multi-site, multi-depth SLBB protocol compared to their ultrasound-guided “triple injection” technique. This technique consisted of injecting 0.5 mL of 2% lidocaine at target points along the sacral lateral crest lateral to the S1 foramen, between the S1 and S2 foramina, and between the S2 and S3 foramina.

In conclusion, fluoroscopically-guided multi-site, multi-depth SLBBs (using the Dreyfuss et al. protocol) effectively target posterior EA SIJ structures with lower false-negative rates than single-site, single-depth SLBBs. In addition, ultrasound-guided multisite blocks along the sacral lateral crest (according to the Finlayson et al. protocol) effectively target posterior EA SIJ structures to a comparable degree according to one randomized controlled trial. Therefore, if one is contemplating an RFA procedure to interrupt the PSN, multi-site, multi-depth SLBBs or ultrasound-guided multisite blocks along the sacral lateral crest (according to the Finlayson et al. protocol) should be favored as a prognostic tool. However, it should be noted that sham-controlled studies that did not to use prognostic SLBBs have yielded positive RFA outcomes,^{21,27} while controlled studies that used SLBBs have yielded negative or equivocal results.¹⁶ In addition, if a patient has relief with an IA SIJ injection, it may not predict the ability of an RFA technique that targets the PSN to effectively mitigate pain since these RFA techniques do not target IA sources of pain as demonstrated in the study by Dreyfuss et al.¹¹⁷

Summary:

- When performing IA SIJ injections, the preferred method includes fluoroscopic guidance, access to the inferior (synovial) portion of the SIJ, use of contrast medium to confirm appropriate spread of subsequent diagnostic and/or therapeutic injectate (if no allergy/contraindication), and a low injectate volume (<2.5 mL); Grade B recommendation, moderate level of certainty.
- If IA access is not possible using the inferior aspect of the joint, consideration can be given to accessing the middle or superior aspects of the joint or, if available, using CT guidance; Grade C recommendation, low-to-moderate level of certainty.
- When considering radiofrequency ablation (RFA) to interrupt the sacral lateral branch nerves (posterior sacral network) for treating posterior sacroiliac joint complex pain, fluoroscopic guidance should be used to perform multi-site, multi-depth sacral lateral branch blocks (SLBBs) targeting the lateral branches of S1 through S3; Grade C-B recommendation, moderate level of certainty.
- Ultrasound-guided multisite blocks along the sacral lateral crest (according to the Finlayson et al. protocol) targets posterior extra-articular SIJ structures and may be considered for prognostic SLBBs; Grade C recommendation, low level of certainty.

Q9. Should sedation be used for intra-articular sacroiliac joint injections? Should sedation be used for sacral lateral branch blocks? Should sedation be used for sacral lateral branch radiofrequency ablation?

The use of sedation for interventional pain procedures is controversial. The debate arises secondary to whether providing

analgesic/anxiolytic medications can alter the patient’s “true” response to the intervention. Accurate or “true” responses from the patient are critical to render a diagnosis or predict (prognosticate) outcome for diagnostic injections. In the context of this article, “sedation” will be referred to as the provision of a sedative and/or analgesic medication (eg, benzodiazepine and/or opioid, respectively) as opposed to the patient’s physiologic response.

The use of sedation during interventional pain procedures is not uncommon. The use of sedation has been found to vary depending on the procedure being performed. A survey study by Kohan et al. found that sedation was used in 80% of RFA procedures, 66% of sympathetic nerve blocks, 54% of epidural corticosteroid injections, 50% of medial branch nerve blocks, and 42% of the time for SIJ injections. Benzodiazepines and opioids were the most commonly used sedatives.¹⁸⁰ An international survey study found that only 29% of physicians “never” use sedation for SIJ injections.¹⁸¹

Whereas the use of sedation can help decrease patient-related discomfort, decrease patient movement, possibly improve patient satisfaction, decrease the incidence of vasovagal reactions,^{182,183} and possibly decrease the risk of false-negative responses,^{184–186} it may increase the risk of false-positives responses, thereby negatively impacting the diagnostic and/or prognostic nature of the procedure.^{44,187}

Improved patient satisfaction with the use of sedation has not been firmly established. Kubulus et al. found improved patient satisfaction with the use of sedation during regional anesthetic injections; however, this study was limited by its retrospective nature and confounding anxiety that may have been experienced secondary to the surgical procedure.¹⁸⁸ Other studies report conflicting results. Cucuzella et al. found that 17% of patients requested intravenous diazepam prior to an initial epidural corticosteroid injection, with 28% requesting it again for subsequent procedures. Higher pain scores, increased anxiety, and depression were associated with requests for repeat sedation, which may explain the paradoxical observation that the use of sedation was associated with increased procedure-related pain.¹⁸⁴ A follow-up study by the same group of authors found that even after an extensive discussion regarding sedation, 58% of patients chose either anxiolysis (oral diazepam) or sedation (IV diazepam) prior to an injection and 93% of those who chose to receive no anxiolysis or sedation were satisfied with their decision.¹⁸⁹ In a retrospective study performed in 4432 patients who underwent 6878 transforaminal epidural corticosteroid injections, Diehn et al. found high levels of satisfaction among non-sedated patients, with 96% reporting good, very good, or excellent satisfaction levels.¹⁹⁰ Similar to Cucuzella et al.¹⁸⁴ who reported higher pain scores in sedated patients, the authors reported lower satisfaction scores in patients who received sedation, though this observation may represent selection bias (ie, patients with increased anxiety and pain sensitivity may be more likely to elect to receive sedation) and the small number of patients who received sedation prevented a meaningful statistical comparison.¹⁹⁰ Analgesia from opioids may decrease pain, making it difficult for the clinician to determine if post-procedural pain relief was related to opioid administration or the intervention itself. Benzodiazepines cause skeletal muscle relaxation and thus may decrease back pain in patients with a myofascial component.^{191–193} Additionally, benzodiazepines and opioids may alleviate the affective (anxiety) component of pain and alter

post-procedural activity, thereby undermining the accuracy of the post-procedural analgesic response.

Effect of sedation during diagnostic or prognostic procedures on treatment outcomes: Indirect evidence

Several studies have evaluated the effect sedation during prognostic blocks has on neurolytic or RFA outcomes, albeit none for sacral lateral branch RFA. Although a small retrospective study found poorer neurolysis outcomes when sedation was used during prognostic celiac plexus blocks, a larger study ($n = 265$) evaluating the effect of sedation during genicular nerve blocks on RFA results reported no effect on treatment outcomes.^{194,195} A randomized trial evaluating methoxyflurane on pain during and after genicular nerve blocks reported rapid recovery for the short-acting inhaled medication used worldwide for out-of-hospital posttraumatic analgesia. The authors recommended consideration of its use for other prognostic procedures based on the tenet that a block's predictive value will be higher when the local anesthetic effect outlasts the duration of sedation.¹⁹⁶

Guidelines

Societies, including the American Society of Anesthesiologists (ASA)¹⁹⁷ and the International Pain and Spine Intervention Society (IPSIS),¹⁹⁸ recommend against the routine use of sedation for most interventional pain procedures except for advanced procedures (vertebral augmentation, spinal cord stimulation, etc.). Studies report an increased risk of overall complications and serious neurological injuries with the use of moderate or heavy sedation.^{199–201} A recently proposed local coverage determination (LCD) asserts that the use of moderate or deep sedation, general anesthesia, or monitored anesthesia care (MAC) is not indicated for SIJ injections and is not considered medically reasonable or necessary. The LCD does note that use of anxiolytics may be indicated in patients with anxiety disorders and needle phobias.²⁰² Additionally, the LCD panel noted that sedation not only increases risk but may also compromise the validity of the diagnostic procedure.¹²⁰

Diagnostic sacroiliac joint injections

Direct Evidence

Cohen et al. examined the impact of sedation with midazolam and fentanyl on the diagnostic validity of SIJ injections and sympathetic blocks in a randomized, controlled crossover trial. The use of sedation was found to result in lower pain diary scores and a higher proportion of positive diagnostic injections than for injections performed without sedation, suggesting a possible increase in false-positive injections. Although procedure-related pain scores were lower in injections performed with sedation, sedation did not improve patient satisfaction or 1-month treatment outcomes.⁴⁴

Therapeutic sacroiliac joint injections

Direct evidence

No studies were identified.

Indirect evidence: sedation for pain-relieving procedures

Dreyfuss et al. found no difference in post procedure pain scores assessed immediately after a therapeutic epidural corticosteroid injection without local anesthetic between patients who had received sedation with midazolam and/or fentanyl and those who did not.²⁰³

Sacral lateral branch blocks

Direct evidence

No studies were identified.

Indirect evidence: sedation prior to medial branch nerve injections

Manchikanti et al. published several studies investigating the impact of sedation on the diagnostic validity of medial branch blocks. The authors suggested that although saline, midazolam, or fentanyl can all create false positives, the likelihood was low when 80% pain relief was used as the cutoff threshold for a positive block rather than 50%. However, these studies had many methodological limitations, including only assessing patients pre- and post-medication administration but before the actual procedure was performed (ie, failure to assess post-injection pain relief), that these procedures were being done therapeutically and not diagnostically, and a high rate of chronic opioid therapy in subjects.²⁰⁴

Sacral lateral branch radiofrequency ablation

Although the use of sedation is rarely indicated with SIJ injections, it can be indicated during SLBRFA according to the subject matter expert (SME) panel in the recent LCD. In addition to multiple lesions at multiple levels, “finder” needles (if used) are often placed in 3-4 sacral foramina as landmarks for electrode placement, and can elicit radicular pain.¹²⁰ Clinical trials are mixed regarding whether they specifically noted that patients routinely received sedation, though no trial reporting prohibiting it.

Summary:

- For diagnostic SIJ injections and prognostic sacral lateral branch injections, the routine use of sedation is not recommended as it may result in a higher proportion of false-positive diagnostic injections; Grade B recommendation, low-to-moderate level of certainty.
- For therapeutic SIJ injections, the routine use of sedation is not recommended; occasionally, light or moderate sedation by properly trained personnel, in extenuating circumstances such as with severe needle phobias, other psychiatric indications, a history of severe vasovagal reactions, or movement disorders that preclude a safe and/or accurate injection, may be necessary; Grade C recommendation, low level of certainty.
- For SLBRFA, the use of light or occasionally moderate sedation with patients remaining responsive may be indicated in certain cases and should depend on patient and provider preferences; Grade C recommendation, low level of certainty.
- If sedation is used, the lowest dose of short-acting medications should be administered; Grade A recommendation, high level of certainty.

Non-surgical treatment

Q10. How effective are non-invasive treatments for sacroiliac joint complex pain?

Non-operative (conservative) treatments for sacroiliac joint pain

Non-operative or conservative management of SIJ complex pain commonly includes a trial of analgesic and anti-inflammatory medications, physical therapy (PT) modalities,

bracing, psychological therapies, acupuncture, and various other treatments. Although supported by little evidence, these treatments are frequently recommended before consideration of operative or procedural treatments. Despite the lack of medium or high-quality evidence, conservative treatments are recommended for the treatment of SIJ complex pain by the Centers for Medicare and Medicaid Services²⁰² and commercial payors in the United States.²⁰⁵ The Centers for Medicare and Medicaid Services require 4 weeks of conservative care prior to performing procedures on the SIJ complex. There is disagreement among professional guidelines, with some expert medical consensus recommending conservative care based on low-quality evidence^{206,207} and others recommending against a requirement²⁰⁸ due to the lack of moderate or strong evidence of efficacy. Many clinical studies evaluating IA SIJ injections, SLBRFA, and SIJ fusion have required a course of conservative treatment,^{11,16,21,22,24} while others have not.^{27,146} The rationale behind the *de facto* use of conservative management of SIJ complex pain is primarily based on the presumption that SIJ complex pain, like many musculoskeletal conditions, will improve on its own with time, and low-risk conservative measures may facilitate this. However, the typical clinical course of SIJ complex pain in the absence of formal treatment has not been reported in the literature. The rationale for a mandatory trial with conservative therapy may be a more reasonable assumption for acute than chronic SIJ complex pain in which symptoms have persisted despite time and self-care, and conservative treatments can pose a financial burden. In an RCT by Cohen et al.,¹⁴ the control group who received a cluster of conservative measures had a poor response rate, with only 11% having a positive outcome with three months of therapy.

It must also be acknowledged that the majority of studies evaluating the effectiveness of various non-invasive treatments for sacroiliac joint complex pain did not use SIJ injections and/or SLBBs to confirm the diagnosis of SIJ complex pain. As such, a proportion of the individuals in these studies likely did not have SIJ pain given the known limitations of history, physical examination, and imaging for identifying a painful SIJ complex.

Pharmacological management

Direct evidence

The chronic inflammatory rheumatic musculoskeletal disease axial spondylarthritis, which usually involves the SIJ, is responsive to NSAIDs and disease-modifying anti-inflammatory medications including tumor necrosis factor inhibitors, interleukin-17 inhibitors, and janus kinase inhibitors.²⁰⁹ There are no RCTs examining the efficacy of oral or topical non-steroidal anti-inflammatory drugs (NSAIDs), opioids, or SNRIs such as duloxetine in SIJ complex pain of non-rheumatic etiology.

Indirect evidence

There are numerous randomized trials that demonstrate the efficacy of muscle relaxants, NSAIDs, and antidepressants for LBP. Oral NSAIDs have been shown to improve pain and disability in patients with back pain in the short-term, but they are associated with significant adverse effects on the gastrointestinal, renal, and cardiovascular systems, and their unmonitored long-term use is not recommended.^{210,211} COX-2 inhibitors have been shown to be effective in patients with chronic LBP and are associated with fewer GI side

effects; however, they are often more expensive than traditional NSAIDs and are still associated with adverse cardiovascular and renal effects with chronic use. A Cochrane review found no significant difference in effectiveness between non-selective NSAIDs and COX-2 inhibitors for LBP.²¹⁰ Acetaminophen has not been found to provide clinically meaningful relief for back pain²¹² and is inferior to COX-2 inhibitors in head-to-head trials.²¹³ There is strong evidence for serotonin-norepinephrine reuptake inhibitors for back pain,^{211,212} and guidelines by the American College of Physicians recommend duloxetine as a second-line treatment.²⁰⁷ In a recent systematic review evaluating antidepressants for back pain and osteoarthritis, tricyclic antidepressants (3 trials, 145 patients) were not found to provide meaningful relief at 2 weeks or less based on low-quality evidence, and neither were other non-SNRI antidepressants.²¹⁴ In another systematic review, gabapentinoids were not found to be effective for the treatment of LBP.²¹⁵ Topical capsaicin has been shown to be beneficial in patients with LBP though penetration into deep tissues is limited,²¹⁶ and topical diclofenac is effective but less so than oral NSAIDs.²¹⁷ Opioid analgesics produce a decrease in the perception of pain, increased pain tolerance, and decreased discomfort after acute post-surgical injury. However, despite the lack of supporting evidence for opioid efficacy in the treatment of clinical acute musculoskeletal pain of the neck or low back,²¹⁸ these remain commonly prescribed medications.^{219,220} Additionally, opioids are associated with significant short and long-term adverse effects such as feelings of intoxication, cognitive/motor dysfunction, constipation, hormone dysregulation, physiological and psychological dependence, and persistent use can lead to hyperalgesia, opioid misuse and/or opioid use disorder.^{218,221}

Sacroiliac joint belts

The purpose of an SIJ belt is to provide compression and stability of the pelvis across the SIJ complex, thereby reducing pain and disability. Vleeming et al.²²² tested this hypothesis by applying SIJ belts in cadavers, revealing a 30% reduction in rotation of the joint. In a prospective survey study, Hammer et al.²²³ compared outcomes in 17 patients with injection-confirmed SIJ complex pain and 17 healthy control patients who received SIJ belts. After 6 weeks of use, the authors reported significant improvements in quality of life in the SIJ belt patients, a small reduction in pain, improved gait and cadence, but no significant changes in muscle activity except for decreased tone in the rectus femoris muscle.

Chiropractic treatment and physical therapy (including structured exercise therapy)

Early uncontrolled and low-quality studies suggested that PT, and osteopathic or chiropractic manipulation reduce pain and improve mobility modestly in patients with SIJ complex pain resulting from altered gait mechanics and spine malalignment.^{224,225} A later systematic review by Al-Subahi et al.²²⁶ investigated how effective PT techniques were for the reduction of pain in patients with SIJ complex pain. Only one of the nine identified studies included a placebo control group. The systematic review examined three types of PT interventions for reducing pain and improving disability: Exercise, manipulation or manual therapy (MT), and kinesio-taping (KT). The authors found the included studies were of low-quality, but that MT was nevertheless most

effective in terms of improving pain and functional capacity. In addition to reducing pain and improving disability, KT was effective in restoring normal pelvic symmetry and position in an uncontrolled study, but ineffective when compared to placebo. A more recent systematic review and meta-analysis by Trager et al.²²⁷ examined the effectiveness of MT for SIJ complex pain. This review included 16 RCTs with a total of 421 adult patients. The results did not show a reduction in pain but did show a small, significant effect in the reduction of disability. The meta-analysis showed that when non-manual physiotherapy (exercise therapy), regardless of whether it included passive modalities, was compared to sham in patients with SIJ dysfunction, there was no reduction in pain. A systematic review of RCTs by Macedo et al.²²⁸ found that a motor control exercise program was more effective than spinal manipulative therapy and home exercise for patients with chronic LBP. A more recent narrative review by Prather et al.²²⁹ concluded that therapeutic exercise alone or combined with manipulation was successful in decreasing SIJ complex pain and accompanying dysfunction. The indirect evidence for psychologically-informed PT was examined in a very large clinical trial ($n = 2300$, 77 sites) that included patients with acute LBP at medium and high risk for developing chronic LBP. The authors found that intensive psychologically-informed PT was no better than usual care.²³⁰

Acupuncture

No placebo-controlled clinical trials examining the efficacy of acupuncture on SIJ complex-related pain have been published to date. A systematic review and meta-analysis by Liu et al.²³¹ examined acupuncture for SIJ complex pain attributed to malposition in 10 studies ($n = 1019$). The quality of the RCTs was deemed to be extremely low with little to no follow-up and “random” intervention techniques. However, indirect evidence from studies of LBP supports the use of needling, including traditional acupuncture and placebo acupuncture, for short-term relief of pain. One study examined 2065 patients with chronic LBP (3 to 12 months) and found that after 3 weeks of twice weekly and 1 week of once weekly treatment, any form of acupuncture or placebo acupuncture was more effective than usual care at 8 weeks, with persistence to one year.²³² A similar study performed in patients with acute LBP found that acupuncture and sham acupuncture produced modestly more pain relief than no treatment 1 week after the 2-week treatment.²³³ A recent Cochrane review of 33 trials found that acupuncture was no better than sham and may be no better than usual care for chronic LBP.²³⁴

Psychological interventions (cognitive behavioral therapy, physical therapy-delivered cognitive behavioral therapy)

No studies have evaluated psychological interventions for SIJ complex pain, so results must be extrapolated from LBP studies. A systematic review found no effect for cognitive behavioral therapy (CBT) compared to no treatment but a substantial effect when CBT was combined with structured exercise.²³⁵ However, a very large RCT found no benefit for CBT delivered by a physical therapist in combination with manual intensive PT for transition from acute to chronic LBP.²³⁰ For behavioral therapy and counseling, no significant benefits were found either as stand-alone treatments or combined with structured exercise.²³⁵ In a narrative review, Cohen et al.⁶⁵ found indirect evidence to support the

influence of psychosocial pathology on the development of SIJ complex pain and concluded CBT may be beneficial in those with comorbid psychological conditions.

Summary:

- There is indirect evidence that physical therapy (PT) and structured exercise may provide intermediate-term benefit for SIJ complex pain; Grade C evidence, low level of certainty.
- There is indirect evidence that cognitive behavioral therapy (CBT) may provide benefit for patients with comorbid psychological conditions; Grade C evidence, low level of certainty.
- There is indirect evidence that PT combined with CBT does not reduce the transition from acute to chronic low back pain; Grade B evidence, low-to-moderate level of certainty.
- There is evidence that SIJ belts may provide benefit in some patients; Grade C evidence, low level of certainty.
- There is insufficient evidence that chiropractic treatment is effective for SIJ complex pain; Grade I evidence.
- There is indirect evidence supporting the use of NSAIDs and SNRIs, but not other antidepressants, for SIJ complex pain; Grade C evidence, low level of certainty.
- There is insufficient evidence supporting acute use of opioids for SIJ complex pain; Grade I evidence.
- There is indirect evidence suggesting no benefit for the use of long-term opioid therapy; Grade D evidence, low level of certainty.
- There is indirect evidence that acetaminophen is ineffective for SIJ complex pain; Grade D evidence, low level of certainty.

Q11. What is the evidence for non-corticosteroid injections in the treatment of sacroiliac joint complex pain?

Corticosteroids are the most used injectable treatment for SIJ complex pain. Whereas corticosteroid injections are an effective treatment for SIJ complex pain, relief may be short-lived for some individuals.^{9,10,139} Unwanted systemic and local side effects of corticosteroid use are well described.^{41,236–239} As such, physicians and scientists have proposed alternative treatments to overcome the relative limitations of corticosteroid use. Numerous other potentially therapeutic injectable agents have been proposed, including autologous orthobiologics, allogeneic orthobiologics, hyaluronic acid, prolotherapy, chemoneurolysis, botulinum toxin, and saline. These proposed therapeutic agents can be classified according to the tissue being targeted for injection (articular, ligamentous, and neuronal).

Regenerative agents may contain properties that promote repair of dense fibrous tissues such as joint capsules, ligaments, and fascia. These injectates fall into one of two categories: (1) naturally occurring bioactive agents [eg, platelet rich plasma (PRP)] and/or extracellular structural components (eg, hyaluronic acid); and (2) irritating or debriding solutions that initiate endogenous repair mechanisms (eg, prolotherapy, saline). IA injections are theorized to relieve pain through mitigation or reversal of degenerative changes to the articular cartilage of the SIJ. Literature reports of IA injectates that have been investigated as potential treatments for

SIJ complex pain include autologous and allogenic orthobiologics (specifically platelet-rich plasma,^{240–242} platelet-rich fibrin,²⁴³ Wharton's jelly placental allograft²⁴⁴; and hyaluronic acid^{245,246}). Dextrose-based prolotherapy and saline injections into and surrounding the SIJ have also been reported.^{247–249} Whereas vigorous lavage with saline may provide a “washout” of inflammatory and pain-mediating molecules from the interior joint space, this is unlikely to occur with a single IA injection; however, introduction of fluid within the joint may indirectly stimulate an anti-inflammatory cascade if proteoglycans are removed from the superficial extracellular matrix of articular cartilage.²⁵⁰ The rationale for EA injection of regenerative agents into structures of the posterior SIJ complex is to relieve pain by strengthening or “tightening” damaged or lax ligaments in order to improve stability. Hypertonic dextrose prolotherapy purportedly induces cell proliferation at ligamentous attachment sites.²⁵¹ There is also an existing report of EA injection of PRP into the posterior SIJ complex.²⁵²

The second class of therapeutic injectates target neural tissues with the goal of relieving pain by interrupting or altering nociceptive signal transmission from the SIJ complex. Published literature includes two types of injectable therapies to potentially treat SIJ complex pain: Phenol-based chemoneurolysis and botulinum toxin A. Phenol is a non-specific protein coagulant; aqueous solutions have previously been injected in both the IA and EA spaces for the purpose of neuronal coagulation.^{253–255} Currently, there is only one publication describing the use of botulinum toxin, which was injected into the EA structures of the posterior SIJ complex.²⁵⁶ Although best known as a paralytic agent that interferes with synaptic signaling at the neuromuscular junction, there is evidence that botulinum toxin A acts on sensory neurons as well.^{257,258} Proposed mechanisms include reduction of neurogenic inflammation, alterations of efferent and afferent signals in spinal nerves leading to decreased central sensitization and inhibition of the release of sensory neuropeptides, as well as inhibiting protein translocation from the endosomal compartment to the cell plasma membrane of transient receptor potential vanilloid 1 (TRPV1) and Transient Receptor Potential Ankyrin 1 (TRPA1) receptors.²⁵⁶

Herein, we describe the published evidence related to effectiveness within each category of potentially therapeutic injectable agents. Notably, no sham-controlled (explanatory) RCTs were identified addressing the efficacy of any non-steroid injectables to treat pain specifically arising from the SIJ complex.

Clinical studies

Autologous orthobiologics

Pragmatic RCTs

In 2022, Chen et al. published results from a randomized study in which 26 participants were treated with a single IA injection of PRP or corticosteroid.²⁴⁰ Among other criteria (Table 13), patients were selected based on $\geq 80\%$ relief of index pain following a single IA SIJ injection of local anesthetic. Fifteen and 11 patients were then allocated to PRP and corticosteroid treatment, respectively. Pain and function improved significantly from baseline for both groups at 1-, 3-, and 6-months post-injection. However, patients in the corticosteroid group reported significantly lower pain scores than

those in the PRP group at all follow-up timepoints, as well as significantly lower ODI scores at 1 and 3 months. Additionally, responder rates for $\geq 50\%$ pain reduction were significantly higher for the corticosteroid group compared to the PRP group at 1 and 3 months (80% vs 21% and 70% vs 21%, respectively), though the intergroup difference did not reach statistical significance at 6 months (67% vs 25%).

A similar randomized comparative trial was reported on by Singla et al. in 2017.²⁴² The investigators randomized 40 patients with three or more positive SIJ provocation tests (no diagnostic injection for selection) to treatment with a single IA injection of either PRP ($n=20$) or corticosteroid ($n=20$). Contrary to the findings of Chen et al., PRP was associated with superior short-term outcomes compared to corticosteroid. Median pain scores were significantly lower at 6- and 12-weeks post-injection in patients treated with PRP vs corticosteroid, and responder rates for $\geq 50\%$ pain improvement were significantly higher in the PRP group compared to the corticosteroid group at 12 weeks (90% vs 25%).

Observational studies

These studies are presented in Table 13.

Allogeneic orthobiologics

Pragmatic RCTs

No pragmatic RCTs were identified.

Observational studies

These studies are presented in Table 13.

Hyaluronic acid

Pragmatic RCTs

In 2022, Abdelkreem et al. published the results of a randomized study comparing short-term outcomes following ultrasound-guided IA injections of either low molecular weight hyaluronic acid (HA) or corticosteroid in 40 participants with sacroiliitis.²⁴⁵ Patients were classified as having degenerative (DSI; $n=20$) or inflammatory (ISI; $n=20$) sacroiliitis based on modified New York criteria. No diagnostic SIJ injections were performed as a part of the selection process. Ten patients from each group were allocated to the two treatment arms, producing a total of four patient phenotype/treatment combinations: DSI+HA, DSI+corticosteroid, ISI+HA, and ISI+corticosteroid. Pain was significantly improved from baseline in all four subgroups post-injection, with no between-group differences detected. However, respective comparisons of patient outcomes between treatment modalities for the DSI and ISI groups revealed IA injections of corticosteroid were more effective than HA at reducing SIJ complex pain secondary to sacroiliitis, regardless of etiology. For patients with DSI, average VAS pain scores were significantly lower among those treated with corticosteroids vs HA at all follow-up timepoints (5.6 ± 3.3 vs 8.0 ± 1.3 at 1-week, 4.4 ± 3.0 vs 7.5 ± 1.2 at 2-weeks, and 3.4 ± 2.3 vs 6.1 ± 1.4 at 4-weeks, respectively). Although 1-week VAS pain score comparisons did not reach statistical significance for ISI patients, similar outcomes favoring corticosteroid over HA were observed at 2-weeks (5.3 ± 2.6 vs 7.9 ± 1.3) and 4-weeks (4.4 ± 2.1 vs 6.8 ± 1.5) post-injection.

Observational studies

These studies are presented in Table 13.

Table 13. Studies evaluating non-corticosteroid injectable treatments for sacroiliac joint complex pain.

Study	Population	Design	Injectate Details	Injection Protocol	Outcomes	Comments
Dextrose prolotherapy Kim, 2010 ²⁴⁸	48 patients with SIJ complex pain lasting ≥ 2 months confirmed by $\geq 50\%$ pain relief following single IA injection with 2.5 mL levobupivacaine 0.25%; patients required to fail 1 month of conservative treatment after positive injection	RCT	Treatment group ($n = 23$): 2.5 mL of 25% dextrose solution mixed with levobupivacaine CS group ($n = 25$): 2.5 mL of triamcinolone acetone (40 mg) in levobupivacaine 0.125%	Fluoroscopic guidance; maximum of 3 IA injections at 2-week intervals	Primary outcome: $\geq 50\%$ improvement on NRS 6-month responder rates: 63.6% in prolotherapy group vs 27.2% in CS group; $P < .01$ 10-month responder rates: 58.7% in prolotherapy group vs 10.2% in CS group; $P < .01$ 15-month responder rates: 58.7% in prolotherapy group vs 10.2% in CS group; $P < .01$	On average, patients in the prolotherapy group received a significantly greater number of injections than those in the CS group (2.7 ± 1.1 vs 1.5 ± 0.8 ; $P < .01$)
Cusi, 2010 ²⁵¹	25 patients with low back or buttock pain lasting ≥ 6 months; SIJ diagnosis based on clinical movement testing and no symptom improvement after 3-month exercise program; no diagnostic injections	Prospective descriptive study	0.8 mL of 18% dextrose solution mixed with bupivacaine	CT guidance; 3 EA injections at 6-week intervals into the dorsal interosseous ligament of affected SIJ	Clinical scores/testing maneuvers performed by two clinicians; significant improvement at 3 months ($n = 19$), 1 year ($n = 19$), and 2 years ($n = 8$; all $P < .001$)	Average follow-up was 26 months (6–39 months); significant improvements from baseline observed for 2 years
Lee, 2009 ²⁴⁹	22 patients with SIJ complex pain confirmed by $\geq 50\%$ relief after a single IA injection with local anesthetic	Prospective observational/ descriptive study	25% dextrose solution mixed with levobupivacaine	3 fluoroscopically-guided IA injections at 2-week intervals	- Quebec Back Pain Disability Scale decreased significantly from baseline at 3 months ($n = 15$; $P < .001$), 1 year ($n = 15$; $P = .002$), and 2 years ($n = 7$; $P = 0.006$) - Roland-Morris Back Pain Questionnaire scores decreased significantly from baseline at 3 months ($n = 15$; $P = .001$), 1 year ($n = 12$; $P = .047$), and 2 years ($n = 7$; $P = .035$) - NRS ($6 [4-8]$ vs $1 [0-3]$) and ODI (34.1 ± 15.5 vs 12.6 ± 9.8) significantly improved from baseline at 1 month ($P < .01$) - Mean duration of treatment effect ($\geq 50\%$ pain relief) was 12.2 months (95% CI: 10.0–14.3) per Kaplan-Meier analysis	Only abstract, tables, and figures are in English

(continued)

Table 13. (continued)

Study	Population	Design	Injectate Details	Injection Protocol	Outcomes	Comments
Hoffman & Agnish, 2018 ²⁴⁷	103 US veterans referred for LBP with suspected SIJ involvement based on local tenderness and limited mobility on Gillet test; unspecified number of patients received either a fluoro-guided confirmatory diagnostic injection with LA + CS or were diagnosed with SIJ complex pain based on unspecified response to the first therapeutic prolotherapy injection	Retrospective cohort study	10 mL of 1.5% dextrose solution mixed with lidocaine	3 IA injections at approximately 1-month intervals; initially performed with fluoroscopic guidance but switched to no imaging after difficulty accessing fluoroscope	• 24/103 (23%) patients met responder definition of $\geq 15\%$ ODI improvement • Average decrease in ODI scores from baseline was significant ($P < 0.05$) but small (mean 4 ± 17 points)	Follow-up was 3–4 months after final injection (median 110 days); authors split patients into “improved” and “not improved” groups based on $\geq 15\%$ ODI improvement (MCID); study objective was to look for predictors of treatment success)
Chemical neurolysis Weksler, 2007 ²⁵³	42 patients with severe chronic nonmalignant pain lasting ≥ 6 months who failed conservative treatment; $n = 5$ SIJ patients; dual diagnostic injection protocol consisting of one LA (injectate and volume not specified) injection requiring 70% pain reduction and one sham injection with 0.9% saline (no pain relief)	Prospective observational study	4% phenol solution	Fluoroscopically guided IA injection	• Treatment was successful (defined as an absolute VAS pain score ≤ 3) in 4/5 SIJ patients, who received an average of 2.6 injections each (range 2–4) • Mean follow-up was 13.6 ± 5.7 months (range 6–26)	Results presented as aggregate with no breakdown by diagnosis; no info about injection frequency, injectate volume
Frederico, 2022 ²⁵³	2 patients with low back/hip pain (NRS = 7) and 3 positive clinical tests for SIJ stress; single US-guided EA diagnostic injection (1 mL bupivacaine 0.25%) requiring $> 75\%$ relief	Case report	0.75 mL of 7% glycerinated phenol	Single series of 3 US-guided injections into posterior sacral network (area of posterior SIJ complex innervated by L4/5, S1–S3) at levels of S1–S3	• Both patients reported $\geq 50\%$ NRS pain reduction and decreased daily analgesic use through 6 months	
Ward, 2002 ²⁵⁴	10 patients with sacroiliitis based on unspecified pain relief lasting 2–4 weeks following fluoroscopically-guided IA injection of unspecified volume of bupivacaine 0.5% + 80 mg Depo-Medrol	Retrospective case series	2.5 mL of 6% phenol in saline	Multiple (no quantification provided) fluoroscopically-guided IA injections	• 2/10 patients (20%) reported $> 70\%$ improvement in symptoms with average duration of 24 weeks • 6/10 patients (60%) had 50–70% improvement for an average of 20 weeks • 1 patient (10%) reported 20–49% improvement lasting 12.5 weeks • 1 patient (10%) reported $< 20\%$ improvement	Symptom improvement was determined by an unspecified combination of patient interviews and responses on the McGill short-form pain questionnaire

(continued)

Table 13. (continued)

Study	Population	Design	Injectate Details	Injection Protocol	Outcomes	Comments
Platelet-rich plasma (PRP) Chen, 2022 ²⁴⁰	26 patients with chronic unilateral LBP without radiculopathy; ≥ 5 NRS pain score, ≥ 3 positive SIJ provocation tests, and no improvement of symptoms after ≥ 4 weeks of physical therapy; SIJ confirmed as pain generator with single fluoroscopically-guided IA diagnostic injection (2 mL lidocaine 2%) requiring $> 80\%$ pain relief	RCT	PRP group ($n = 15$): 2 mL PRP CS group ($n = 11$): 1 mL betamethasone sodium phosphate suspended in acetate (6 mg/mL) + 1 mL lidocaine 2%	Single fluoroscopically-guided IA injection	Responder rates: $\geq 50\%$ NRS pain reduction 1 month: 3/14 patients (21.4%) in PRP group vs 8/10 patients (80.0%) in CS group; $P = .011$ 3 months: 3/14 patients (21.4%) in PRP group vs 7/10 patients (70.0%) in CS group; $P = .035$ 6 months: 3/12 patients (25.0%) in PRP group vs 4/6 patients (66.7%) in CS group; $P = 0.141$ - Both groups experienced significant NRS pain reduction and disability improvement across follow-up time points; mean NRS pain and disability scores for CS group were significantly lower than those for PRP group at 1, 3, and 6 months	
Singla, 2017 ²⁴²	40 patients with LBP lasting ≥ 3 months; diagnosis based on SIJ pathology on imaging and ≥ 3 positive provocation tests; no diagnostic injections performed	RCT	PRP group ($n = 20$): 3 mL leukocyte-free PRP + 0.5 mL CaCl_2 CS group ($n = 20$): 1.5 mL methylprednisolone (40 mg/mL) + 1.5 mL lidocaine 2% + 0.5 mL saline	Single US-guided IA injection	- A significantly greater proportion of patients in the PRP group reported $\geq 50\%$ VAS pain improvement compared to the CS group at 3 months (90% [95% CI: 77-10%] vs 25% [95% CI: 6-44%]) - Pain scores significantly lower in PRP vs CS group at 6 weeks (median [IQR] = 1 [1-1] vs 3.5 [2-5]) and 3 months (median [IQR] = 1 [1-3] vs 5 [3-5])	

(continued)

Table 13. (continued)

Study	Population	Design	Injectate Details	Injection Protocol	Outcomes	Comments
Ko, 2017 ²⁵²	4 patients with SIJ complex pain unresponsive to conservative treatment who received at least one type of therapeutic IA injection ($n = 3$ sodium morphuate and dextrose prolotherapy; $n = 1$ botulinum toxin A); no diagnostic injections performed; SIJ complex pain confirmed based on a combination of pt history and clinical examination, unspecified # of positive provocation tests, and imaging	Retrospective case series	10 mL PRP prepared with a citric acid dextrose solution	Series of 2 US-guided EA injections into the posterior SIJ ligaments performed at unspecified time intervals; each session consisted of injecting 3 x 0.5 mL doses into Hackett's trigger points A, B, and C	- Pooled data revealed pain was significantly reduced at 1-year post-treatment, with Short form McGill Questionnaire, NRS, and ODI scores reduced by 93%, 88%, and 75%, respectively. - Pain improvement remained significant at 4 years (no statistics provided)	No raw data provided
Navani, 2015 ²⁴¹	10 patients with LBP lasting >6 months unresponsive to conservative treatment and at least 1 positive provocative test; diagnosis based on >50% pain relief following "one or more diagnostic or therapeutic SIJ injections with LA $\pm$ corticosteroids"	Retrospective case series	4 mL PRP injection without additives or activating agents	Single, fluoroscopically-guided IA injection	All patients experienced $\geq 50\%$ pain improvement on VAS pain scale through 12 months	Diagnostic injection details (location, imaging guidance, injectate, volume, etc.) not reported. No raw data or statistical interpretation of findings provided.
Eldin, 2019 ²⁴³	186 patients with LBP >6 months unresponsive to conservative treatment; diagnosis of SIJ complex pain based on ≥ 3 positive provocation tests and a single diagnostic injection (no details were provided regarding location, injectate, pain relief requirements, etc.)	Prospective case control study	PRP group ($n = 62$): PRP prepared with citrate dextrose and calcium gluconate solutions (injected volume not specified) PRF group ($n = 124$): injected volume of PRF not specified	Single, fluoroscopically-guided IA injection	- No significant between-group differences in average VAS pain scores at baseline or 1-month follow-up - Average VAS pain scores were significantly lower for PRF vs PRP group at 6 months (4.61 ± 2.00 vs 5.19 ± 1.49; $P = .045$)	(continued)

Table 13. (continued)

Study	Population	Design	Injectate Details	Injection Protocol	Outcomes	Comments
Hyaluronic acid Abdelkrem, 2022 ²⁴⁵	40 patients previously diagnosed with either inflammatory (ISI; $n = 20$) or degenerative (DSI; $n = 20$) sacroiliitis based on modified New York criteria or radiographic findings, respectively. No diagnostic injections.	RCT	CS subgroups ($n = 10$ ISI; $n = 10$ DSI): 2 mL betamethasone dipropionate + 2 mL lidocaine 2% Hyaluronic acid subgroups ($n = 10$ ISI; $n = 10$ DSI): 2 mL low molecular weight hyaluronic acid + 2 mL lidocaine 2%	US-guided IA injection	- No significant differences in VAS pain scores between ISI vs DSI groups at any time point ISI group: - VAS pain scores were significantly different before and after injection ($P < .001$) - Significantly lower VAS pain scores for patients who received CS vs HA at 2 weeks (5.3 ± 2.6 vs 7.9 ± 1.3; $P = .012$) and 4 weeks post-injection (4.4 ± 2.1 vs 6.8 ± 1.5, $P = .008$) DSI group: - VAS pain scores were significantly different before and after injection ($P < 0.001$) - Significantly lower VAS scores for patients who received CS vs HA at 1 week (5.6 ± 3.3 vs 8.0 ± 1.3, $P = .044$), 2 weeks (4.4 ± 3.0 vs 7.5 ± 1.2, $P = .006$), and 4 weeks (3.4 ± 2.3 vs 6.1 ± 1.4, $P = .005$)	Repeated measures ANOVA used to compare VAS pain scores between different time points; no post-hoc tests performed to ascertain which paired comparisons (baseline vs follow-up) were significant
Srejić, 1999 ²⁴⁶	4 patients with chronic LBP refractory to conservative treatment; SIJ complex pain confirmed by dual fluoroscopically guided IA injections with 2 mL bupivacaine 0.75% (no pain relief threshold established)	Case report	1 mL (8 mg) hyaluronic acid (Hylan GF 20) per joint	3 fluoroscopically-guided IA injections administered at 2-week intervals	All patients reported pain improvements of 40%-67% 3 months after the last injection	

(continued)

Table 13. (continued)

Study	Population	Design	Injectate Details	Injection Protocol	Outcomes	Comments
Botulinum toxin Lee, 2010 ²⁵⁶	39 patients with back or pelvis pain, ≥3 positive provocation tests, and no signs of inflammatory joint disease; diagnosis confirmed with a single flu- oroscopy-guided EA injection of 2 mL lidocaine 2% requiring ≥50% pain relief	Prospective case-control study	Botulinum toxin (BT) group (<i>n</i> = 20): 100 units of botulinum toxin type A (volume not noted) CS group (<i>n</i> = 19): 40 mg triamcinolone in 2 mL lidocaine 0.5%	Single fluoroscopically- guided EA injection into the middle portion of the posterior ligaments	• NRS pain scores were significantly lower at 2- and 3-months post-treatment for the BT group (1.8±1.7 and 1.9±2.0) compared to the CS group (3.7±1.7 and 4.9±1.7), respectively • ODI scores were significantly lower at 2- and 3-months post-treatment for the BT group (11.1±10.0 and 11.9±9.1) compared to the CS group (20.4±11.1 and 24.0±10.6), respectively • BT group had a significantly greater proportion of patients with ≥50% NRS pain score reduction compared to the CS group at 3 months (88.2% vs 6.7%) • BT group had a significantly greater proportion of patients with ≥40% ODI reduction compared to the CS group at 3 months (88.2% vs 26.7%)	

(continued)

Table 13. (continued)

Study	Population	Design	Injectate Details	Injection Protocol	Outcomes	Comments
Placental (Wharton's) Jelly Allograft Lai, 2023 ²⁴⁴	38 patients with degenerative structural defects of SIJ articular cartilage based on radiologic imaging who failed >8 weeks of conservative treatment; no diagnostic injections performed (unspecified number of patients had prior diagnostic SIJ injections)	Case series	2 mL (100 mg) Wharton's jelly	Single, fluoroscopically-guided IA injection into inferior third of SIJ	• 32/38 patients (84%) reported a reduction in NRS pain score at 90 days; average NRS pain score reduced from 6.7±2.1 at baseline to 3.6±2.3 at 90 days post-injection (42% decrease) • 29/38 patients (76%) reported average WOMAC score reduction of 22% at 90 days; significant difference in baseline vs 90-day follow-up scores (56.1±18.8 vs 43.3±22.7; $P = 0.009$)	No statistical comparisons/significance levels reported for NRS pain outcomes
Saline Maugars, 1996 ¹¹	10 patients (13 joints total) diagnosed with painful inflammatory sacroiliitis (based on CT imaging) who failed >1 month of treatment with anti-inflammatory medications (NSAIDS or corticosteroids); no diagnostic injections performed	RCT	Saline group ($n = 7$ SIJ joints): 1.5 mL isotonic saline Corticosteroid (CS) group ($n = 6$ SIJ joints): 1.5 mL cortivazol (equivalent to 62.5 mg of prednisone)	Single, fluoroscopically-guided IA injection; patients in saline control group offered crossover to CS at 1 month	• 1-month treatment success rates, defined as >70% SIJ complex pain improvement, were significantly higher for CS vs saline group (5/6 vs 0/7 cases, respectively; $P < .05$) • 11-point dolorimetry scores were significantly reduced from baseline in the saline group at 1 month (7.0 ± 0.6 vs 5.2 ± 0.5; $P < .005$) • 6/7 cases originally allocated to saline treatment crossed over to CS at 1 month with 12/14 (86%) joints experiencing a positive 1-month outcome, which declined to 62% and 58% at 3 and 6 months, respectively; the one patient who opted not to cross over maintained 50-70% pain improvement through final follow-up at 6 months	

ANOVA, analysis of variance; CS, corticosteroid; EA, extraarticular; IA, intraarticular; LBP, low back pain; MCID, minimal clinically important difference; NRS, numeric rating scale; ODI, Oswestry disability index; PRF, platelet-rich fibrin; PRP, platelet-rich plasma; RMDQ, Roland-Morris disability questionnaire; SIJ, sacroiliac joint; VAS, visual analog scale.

Prolotherapy

Pragmatic RCTs

In a 2010 RCT, Kim et al. compared long-term treatment outcomes in 48 patients randomized to IA injections with corticosteroid or 25% dextrose prolotherapy solution.²⁴⁸ Among other criteria, patients were selected by single diagnostic IA injections with local anesthetic that provided $\geq 50\%$ relief of index pain. Participants allocated to both treatment arms received up to three injections at 2-week intervals. Of note, the average number of study injections was significantly higher among the 23 prolotherapy patients compared to the 25 patients treated with corticosteroid. Responder rates for $\geq 50\%$ pain improvement were significantly higher among patients treated with dextrose prolotherapy vs corticosteroid at all follow-up timepoints: 64% vs 27% at 6-months and 59% vs 10% at both 10- and 15-months post-treatment.

Observational studies

These studies are presented in Table 13.

Chemoneurolysis

Pragmatic RCTs

No pragmatic RCTs were identified.

Observational studies

These studies are presented in Table 13.

Botulinum toxin

Pragmatic RCTs

No pragmatic RCTs were identified.

Observational studies

These studies are presented in Table 13.

Saline

Pragmatic RCTs

In 1996, Maugars et al. published the results of a small RCT in which 10 patients with SIJ complex pain secondary to inflammatory sacroiliitis were randomized to receive a single IA injection with either corticosteroid ($n=6$ joints) or saline ($n=7$ joints).¹¹ No diagnostic SIJ injections were performed as a part of the selection process. Although pain was improved significantly from baseline for the saline group at 1-month follow-up, none of the participants who received saline injections reported pain relief exceeding 70%, which was the pre-defined criterion for success. In contrast, five of six (83%) participants who received corticosteroid injections reported a successful outcome at 1 month. Between-group comparisons were not possible at subsequent follow-up timepoints, as all but one patient in the saline arm crossed over to corticosteroid treatment at 1 month. The individual who did not cross over reported 50%-70% pain improvement at 3 months and at the final 6-month follow-up assessment.

Observational studies

These studies are presented in Table 13.

Summary:

- There is insufficient evidence demonstrating efficacy or effectiveness of autologous orthobiologics, allogeneic orthobiologics, hyaluronic acid, non-dextrose-based

prolotherapy, chemoneurolysis, botulinum toxin, and saline for the treatment of SIJ complex pain; Grade I evidence.

- Dextrose-based prolotherapy may be effective for SIJ complex pain 6 months post-procedure; Grade C evidence, low level of certainty.
- Platelet-rich plasma may be effective for the treatment of SIJ complex pain at 3 months post-procedure; Grade C evidence, low level of certainty.

Q12. What is the evidence for cryoablation in the treatment of sacroiliac joint complex pain?

Cryoablation of peripheral nerves leads to cellular destruction and temporary or permanent interruption of pain signal transmission along the affected nerve pathway by applying extreme cold to the target nerve, causing ice crystal formation within the nerve cells and surrounding tissue. Cryoablation may cause less extensive damage to surrounding tissues and may allow for better preservation of the nerve's connective tissue structures (endoneurium, perineurium, and epineurium) compared to RFA. This relative preservation of the nerve's scaffold can potentially facilitate remyelination and nerve regeneration in some cases, depending on the intensity and duration of the freezing process.²⁵⁹ Other benefits of cryoablation may include: Creation of large volume lesions,²⁶⁰ less procedural pain, and lower cost compared to some RFA technologies, though this depend in part on the system used and how costs are attributed.²⁶¹

Evidence-base for treatment of sacroiliac joint complex pain

The literature search revealed very limited published evidence addressing the clinical outcomes of cryoablation for SIJ complex pain. Two case series and one retrospective study were identified. One case series included five cases in which patients were selected for cryoablation used a diagnostic IA SIJ injection with 3 mL of 2% lidocaine.²⁶¹ A strip-lesion technique of cryoablation was used to capture the S1, S2, and S3 lateral branch nerves. The authors reported that patients experienced "more than 50%" pain relief for up to 6 months after SLB-cryoablation using combined ultrasound and fluoroscopic-guidance. Another case series included two patients who were treated with cryoablation (without a prior prognostic injection). The authors did not report which nerves were included (L5 dorsal ramus, sacral lateral branch nerves, or both). The authors reported that both patients experienced 50% pain reduction up to the end of the 4-month follow-up.²⁶²

In a retrospective case-control study, outcomes in 39 patients treated with cryoablation for SIJ complex pain were compared to 44 patients who underwent IA SIJ corticosteroid injection. In the cryoablation group, participants were selected using a single IA SIJ injection with 1% lidocaine that resulted in $\geq 50\%$ pain reduction. Both groups demonstrated statistically significant pain relief at 1-, 3-, and 6-months compared to their baseline pain scores. However, the cryoablation group demonstrated a larger magnitude of pain relief and a greater proportion of responders based on using both a $\geq 50\%$ pain reduction and complete pain relief thresholds as the definitions of "treatment success".²⁶³

Extrapolation of evidence for treatment of similar conditions

A randomized, placebo-controlled, single-blind study compared RFA, cryoablation and sham cryoablation in 120 patients who

reported >50% pain relief following high-volume (2 mL) peri-articular lumbar facet injections. Ablations were performed with small radiofrequency electrodes (22-gauge) and large cryoablation (14-gauge) probes. The authors reported no difference between groups with regard to any outcome measure except for improvement on the Patient Global Impression of Change scale in the cryoablation group, but not the RFA group at 6 months post-procedure.²⁶⁴ In a narrative review evaluating cryoneurolysis for knee osteoarthritis, non-specific knee pain and post-arthroplasty knee pain (14 studies, 3 RCTs), Diep et al. found evidence for improvements in pain, quality of life, function and opioid consumption.²⁶⁵ However, the low quality of the trials (10 targeted only the infrapatellar branch of the saphenous nerve, while 4 did not report the neural targets) led the authors to the conclusion that while promising, cryoablation for knee pain remains investigational.

Summary:

- There is insufficient evidence to assess the efficacy and effectiveness of cryoablation for SIJ complex pain; Grade I evidence.

Recommendation:

- Further studies, including RCTs, are warranted. Future studies should include investigation of anatomically valid techniques for sacral lateral branch nerve capture, like what has been done in clinical trials and other outcome studies evaluating SLBRFA.

Q13. Is sacral lateral branch radiofrequency ablation effective for the treatment of sacroiliac joint complex pain?

SLBRFA is the process of coagulating the neural tissues of the posterior sacral network (PSN), which is comprised of sensory fibers from the L5 dorsal ramus and sacral lateral branches of the S1-S4 dorsal rami, in order to disrupt nociceptive signals from the EA structures and posterior bony

cortex of the posterior SIJ complex.^{108,113,266} Variations of this procedure have been applied for over two decades by interventional pain physicians. In a 2001 retrospective case series, Ferrante et al. first attempted RFA by lesioning the posterior inferior part of the posterior joint by sequentially walking bipolar radiofrequency cannulas cephalad in the joint space as far superior as possible. The authors reported 35% of patients experienced $\geq 50\%$ pain relief through 6 months.¹⁹ Although these results established the feasibility of RFA, future investigations that targeted the nerves themselves would go on to yield more robust findings as subsequent advances in our understanding of PSN neuroanatomy has led to the development of increasingly comprehensive and anatomically-valid lesioning protocols.

Numerous reports have now been published that address the efficacy and effectiveness of SLBRFA. Some of these studies have used anatomically validated techniques for capturing the sacral lateral branch nerves (Figure 2), while others failed to do so.¹²² In addressing the question as to whether SLBRFA is effective, it is necessary to specifically evaluate anatomically-valid procedural techniques, as other techniques potentially represent modifications that are not likely to capture the sacral lateral branch nerves and therefore result in predictable technical failure (ie, small-gauge electrodes placed perpendicularly near the foramina, or a single longitudinal electrode placement technique do not provide precision or flexibility for anatomic differences). Here, we catalogue the RCTs within the published literature and describe in detail those that used an anatomically-valid SLBRFA technique.

Clinical studies

Randomized trials

Explanatory RCTs using anatomically valid SLBRFA techniques

In 2008, Cohen et al. reported results of a double-blind, sham-controlled study performed in 28 patients selected by a single IA SIJ injection with local anesthetic and corticosteroid resulting in $\geq 75\%$ relief of index pain.²¹ Study participants were randomized in a 1:1 ratio to receive either true or placebo denervation. RFA of the L4 medial branch and L5

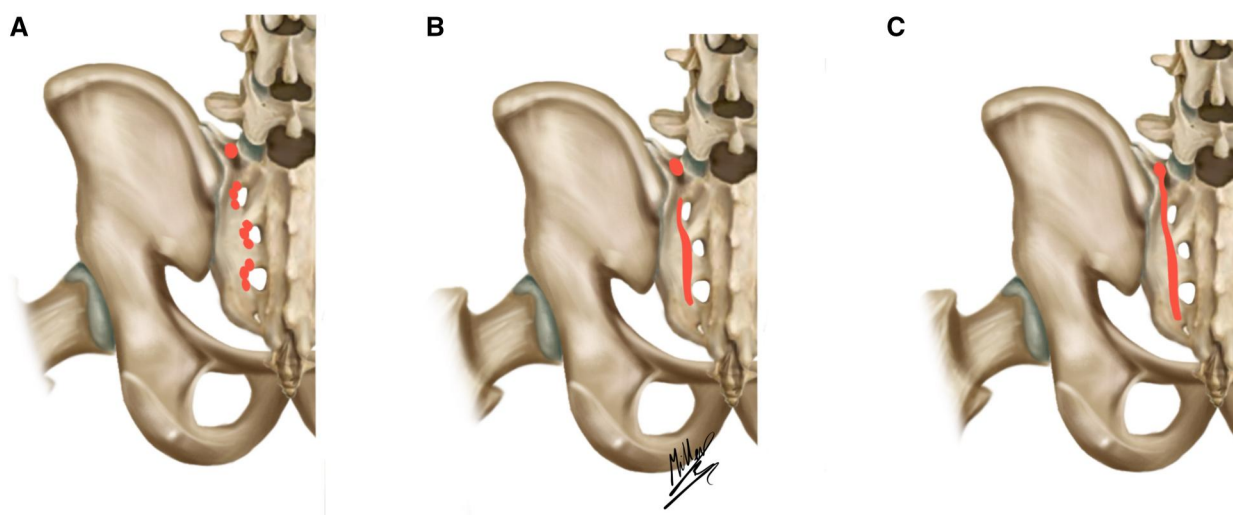


Figure 2. Schematic drawing demonstrating (A) Expected peri-foraminal lesion locations, commonly used with internally-cooled radiofrequency ablation; (B) Ablation pattern for a longitudinal strip lesion extending from S1 through S3, often performed using a bipolar leapfrog technique, with a separate lesion site targeting the L5 dorsal ramus; (C) Optimal strip lesion pattern from the site of the L5 dorsal ramus, extending beyond the inferior aspect of the S3 foramen.

dorsal ramus was performed with conventional electrodes and RFA of the S1-S3/4 lateral branches used an internally cooled probe with monopolar lesioning technique. For sham procedures in the control group, electrodes were similarly situated, electrostimulation was performed in an identical manner, and lidocaine was injected, but no RFA current was applied. Control patients were given the option to cross over to active RFA treatment with a conventional (non-internally cooled) monopolar technique. Average NRS pain scores at 1-month follow-up (the primary outcome) were significantly lower for the treatment group compared to the sham group (2.4 ± 2.0 vs 6.3 ± 2.4 ; $P < .001$). Significantly greater improvements in function and analgesic consumption were also observed at 1 month for patients who received active vs sham RFA procedures. Similarly, 1-month treatment success rates were higher among those who received RFA vs sham procedures: 79% of participants in the RFA group met all criteria for the predefined composite variable “successful outcome” compared to only 14% in the sham group. Eleven sham arm participants crossed over to active RFA treatment by 3 months, precluding between-group comparisons at subsequent timepoints. The treatment effect of RFA remained durable through 6 months for the original active treatment group: 3- and 6-month success rates were 64% and 57%, respectively, before declining to 14% by 12 months post-RFA. For the 11 participants who crossed over from SLBRFA with conventional monopolar technology at either 1 month ($n=9$) or 3 months ($n=2$) after the sham procedure, RFA success rates were slightly (but not significantly) lower than those for the original treatment group at 1-, 3- and 6-month follow-ups (44%, 67%, and 52%, respectively).

Patel et al.²² later reported on the results of a single-blind RCT comparing outcomes of 51 participants who received either internally-cooled monopolar SLBRFA procedure or a sham procedure. SIJ complex-mediated pain was confirmed by $\geq 75\%$ relief of index pain with dual fluoroscopically guided injections to anesthetize the L5 dorsal ramus and S1-S3 lateral branches. A 2:1 randomization strategy resulted in 34 and 17 patients allocated to the treatment and sham groups, respectively. Treatment success was defined as $\geq 50\%$ pain reduction accompanied by a 10-point improvement on either SF-36BP or ODI score. Success rates at 3-month follow-up were significantly greater for participants in the active treatment group compared to those who received a sham procedure (47% vs 12%, respectively). No subsequent comparisons between the treatment and sham groups were made, as all sham group patients either crossed over to SLBRFA ($n=16$) or dropped out without crossover ($n=1$). Among the active treatment group, successful outcomes were observed for 38% and 59% of patients at 6- and 9-months, respectively. Outcomes for patients who opted to cross over from sham to active treatment were comparable to those for the original treatment group, with 44% reporting treatment success at 3- and 6-months post-RFA.

Explanatory RCTs using non-anatomically valid SLBRFA techniques
These studies are shown in [Table 14](#).

Pragmatic RCTs using anatomically valid SLBRFA techniques

In 2014, Zheng et al. reported the results of a randomized study conducted in 155 participants with ankylosing spondylitis who were treated with either CT-guided RFA of the L5 dorsal ramus and a conventional bipolar technique for RFA

of the S1-S4 lateral branches ($n=82$) or daily doses of celecoxib ($n=73$).²⁶⁷ Patients were selected based on $\geq 50\%$ pain relief following a single IA SIJ injection with local anesthetic and corticosteroid. Pain intensity scores at follow-up were lower on average for participants treated with RFA compared to those taking celecoxib at both 3- and 6-month follow-up time points (2.5 vs 4.4 at 3-months; 2.8 vs 5.0 at 6-months; $P < .001$). Categorical responder data were not reported.

Cánovas Martínez et al. published the results of a randomized study in 2016 comparing treatment outcomes following conventional bipolar RFA technique for coagulation of the sacral lateral branches to IA injections of local anesthetic and corticosteroid in 60 participants.²⁶⁸ Participants were selected through a single IA SIJ injection with local anesthetic and corticosteroid resulting in $\geq 50\%$ relief of index pain.²⁶⁸ The investigators also evaluated whether a modified version of the “palisade” SLBRFA technique (12 mm electrode separation) was more effective than the original protocol (10 mm electrode separation).²⁶⁸ Twenty patients were allocated to each of three treatment groups: Conventional bipolar RFA from S1 to S3, modified conventional bipolar RFA, and ultrasound-guided IA SIJ corticosteroid injection. Whereas index pain was substantially reduced from baseline at 1-month follow-up in all three groups, only the two groups treated with SLBRFA maintained statistically significant levels of pain relief at 3- and 12-months post-procedure. Between-group comparisons, which were performed for the 12-month time point only, revealed that patients belonging to the modified bipolar RFA group had significantly lower follow-up VAS pain scores than those treated with the original bipolar RFA technique or IA SIJ corticosteroid injection (4.2 ± 0.8 vs 6.1 ± 1.1 and 6.2 ± 0.8 , respectively; $P < .001$). However, it is unclear why a greater inter-electrode separation distance would result in a superior outcome given that there is a greater chance of incomplete bipolar lesion development (“hourglass” lesion effect) compared to a reduced inter-electrode separation distance, particularly with the use of small-gauge electrodes (22 ga).^{269–271} This finding may be due to the small sample size.

A recent study by Cohen et al.¹⁴ compared intermediate-term outcomes following an anatomically valid monopolar icRFA technique coagulating the L5 dorsal ramus and S1-S3/4 lateral branches to standard medical management (SMM), which included conservative therapies (eg, PT, exercise, analgesic medications, corticosteroid injections, and nerve blocks). Two hundred and ten patients were randomized in a 1:1 fashion. Patients were selected if they experienced $\geq 50\%$ relief of index pain from a previous therapeutic or diagnostic IA SIJ injection, in addition to $\geq 50\%$ relief of index pain following a single set of SLBBs with local anesthetic. Treatment effectiveness was evaluated based on a primary outcome of average NRS pain reduction at 3 months, as well as predefined responder rates considering both NRS pain intensity score and Patient Global Impression of Change scores. At 1-month follow-up, both average pain improvement and the proportion of patients meeting the responder definition were greater for the SLBRFA group compared to the SMM group (39% vs 14% for NRS pain improvement $\geq 50\%$ and 42% vs 15% for responder rates, respectively). The differences favoring SLBRFA persisted at 3 months for both substantial ($\geq 50\%$) pain improvement from baseline (42% vs 7%) and responder rate (52% vs 4%). The 12-month follow-up study

Table 14. Explanatory and pragmatic randomized controlled trials evaluating sacral lateral branch radiofrequency ablation.

Study	Procedure Details			Outcomes	
	Population	SLB/RA	Comparator	Responder Rates	Pain Relief
Explanatory RCTs Mehra ²⁷	17 pts with LBP >6 months and 1-week average NRS pain score ≥ 5 ; positive FABER provocation test	N = 11 Monopolar RFA • Cannula: 22G, 10mm active tip • Target(s): L5DR • Temp: not listed • Duration: not listed	N = 6 Sham procedure with crossover to RFA at 3 months (4/6 pts)	Responder definition not specified	3 months, RFA arm: mean improvement on NRS 58% ^{b,c} 3 months, sham arm: mean improvement on NRS 11% ^b 3 months, crossover arm ($n = 4$): mean improvement on NRS 45%
	Double IA injection with 2 mL lidocaine 1% under fluoroscopic guidance requiring $\geq 80\%$ relief	Multipolar Strip Lesion • Simplicity III • Target(s): S1-S3 • Temp: not listed • Duration: not listed			6 months, RFA arm: mean improvement on NRS 47% ^b
Van Tilburg ²⁴	60 pts with LBP >3 months who did not improve with conservative care	N = 30 Monopolar RFA • Cannula: 10cm Sluiter-Mehta Kit needle • Target(s): L5DR • Temp: 85°C • Duration: 90s	N = 30 Sham procedure with 3-month crossover (19/30)	Responder definition: ≥ 2 -point decrease in pain on NRS 1 month, RFA arm: 13/30 pts (43%) 1 month, crossover arm: 8/19 pts (42%) 1 month, sham arm: not reported	1 month, RFA arm: mean improvement on NRS 25% 1 month, crossover arm: not reported 1 month, sham arm: mean improvement on NRS 28%
	Single IA injection with 3 mL lidocaine 2% under fluoroscopic guidance requiring ≥ 2 -point pain reduction on NRS	Multipolar Strip Lesion • Simplicity III • Target(s): S1-S4 • Temp: 85°C • Duration: 90s			
Patel ^{22,c}	51 pts aged 18-88 years with chronic axial LBP >6 months and 3-day avg NRS pain score between 4 and 8	N = 34 icRFA ^c • Cannula: 17G, 75mm electrode, 4mm active tip • Target(s): L5DR, S1-S3 • Temp: 60°C • Duration: 150s	N = 17 Sham procedure with 3-month crossover to RFA (16/17)	Responder definition: $\geq 50\%$ improvement in pain on NRS corroborated by either: 1) 10-point improvement on SF-36BP; or 2) 10-point improvement on ODI 3 months, RFA arm: 16/34 pts (47%) ^c 3 months, sham arm: 2/17 pts (12%) 3 months, crossover arm: 7/16 pts (44%)	1 month, RFA arm: mean improvement on NRS 44% 1 month, sham arm: mean improvement on NRS 29% 3 months, RFA arm: mean improvement on NRS 39% ^c 3 months, sham arm: mean improvement on NRS 14%
	Dual SLBB requiring $\geq 75\%$ pain relief on NRS			6 months, RFA arm: 13/34 pts (38%) 6 months, crossover arm: 7/16 pts (44%) 9 months, RFA arm: 20/34 pts (59%)	

(continued)

Table 14. (continued)

Study	Procedure Details			Outcomes	
	Population	SLB/RFA	Comparator	Responder Rates	Pain Relief
Cohen ^{21,c}	28 pts >18 years of age with axial low back or buttock pain lasting over 6 months (plus tenderness over SI joint) who failed to respond to conservative care; pain relief <2 months with single IA local anesthetic and corticosteroid injection under fluoroscopic guidance	N = 14 Monopolar RFA • Cannula: 22G, 5 mm active tip • Target(s): L4MB, L5DR • Temp: 80°C • Duration: 90s icRFA ^c • Cannula: 17G, 75 mm electrode, 4 mm active tip • Target(s): S1-S3 (S4 included in 10pts) • Temp: 75°C • Duration: 150s	N = 14 Placebo with 1- (n = 9) and 3-month (n = 2) crossover to conventional RFA (11/14)	Responder definition: ≥50% improvement on NRS, a positive global perceived effect, and either 1) 10-point improvement on ODI; or 2) 4-point improvement on ODI accompanied by reduction in medication usage 1 month, RFA arm: 11/14 pts (79%) 1 month, placebo arm: 2/14 pts (14%) 3 months, RFA arm: 9/14 pts (64%) 3 months, placebo arm: 0/14 pts (0%) 6 months, RFA arm: 8/14 pts (57%) 12 months, RFA arm: 2/14 pts (14%)	1 month, RFA arm: mean NRS improvement 60% ^{b,d} 1 month, placebo arm: mean NRS improvement 3% 1 month, crossover arm: mean NRS improvement 44% ^{b,d} 3 months, RFA arm: mean NRS improvement 60% ^b 3 months, placebo arm (n = 2): mean NRS improvement 8% 3 months, crossover arm: mean NRS improvement 67% ^b 6 months, RFA arm: mean NRS improvement 57% ^b 6 months, placebo arm (n = 0): NA 6 months, crossover arm: mean NRS improvement 52% ^b
Pragmatic RCT's Cohen ^{14,c}	210 pts aged >21 years with SIJ complex pain lasting ≥3 months and 7-day average NRS score ≥4; at least one positive clinical provocation test; ≥50% pain relief from prior therapeutic or diagnostic injection Single SLBs with ≤2 mL long-acting LA requiring ≥50% pain relief under fluoroscopic guidance	N = 105 icRFA ^c • Cannula: 17G, 4 mm active tip • Target(s): L5DR, S1-S3 (S4 included at provider discretion) • Temp: >80°C • Duration: 150 s	N = 105 Standard medical management (SMM): Included corticosteroid injections, nerve blocks, physical therapy, analgesics, acupuncture, exercise, etc.	Responder definition: ≥30% or 2-pt decrease in 7-day average NRS and ≥5 on PGIC at 3 months 1 month, RFA arm: 40/94 pts (42%) ^c ; ≥50% NRS pain reduction 39% ^c 1 month, SMM arm: 49/95 pts (51%); ≥50% NRS pain reduction 14% 3 months, RFA arm: 45/86 pts (52%) ^c ; ≥50% NRS pain reduction 42% ^c 3 months, SMM arm: 4/92 pts (4%); 50% NRS pain reduction 7%	1 month, RFA arm: mean NRS improvement 37% ^{c,d} 1 month, SMM arm: mean NRS improvement 17% 3 months, RFA arm: mean NRS improvement 39% ^{c,d} 3 months, SMM arm: mean NRS improvement 5%

(continued)

Table 14. (continued)

Study	Population	Procedure Details		Outcomes	
		SLBFA	Comparator	Responder Rates	Pain Relief
Eissa ²⁷³	30 pts with LBP lasting >3 months and unresponsive to conservative care; required to have SIJ complex discomfort with a positive response to at least 3 provocative clinical movement tests	N = 15 Monopolar RFA • Cannula: 22 G, 5 mm active tip • Target(s): L4, L5DR, S1-S3 • Temp: 80°C • Duration: 90 s	N = 15 IA corticosteroid injection (2 mL methylprednisolone + 1 mL lidocaine 2%; n = 15)	Responder definition: >50% improvement on NRS 1 month, RFA arm: 9/15 pts (60%) 1 month, corticosteroid arm: 7/15 pts (46%) 3 months, RFA arm: 9/15 pts (60%) 3 months, corticosteroid arm: 6/15 pts (40%)	1 month, RFA arm: mean NRS improvement 56% ^b 1 month, corticosteroid arm: mean NRS improvement 53% ^b 3 months, RFA arm: mean NRS improvement 55% ^{b,d} 3 months, corticosteroid arm: mean NRS improvement 37% ^b
	Single IA injection with LA (2 mL lidocaine 2%) under fluoroscopic guidance requiring ≥50% pain relief				
Cánovas Martínez ^{268,c}	60 pts with intense (VAS >6) SIJ complex pain lasting ≥3 months unresponsive to conservative care; 3 positive clinical provocation tests	N = 40 Conventional Bipolar RFA (1 cm distance between electrodes, n = 20) ^c • Cannula: 22 G, 10mm active tip • Target(s): S1-S3 • Temp: 90°C • Duration: 180 s	N = 20 Two ultrasound-guided IA injections of 3 mL 5% levobupivacaine + 12 mg betamethasone sodium with a 7-day interval	Responder definition not specified	1 month, corticosteroid arm: mean VAS improvement 53% ^b 1 month, conventional RFA arm: mean VAS improvement 42% ^b 1 month, modified RFA arm: mean VAS improvement 41% ^b 3 months, corticosteroid arm: mean VAS improvement 15% 3 months, conventional RFA arm: mean VAS improvement 41% ^b 3 months, modified RFA arm: mean VAS improvement 52% ^b
	Single IA injection with LA (3 mL) Levobupivacaine 5% and corticosteroid (6 mg sodium phosphate + 6 mg betamethasone acetate) requiring ≥50% pain relief	Modified Bipolar RFA (≥1 cm distance between electrodes, palisades technique, n = 20) ^c • Cannula: 22 G, 10mm active tip • Target(s): S1-S3 • Temp: 90°C • Duration: 180 s			12 months, corticosteroid arm: mean VAS improvement 9% 12 months, conventional RFA arm: mean VAS improvement 2.5% (P = .01) ^d 12 months, modified RFA arm: mean VAS improvement 48% ^d

(continued)

Table 14. (continued)

Study	Population	Procedure Details		Outcomes	
		SLBRFA	Comparator	Responder Rates	Pain Relief
Salman ¹⁸	30 pts aged ≥18 years with LBP lasting ≥6 months	N = 15 Monopolar RFA • Cannula: 22 G, 10mm active tip (L4-L5); 22 G, 5 mm active tip (S1-S3) • Target(s): L4MB, L5DR, S1-S3 • Temp: 80°C • Duration: 90 s	N = 15 IA corticosteroid (1 mL depo-methylprednisolone 40 mg/mL)	Responder definition: ≥50% VAS improvement 1 month, RFA arm: 11/15 pts (73%) ^c 1 month, corticosteroid arm: 3/15 pts (20%) 3 months, RFA arm: 9/15 pts (60%) ^c 3 months, corticosteroid arm: 0% 6 months, RFA arm: 8/15 pts (53%) ^c 6 months, corticosteroid arm: 0%	1 month, RFA arm: mean VAS improvement 69% ^{b,c} 1 month, corticosteroid arm: mean VAS improvement 3% 3 months, RFA arm: mean VAS improvement 63% ^{b,c} 3 months, corticosteroid arm: mean VAS improvement 0% 6 months, RFA arm: mean VAS improvement 58% ^b 6 months, corticosteroid arm: no pts remaining
	Single IA injection confirmed by SIJ arthrogram with LA (2 mL lidocaine 2% + 1 mL bupivacaine 0.5%) requiring ≥75% pain relief				
Zheng ^{267,c}	155 pts diagnosed with ankylosing spondylitis with LBP lasting >3 months and pain exacerbation upon SIJ palpation	N = 82 Bipolar RFA ^c • Cannula: 20 G, 5 mm active tip • Target(s): L5DR, S1-S4 • Temp: 90°C • Duration: 180 s	N = 73 Celecoxib (NSAID): 200 mg twice daily for 24 weeks	Responder definition not specified 3 months, RFA arm: mean VAS improvement 65% ^{b,d} 3 months, NSAID arm: mean VAS improvement 36% ^b 6 months, RFA arm: mean VAS improvement 61% ^{b,d} 6 months, NSAID arm: mean VAS improvement 28% ^b	
	Single IA injection with 3 mL triamcinolone 40 mg + bupivacaine 0.5% under fluoroscopic guidance requiring ≥50% pain relief				

CI, confidence interval; GPE, Global Perceived Effect; IA, intraarticular; icRFA- internally-cooled radiofrequency ablation; L4MB, L4 medial branch; L5DR, L5 primary dorsal ramus; LA, local anesthetic; LBP, low back pain; NRS, Numerical Rating Scale; NSAID, non-steroidal anti-inflammatory drug; ODI, Oswestry Disability Index; PGIC, Patient Global Impression of Change; SF-36BP, 36-Item Short Form Survey, Bodily Pain subscale; SIJ, sacroiliac joint; SLBRFA, sacral lateral branch radiofrequency ablation; VAS, Visual Analog Scale.

^a Anatomically valid technique.

^b $P < .05$ vs baseline of the respective group.

^c $P < .05$ vs comparator group (responder rate/mean improvement from baseline).

^d $P < .05$ vs comparator group (mean follow-up score).

revealed sustained relief (56% combined responder rate) in both the original icRFA group and icRFA patients who crossed over from SMM.²⁷²

Pragmatic RCTs using non-anatomically valid SLBRFA techniques

These studies are shown in [Table 14](#).

Summary:

- SLBRFA is effective in the treatment of SIJ complex pain for at least 3 months post-procedure using the criteria of $\geq 50\%$ pain reduction to define a robust improvement threshold in individuals with chronic low back pain; Grade B evidence, moderate-to-high level of certainty.
- SLBRFA is effective in the treatment of SIJ complex pain for at least 6 months post-procedure when non-anatomically valid RFA techniques that fail to account for neuroanatomy are excluded; Grade B evidence, moderate level of certainty.

Q14. What nerves should be targeted (dorsal innervation) during sacral lateral branch radiofrequency ablation?

There are several (sometimes contradictory) reports on innervation of the SIJ complex leading to ongoing debate on this topic, with the most inconsistent reports pertaining to the ventral part of the SIJ complex. One of the earliest reports on SIJ complex innervation is from Horwitz,¹¹⁰ who during the dissection of 114 human cadaveric pelvises, traced numerous branches from the first and second sacral nerves to the long and short posterior sacroiliac ligaments. In a subsequent monograph by Solonen, the author described extensive innervation of the SIJ complex emanating from the S1 and S2 spinal nerves dorsally, and ventrally from L3-S2 spinal nerves.¹¹⁴ Ikeda reported posterior SIJ complex innervation arising from the L5 and sacral dorsal rami and anterior innervation arising from the L5 and S2 ventral rami.¹¹¹ Bradley asserted that the nerves innervating the posterior portion of the SIJ complex are closely associated with the interosseous and sacrotuberous ligaments.¹⁰⁶ The main nerve trunks in this region vary significantly in diameter, with the fifth lumbar nerve descending vertically near the S1 superior articular process, then dividing into lateral and medial branches. The lateral branch joins up with the first sacral nerve, while the medial branch curves beneath the lumbosacral facet joint and enters the multifidus muscle. Bradley described a complex network of nerves, including branches from the fifth lumbar and first to fourth sacral nerves, which contribute to the innervation of the posterior sacral region and sacroiliac ligaments, which was named the “Posterior Sacral Network” (PSN) by Roberts et al.¹¹³ [Figure 1](#) demonstrates the location of the posterior interosseous ligaments and sacral lateral branches.

In the 1990s, two studies evaluating the innervation of the SIJ complex were published, one by a Japanese author and the other by German authors. In the earlier study by Ikeda¹¹¹ in which 13 specimens (26 SIJ complexes) were examined anteriorly, and 7 specimens (14 SIJ complexes) were examined posteriorly, the authors reported dorsal innervation, which was consistent with earlier findings, but also identified extensive ventral innervation (see [Table 16](#)). According to macroscopic examination, the author found the upper ventral portion of the SIJ complex to be innervated by the ventral

ramus of the fifth lumbar nerve in seven cadavers bilaterally, and in two unilaterally, for an innervation rate of 61.5%. The lower ventral portion of the joint was supplied by the ventral ramus of S2 or branches from the sacral plexus in eight dissections unilaterally, and in the remaining five dissections bilaterally, for an innervation rate of 69.2%. In the dorsal upper part of the SIJ complex, the lateral branch of the L5 dorsal ramus penetrated the posterior and interosseous ligaments of the SIJ on seven of the 14 hemipelvises (50%). Innervation arising from S1 dorsal rami was observed in three hemipelvises from three specimens (21.4%). In the lower portion of the dorsal SIJ, 100% of the branches were mainly directed to the SIJ after a network of communication between the S2 and S3 lateral branches, which the authors referred to as the “dorsal plexus.” Additionally, in 21.4% of specimens, SIJ complex innervation was derived directly from the dorsal ramus of S3.

In an anatomical dissection and histochemistry study by Grob et al. using four male and four female pelvises,¹⁰⁹ the authors reported that the posterior innervation was exclusively derived from the S1-S4 dorsal rami. They found that after the S1-4 dorsal rami exit the posterior sacral foramina, they emerge in the loose connective tissue of the dorsal SIJ complex ligaments where they anastomose in a longitudinal fashion. Fine branches innervated the dorsal ligaments. Branches from S3 and S4 extended into the sacrotuberous and sacrospinous ligaments. Based primarily on the results of histological and immunocytochemical analyses conducted on fetal SIJs, which demonstrated the presence of neurofilament-positive nerve fibers in their dorsal portions, the authors could not identify significant ventral joint innervation, finding no neural contribution from the sacral plexus or obturator nerve. In their histological examination of dissected nerves, they found a multitude of thick, myelinated fibers, as well as thin myelinated and unmyelinated fibers, indicating a diverse array of sensory receptors, including encapsulated mechanoreceptors.

In 2002, Vilensky et al.¹¹⁶ examined histological staining patterns of ligamentous tissue adjacent to the medial aspect of the posterior superior iliac spine and sacrum obtained from six patients scheduled for posterior SIJ arthrodesis. Using the gold chloride staining technique, the authors reported both myelinated and unmyelinated nerve fibers, as well as mechanoreceptors. However, when they tried to confirm their findings using immunohistochemical staining for protein gene product 9.5, the presence of axons, nerve fascicles, or mechanoreceptors could not be conclusively identified. When immunohistochemical staining for substance P (a neuropeptide associated with pain signaling) was performed, reactive components were identified, but due to background staining, the authors could not definitively conclude these components represented neural tissue. In a 2008 immunohistochemical study by Szadek et al.,³ the authors confirmed the presence of Substance P- and CGRP-immunoreactive fibers in tissue obtained from anterior and posterior interosseous ligaments surrounding the SIJ. During dissection, the authors observed small fibers from the lumbosacral plexus traveling toward the anterior SIJ ligaments.

Since RFA treatments for SIJ complex pain target the posterior portion of the joint and associated dorsal ligaments, the most recent anatomical studies have focused on this part of the joint complex. Only one study by Cox et al.¹⁰⁷ focused on the ventral portion of the joint, finding small branches

Table 15. The relative contributions of the sacral lateral branches and L5 dorsal ramus innervating the sacroiliac joint complex.

Lateral branch		Contribution to posterior SIJ innervation (%; N)		Exit quadrant relative to the sacral tubercle (N)	
Roberts et al. ¹¹³	L5	8% (2)	1 branch (n = 25)	IL (2)	
	S1	100% (25)	1 branch (n = 15)	Superior to posterior sacral ligament (23)	SL (2)
			2 branches (n = 10)		IL (8)
	S2	100% (25)	2 branches (n = 19)	Emergence of superior branch	IL (10)
Cox and Fortin ¹⁰⁸	S3	88% (22)	1 branch (n = 6)	Emergence of inferior branch	SL (11)
				Emergence of superior branch	IL (8)
				Emergence of inferior branch	
	S4	4% (1)	1 branch (n = 1)	2 branches originated from IL quadrant and furnished SIJ innervation directly	IL (5)
	L5	75% (9)	1 branch (n = 9)		SL (1)
	S1	100% (12)	2 branches (n = 1)		IL (21)
			3 branches (n = 3)	Average range of the lateral branches of the dorsal sacral foramen were from 1:00 to 5:00 o'clock on the right and 8:00 to 10:00 on the left	
			4 branches (n = 8)		
	S2	92% (11)	1 branch (n = 5)		
			2 branches (n = 4)	IL (1)	
			3 branches (n = 2)	IL (1) SL&IL (7)	
	S3	92% (11)	1 branch (n = 2)	SL&IL (3)	
			2 branches (n = 6)	SL (2) SL&IL 9:00 (3)	
			3 branches (n = 3)	SL&IL (4)	
	S4	67% (8)	4 branches (n = 1)	SL&IL (2)	
			2 branches (n = 7)	IL (1) SL (1)	
			3 branches (n = 1)	SL&IL 8:00, 2:00-5:00 (6)	
				SL&IL (3)	
				SL&IL (1)	

IM, inferomedial; IL, inferolateral; SL, superolateral; SM, superomedial.

Table 16. Summary of cadaveric dissection studies for posterior sacroiliac joint complex innervation patterns.

Author	L5	S1	S2	S3	S4	Superior gluteal	Number of specimens (Hemipelvic dorsal dissections)
Horwitz ¹¹⁰			33.3% (20)	13.3% (8)			30 (60)
Solonen ¹¹⁴ Bradley ¹⁰⁶ Ikeda ¹¹¹	(+) 100% 50% directly to SI joint	(+) 100% 21.4% directly to SI joint	5% (3) 100% (18) 100%	41.6% (25) 6.7% (4) 100% 21.4% directly to SI joint	100%	(+)	x x 7 (14)
Grob ¹⁰⁹ McGrath & Zhang ¹¹²		96% (21) passed superiorly away from LPSL. 4% (1/22) penetrated the LPSL	Dorsal plexus 100% indirectly to SI joint 100% Dorsal Rami of S1-S4 96% (21) penetrated the LPSL obliquely. 4% penetrated near superior end	100% (22) penetrated the LPSL Obliquely.	59% (13) 60% passed superficially above or emerged from the superficial portion of the LPSL. 40% passed inferiorly away from LPSL.		8 (x) 16 (22)
Roberts ¹¹³ Cox & Fortin ¹⁰⁸	8% (2) 75% (9)	100% (25) 100% (12) Average range of the lateral branches of the dorsal sacral foramina were from 1:00 to 5:00 O'clock on the right and 8:00 to 10:00 on the left	92% (11)	88% (22) 92% (11)	4% (1) 67% (8)	42% (5)	25 (x) 9 (12)
Steinke ¹¹⁵		Communicating branches of the PSN did not reach the SIJ, L5-S1 branches pierced the i-SIL and S1 to S4 pierced the o-SIL					43 (6)

iSIL, inner sacroiliac ligaments; LPSL, long posterior sacroiliac ligament; oSIL, outer sacroiliac ligaments; PSN, posterior sacroiliac ligament; PSN, posterior sacral network.

originating from either the L4 ventral ramus (10%), the L5 ventral ramus (80%), or from both the L4 and L5 ventral rami (10%). A combined cadaveric and clinical study by Yin et al.²⁵ reported results consistent with previous studies, finding at least one sacral lateral branch nerve from S1 to S3 innervating the SIJ (ranging from 2:00 to 6:00 O'clock on the right or 6:00 to 10:00 O'clock on the left), with an S4 branch identified in one specimen. These sacral lateral branches frequently anastomosed with the sacral arcade and occasionally sacral medial branches. A study by Roberts et al. further defined the dorsal SIJ complex innervation in order to inform optimal SLBRFA technique.¹¹³ The authors found that the PSN emerges from the superolateral and inferolateral quadrants of the posterior sacral foramina relative to the sacral tubercle, located directly on the periosteum or on the overlying interosseous sacroiliac ligament. More laterally, the nerves were covered and present within the long posterior sacral ligament. The contribution of the lateral branches to the innervation of the SIJ complex is shown in Table 15. Although Roberts and colleagues reported that the S4 lateral branch innervated the SIJ complex only in one specimen (4%), this finding is clinically important for SLBRFA techniques. In this specimen, the inferior border of the SIJ was adjacent to the S4 neuroforamen. This is consistent with previous anatomical studies that reported an S4 lateral branch contribution to SIJ complex innervation in between 13% and 100% of specimens,^{25,106,109,110,112} more commonly when the foramen was level to or above the inferior margin of the SIJ.^{113,274} As such, paraforaminal S4 lateral branch ablation should be considered in these cases. The authors concluded that RFA targets should be located along the medial portion of the PSN, just as they exit the foramina.¹¹³

The most recent study by Steinke et al. reported the results of both dorsal and ventral dissections in 51 cadavers.¹¹⁵ Although the authors described an extensive network of the nerves ranging from L5 to S5 penetrating the dorsal ligaments of the SIJ complex, they emphasized that most of these nerves did not reach the SIJ itself. However, similar anatomical dissection studies have confirmed an extensive dorsal innervation network extending to the SIJ (see Tables 15 and 16).^{108,112,113}

Clinical studies

The results of clinical trials are consistent with cadaveric studies in terms of levels targeted. All sham-controlled trials have targeted innervation from the L5 to S3 spinal nerve levels. In the first placebo-controlled trial by Cohen et al. in 2008, the authors also lesioned the L4 medial branch nerve and S4 lateral branch nerve in the 36% of individuals in whom the foramen was situated at or above the level of the lower margin of the SIJ.²¹ In another study comparing icRFA to sham ablation, Patel et al. targeted L5 dorsal ramus and S1-3 lateral branches.²² In the only definitively negative study, van Tilburg et al. targeted the L5-S4 spinal nerve levels in all patients;²⁴ however, it is notable that these investigators used RFA technology and a technique that is not anatomically valid and likely did not effectively capture the sacral lateral branches.^{121,122} Finally, a recent multi-center comparative-effectiveness study by Cohen et al. targeted L5-S3 in every participant, and S4 at the discretion of the physician when the foramen was located at or above the inferior margin of the SIJ.^{14,272}

Transitional anatomy

Transitional anatomy, including partial or complete sacralization of L5, is associated with back pain in general and SI joint pain in particular. One study found a prevalence of transitional anatomy in 26% in patients with low back pain. Among these patients with low back pain, the prevalence of SIJ complex pain was 28.5% in those with transitional anatomy vs 10.8% in those with normal lumbosacral anatomy, with sacralization of L5 being particularly common.²⁷⁵ In these individuals, because the SIJ extends more cephalad, there are biomechanical alterations that increase the likelihood of pain, especially when the altered anatomy is unilateral, and theoretically a greater likelihood of L5, or even L4 (which often assumes the innervation pattern of L5), innervating the superior joint.^{276,277}

Summary:

- The dorsal innervation to the SIJ is complex and variable between individuals, with most high-quality cadaveric studies demonstrating innervation from S1 to S3 in over 90% of specimens. For the L5 dorsal ramus and S4 lateral branch nerve, most studies have found that over 50% of cadaveric specimens contain branches innervating the dorsal ligaments. Grade B evidence, moderate level of certainty.
- S1 to S3 should be targeted close to the lateral margin of the neural foramina in all patients undergoing SLBRFA; Grade A recommendation, high level of certainty.
- Given variability between individuals, physicians should consider also targeting the L5 dorsal ramus (in those with transitional anatomy or upper SIJ complex pain) and the S4 lateral branch when the foramen is located at or above the inferior margin of the SIJ, to ensure the most complete posterior SIJ complex denervation possible; Grade B recommendation, moderate level of certainty.

Q15. What should the pain relief cutoff be for selecting patients for treatment based on prognostic sacroiliac joint injections or sacral lateral branch blocks and for designating an outcome as positive after therapeutic sacroiliac joint injection, sacral lateral branch radiofrequency ablation, and sacroiliac joint fusion surgery?

The question of what percent pain relief constitutes a positive injection depends on the purpose of the injection and what type of injection is being considered, with SLBBs being purely prognostic before RFA.

Therapeutic sacroiliac joint complex procedures

SIJ injections can be IA, EA, diagnostic, prognostic, and therapeutic. For therapeutic injections, randomized trials evaluating outcomes have employed different cutoffs for designating a binary result as "positive." For therapeutic injections, most randomized trials that contained a categorical outcome used $\geq 50\%$ pain relief as the cutoff for designating that outcome as positive,^{242,248,256} though the largest randomized trial comparing IA to EA injections used a ≥ 2 -point pain reduction coupled with a positive satisfaction score on a 5-point Likert scale.⁶ This is consistent with the IMMPACT guidelines and randomized studies specifically evaluating LBP treatments, which assert that a ≥ 2 -point or 30% reduction in pain is considered to constitute clinically meaningful benefit,

Table 17. Pain relief cutoffs for diagnostic and therapeutic sacroiliac joint injections in randomized trials.

First author, year	Design and pain relief threshold	Treatment groups	Designation of positive outcome ^a	Results
Maugars, 1996 ¹¹	Randomized, double-blind, placebo-controlled trial in 10 pts (13 joints) with spondyloarthritis and clinically-diagnosed SI joint pain	IA injection of corticosteroid or saline	Good improvement >70% relief at 1-month, fair improvement 50%-70% relief	Corticosteroids > placebo
Kim, 2010 ²⁴⁸	Randomized, comparative-effectiveness trial in 50 pts who obtained ≥50% pain relief from diagnostic injection	IA prolotherapy or corticosteroid + LA up to 3 times	≥50% pain relief at 2 weeks	Equivalent in short term, prolotherapy > corticosteroids in long term
Lee, 2010 ²⁵⁶	Randomized, comparative-effectiveness trial in 39 pts who obtained ≥50% pain relief from diagnostic injection	EA botulinum toxin or corticosteroid + LA	≥50% pain relief at 1 month	Equivalent in short-term, botulinum toxin > corticosteroids in intermediate term
Visser, 2013 ¹³⁴	Randomized comparative-effectiveness study in 51 pts with clinically-diagnosed SI joint pain	Physical therapy or manual therapy or IA corticosteroid + LA	Any reduction in pain score at 12 wks or complete reduction at 6 wks	Manual therapy > IA injection > physical therapy
Jee, 2014 ¹⁵⁴	Randomized, single-blind trial in 120 pts who obtained >80% pain relief from IA diagnostic injection	Fluoroscopically- vs. ultrasound-guided IA injection with corticosteroid + LA	Verbal pain scale 2 and 12 weeks after injection (no categorical outcome)	No difference in outcomes, fluoroscopy more accurate
Singla, 2017 ²⁴²	Randomized, comparative-effectiveness trial in 40 pts with clinically-diagnosed SI joint pain	IA platelet-rich plasma or corticosteroid + LA	≥50% pain relief at 2-week to 3-month follow-ups.	Platelet rich plasma > corticosteroid
Cohen, 2019 ⁶	Randomized, double-blind comparative-effectiveness trial in 125 pts with clinically-diagnosed SI joint pain	Fluoroscopically-guided (usually IA) or landmark-guided SI joint injections	≥2-point reduction in pain + positive satisfaction score at 1 month	Equivalent at 1-month, fluoroscopically-guided and IA > landmark-guided and EA injections for some outcome measures at 3 months.

EA, extra-articular; IA, intra-articular; LA, local anesthetic.

^a Does not necessarily denote the primary outcome measure.

and is the most commonly used cutoff in randomized drug trials seeking regulatory approval.^{278,279} One study from the 1990s used a 70% cutoff to constitute “good improvement,” with 50% indicating “fair improvement,” while another considered any sustained pain relief from baseline to be a positive outcome (see Table 17).^{11,134}

Diagnostic sacroiliac joint injections

The Centers for Medicare and Medicaid Services require $\geq 75\%$ pain relief for a “diagnostic” injection to be considered positive, but note that subsequent therapeutic injections require $\geq 50\%$ pain relief to be considered reasonable and necessary.²⁸⁰ This inconsistency may be due to conflation of the terms “diagnostic” and “prognostic” in the medical literature, as SIJ injections can be used to predict the response of more invasive procedures such as SLBRFA and SIJ fusion surgery. Compared to more definitive procedures such as SLBRFA, patients generally experience greater relief with prognostic injections (eg, EA or IA) injections because of their lack of specificity (ie, spread to non-targeted pain-generating structures).

In epidemiological prevalence studies that have used controlled injections, cutoff thresholds have been equally divided between those that used $\geq 50\%$ pain relief to identify the SIJ as the primary pain generator^{44,281,282} and those that employed higher cutoff values ($\geq 75\%$, including two studies by the same group of investigators).^{53,128,283} In a recent systematic review by an international group of experts that sought to determine the diagnostic utility of physical exam signs with diagnostic injections as the reference standard, the authors used a $\geq 50\%$ pain relief cutoff as the criterion for diagnosis.⁷¹ In an earlier systematic review, Kennedy et al. found only a small difference in prevalence rates stratifying epidemiological studies based on 50% vs $\geq 50\%$ cutoff thresholds but found that using a second set of injections significantly reduced the “positive” rate. The authors also noted that the addition of corticosteroids, which is commonly used even in purely diagnostic injections, increases the rate of “positive” injections (see Table 18).^{8,284}

Extra-articular injections as stand-alone prognostic blocks

There are no randomized trials that have used only response to EA injections to select patients for RFA and the few that have used this approach are small, observational, and older studies that used non-validated RFA techniques. In one of the earliest observational studies evaluating SLBRFA, Yin et al. required at least 70% pain relief after two high-volume EA injections with corticosteroid before proceeding to RFA²⁵; the success rate in this small ($n = 14$) retrospective study, in which sacral lateral branch targets were selected based on sensory stimulation before lesioning (L5 and S1 in all patients, S2 and S3 in select patients), was 64%. In a 2002 prospective observational study, Gevarguez et al. performed CT-guided L5 dorsal ramus and posterior interosseous ligament RFA in 38 (of 43) patients who obtained only short-term (< 2 weeks) but “definite” improvement following “intra-ligamentous neural blockade.” Three months post-procedure, 65.8% of patients reported at least substantial pain relief.²⁰

Diagnostic-prognostic sacroiliac joint injections and sacral lateral branch blocks before radiofrequency ablation and categorical outcome thresholds

For randomized trials evaluating RFA, studies have been roughly equally divided in using 50% ($n = 3$) or higher ($n = 4$) cutoffs for both IA SIJ injections and SLBBs in selecting patients for RFA, with no differences in outcomes.^{14,16,18,21,22,24,27} In the only negative study, a cutoff of ≥ 2 -points was used, but the investigators inexplicably included patients with radicular pain and also used an unvalidated technique for SLBRFA.^{24,122} No study used a higher cutoff value than 50% to designate a categorical outcome as “positive,” with most of the more recent studies,^{14,16,24,27} including the two largest comparative-effectiveness studies^{14,16} using ≥ 2 -points as the designation standard for a clinically important outcome, consistent with the IMMPACT guidelines.²⁷⁸ In two studies comparing SLBRFA outcomes stratified by percent pain relief following SIJ injections or SLBBs, both Cohen et al. and Amatto et al. found no difference between 50% and 80% thresholds.^{119,285}

Diagnostic-prognostic sacroiliac joint injections before surgery and categorical outcome thresholds

In a randomized trial by Whang et al. comparing minimally-invasive SIJ fusion to nonsurgical management, the authors used $\geq 50\%$ pain relief from an IA SIJ local anesthetic injection to select patients for enrollment, and a ≥ 20 mm reduction on a 0-100 VAS pain scale (equivalent to ≥ 2 -points on a 0-10 pain scale) as the binary primary outcome measure to assess the effect of the SIJ fusion intervention.²⁸⁶ In a subsequent randomized trial that also compared minimally-invasive SIJ fusion using triangular titanium implants to conservative therapy, Stureson et al. used the same diagnostic injection cutoff ($\geq 50\%$ pain relief) and the same criteria for a positive binary outcome (≥ 20 mm on a 0-100 VAS scale).²⁸⁷ A randomized study comparing SIJ fusion to sham fusion also used $\geq 50\%$ pain relief from an IA SIJ local anesthetic injection to select patients, and similar to other SIJ fusion trials, the authors designated an outcome as positive if a ≥ 2 -point change was reported on a 0-10 NRS pain scale.²⁸⁸ In this first-ever sham-controlled trial comparing minimally-invasive fusion to sham placement and removal of a single blunt pin from the surface of the ilium, the authors reported no significant difference in any outcome measure between treatment groups.²⁸⁸

Summary:

- $\geq 50\%$ pain relief should be considered the cutoff for considering a diagnostic or prognostic SIJ injection to be “positive” with regard to selecting patients for SLBRFA; Grade B recommendation, moderate level of certainty.
- For EA injections as stand-alone prognostic tools, there is insufficient evidence to designate their use, or a specific cutoff threshold, before RFA given the low-quality studies and invalid RFA techniques; Grade I evidence.
- Evidence is mixed for using $> 50\%$ pain relief as the prognostic threshold to select patients for SIJ fusion, with two pragmatic RCTs showing effectiveness but a sham-controlled study failing to distinguish SIJ fusion from sham outcomes. Considering the invasiveness of SIJ fusion surgery, in the context of these data, dual prognostic SIJ injections without corticosteroid and with a high

Table 18. Pain relief cutoffs for sacroiliac joint and lateral branch blocks and for outcome measures in randomized trials evaluating radiofrequency ablation and surgery.

First author, year	Design and pain relief threshold	Treatment groups	Designation of positive outcome ^a	Results
Cohen, 2008 ²¹	Randomized, double-blind, sham-controlled trial in 28 pts who obtained $\geq 75\%$ temporary pain relief from IA joint LA and corticosteroid injection (volume 3 mL with EA extravasation)	L5 dorsal ramus and S1 to S3/S4 lateral branch icRFA + local anesthetic or local anesthetic and sham RFA	$\geq 50\%$ pain relief coupled with positive global perceived effect requiring no additional therapy from 1–6 months.	RFA > sham RFA
Patel, 2012 ²²	Randomized, double-blind, sham-controlled trial in 51 pts who obtained short-lasting pain relief (% not specified) from IA or EA SIJ injection + $\geq 75\%$ relief from L5 dorsal ramus and S1–3 SLBBs	L5 dorsal ramus and S1 to S3 lateral branch icRFA + LA or LA and sham RFA	$\geq 50\%$ pain relief coupled with either a 10% change in Short Form-36 bodily pain or Oswestry Disability index, from 1–9 months.	RFA > sham RFA at 3-month primary endpoint
Salman, 2016 ¹⁸	Randomized, double-blind, comparative-effectiveness study in 30 pts who obtained $\geq 75\%$ relief from IA injection with LA (volume 3 mL with EA extravasation)	L4 and L5 dorsal rami and S1–3 lateral branch RFA or IA corticosteroid injection	$\geq 50\%$ pain relief at 1, 3 and 6 months	RFA > corticosteroids
van Tilburg, 2016 ²⁴	Randomized, double-blind, sham-controlled trial in 60 pts (included pts with sciatica) who obtained ≥ 2 -point decrease in average pain from IA injections with LA (volume 3 mL with EA extravasation)	L5 dorsal ramus and S1–S4 RFA with single probe containing 3 active electrodes + LA or LA and sham RFA	Pain score on 0–10 NRS at 1 and 3 months; no categorical outcome noted, but the percentage of crossover pts who obtained ≥ 2 -point pain relief at 1 month noted.	No difference in outcomes
Juch, 2017 ¹⁶	Randomized, controlled trial in 228 pts who obtained $\geq 50\%$ pain relief from L5 dorsal ramus and S1–3 SLBBs	L5 dorsal ramus and S1–3 RFA with either internally-cooled, bipolar RFA or RFA with a single probe containing multiple electrodes, with LA before lesioning + exercise therapy, or exercise therapy without RFA. Pts could receive psychotherapy in both groups if needed.	≥ 2 -point decrease in pain on 0–10 NRS, and/or ≥ 20 percentage points on 0%–100% Oswestry disability index.	Difference in primary outcome measure (pain reduction) favoring RFA at primary endpoint but not afterwards. For categorical outcome, RFA > control group at 3 wks but not later.

(continued)

Table 18. (continued)

First author, year	Design and pain relief threshold	Treatment groups	Designation of positive outcome ^a	Results
Mehra, 2018 ²⁷	Randomized, double-blind study in 17 pts who obtained >80% pain relief from 2 IA injections with LA	RFA with LA using a single probe containing multiple electrodes or LA + sham RFA	Improvement of ≥ 2 -points on 0-10 pain scale, at 3 and 6 months.	RFA > sham RFA at 3-month primary endpoint
Cohen, 2024 ¹⁴	Randomized, comparative-effectiveness study in 210 pts who obtained $\geq 50\%$ relief from IA or EA SIJ and $\geq 50\%$ relief from L5 dorsal ramus and S1-3 or 4 SLBBs	icRFA with LA at L5 dorsal ramus and S1-3 or 4 lateral branches or standard medical management	Improvement of ≥ 2 -points or 30% on 0-10 pain scale + at least moderately better ($\geq 5/7$) on Patient Global Impression of Change scale, followed through 12 months.	RFA > standard medical management at 3-month primary endpoint and after.
Whang, ²⁸⁶	Randomized comparative-effectiveness study in 148 patients who obtained $\geq 50\%$ pain relief from an IA SIJ injection	Minimally-invasive surgical fusion or conservative treatment that included medications, physical therapy, joint injections and RFA in a stepwise fashion. Cognitive behavioral therapy was not permitted.	Reduction in pain score by ≥ 20 mm on a 0-100 VAS scale and absence of neurological or surgical complications.	Surgery > conservative care at 6 months and later follow-ups.
Sturesson, ²⁸⁷	Randomized comparative-effectiveness study in 103 patients who obtained $\geq 50\%$ pain relief from an IA SIJ injection	Minimally-invasive surgical fusion or conservative treatment that included medications, physical therapy, psychological interventions if indicated. Nonsurgical procedures were not permitted.	Pain score on 0-100 VAS at 6 months. No categorical outcome noted, but the percentage of pts who obtained ≥ 20 mm pain relief was reported.	Surgery > conservative care at 6 months and later follow-ups.
Randers, ²⁸⁸	Randomized, double-blind, sham-controlled trial in 63 pts who obtained $\geq 50\%$ pain relief from an IA SIJ injection	Minimally-invasive surgical fusion or sham surgery (pin inserted to iliac crest & removed). Both groups received an SIJ injection with LA.	Pain score on 0-10 NRS at 6 months; no categorical outcome noted, but the authors reported those who achieved a ≥ 2 -point reduction in pain score and those who reported they were "better or much better".	No significant difference in primary outcome or categorical outcomes between groups.

icRFA- internally-cooled radiofrequency ablation; IA- intra-articular; RFA- radiofrequency ablation; SIJ- sacroiliac; SLBB- sacral lateral branch block.

^a Does not necessarily denote the primary outcome measure.

pain relief threshold (with documented functional improvement) are recommended to select patients for SIJ fusion; Grade I recommendation for the number of blocks and designating a specific high cutoff percentage.

- For prognostic procedures before lateral branch RFA, since SLBBs have greater face validity to predict outcomes than IA (and possibly EA) SIJ injections, we recommend using a 50% cutoff for SLBBs. The rationale for this is that the pain relief from RFA is generally less than from prognostic injections because of the lower specificity of the latter; Grade B recommendation, moderate level of certainty.
- For designating an outcome as positive when performing a therapeutic SIJ complex procedure, the most recent literature and guidance from the IMMPACT group and the FDA suggest using thresholds of ≥ 2 points or 30% improvement **provided** there are other objective measures of benefit (eg, satisfaction, improved quality of life, decreased resource utilization); Grade B evidence, moderate level of certainty.

Dissent: On this question, three societies—IPSS, NASS, and the NASS Fellowship Consortium—dissented, recommending more stringent criteria: Dual blocks with $\geq 75\%$ relief for SLBRFA, and $\geq 75\%$ relief on two separate diagnostic injections for SIJ fusion.²⁸⁹

Q16. Who are the best candidates for sacral lateral branch radiofrequency ablation?

Identifying the most appropriate patients for any interventional procedure is important.^{290–293} Appropriate selection may be even more critical for procedures involving the SIJ complex due to its intricate anatomy and varied presentations.^{43,79} Numerous studies demonstrate marked referral map variability in selection criteria when investigating SIJ complex denervation.^{19,20,294} It is likely that different areas of the SIJ complex contribute to these different referral patterns. Thus, given that SLBRFA does not disrupt all the afferent input from the SIJ complex, identifying which referral patterns are most conducive to SLBRFA could improve outcomes and promote economic savings.¹¹⁹

The first consideration in identifying patients who may benefit from SLBRFA is to appropriately diagnose SIJ complex dysfunction as the source of LBP. Approximately 15%–30% of mechanical LBP predominantly below L5 can be attributed to SIJ dysfunction.²⁹⁵ SIJ dysfunction can result from prior spinal fixation, pregnancy, true and apparent leg length discrepancy, trauma, systemic inflammation, natural degeneration, and other factors leading to abnormal SIJ motion, and joint and soft tissue injury.^{1,2} After putatively diagnosing suspected SIJ dysfunction with physical exam maneuvers,² in an attempt to better identify which patients are more likely to achieve improvement following SLBRFA, studies have used both prognostic SLBBs with local anesthetic^{294,296} and/or confirmatory IA SIJ injections.^{80,281} These differences are important because the sacral lateral branches innervate the dorsal ligament complex, posterior aspect of the SIJ capsule, and posterior bone structure of the SIJ, but not the anterior components of the SIJ complex.¹¹⁷ In addition, identifying the ideal nerves to target and optimizing the cutoff threshold used to delineate a diagnostic or prognostic injection as “positive” have been the focus of

investigation.¹¹⁹ Clinical and psychosocial factors have also been investigated.

Failure of non-invasive therapies

Treatment options for SIJ complex pain include conservative therapies such as PT, yoga, tai chi, chiropractic care, acupuncture, analgesic medications, as well as minimally-invasive IA, EA injections, SLBB, SLBRFA and SIJ fusion surgery.²⁹⁷ The noninvasive modalities and joint injections can all be considered first-line therapies under different circumstances² and may be offered to the patient based on a shared decision model. A progression of SLBB followed by SLBRFA is typically offered after failure of noninvasive therapies.²⁹⁸

General factors associated with decreased response to invasive procedures

In a multicenter study aiming to identify responders to various LBP procedures, Cohen et al. found that individuals with greater disease burden, depression, sleep dysfunction, concomitant pain conditions, smoking history, and obesity were more likely to fail interventions, indicating a need to address these comorbid conditions prior to or concurrent with procedures.⁷³ Additional factors reported to be associated with poorer outcomes to invasive procedures include psychosocial pathology (poorly controlled depression or anxiety, poor coping skills, high levels of catastrophizing, untreated substance use disorders, and sedentary life-style), greater disease burden (opioid use, numerous previous failed treatments, higher pre-procedure pain scores, and reduced physical function), central sensitization, and work-related factors (disability, secondary gain, poor job satisfaction, performing manual labor).^{38,293}

Demographic and clinical factors

In their bi-institutional study evaluating outcome predictors for SLBRFA, Cohen et al. reported that sex, physical examination signs (including SIJ tenderness, positive Patrick’s test, positive Gaenslen’s test), previous surgery, etiology, concomitant medical conditions, and disability claims, were not predictive of outcome in 77 patients with SIJ complex pain.¹¹⁹ One consideration for the lack of association between provocation tests and outcomes may be that provocation tests are more likely to reproduce pain from IA vs EA pathology, as most studies examining correlations between exam maneuvers and interventional procedures have used IA injections. Since SLBRFA reduces pain primarily from EA pathology, commonly used “SIJ provocation maneuvers” on physical examination may be less predictive of SLBRFA outcome. Most prior randomized studies have reported favorable results despite requiring one or no provocative tests as a criterion for enrollment.^{21,22,27}

Referral patterns and opioid use may also impact outcomes. Although not statistically significant, Cohen et al. noted a higher percentage of unsuccessful outcomes in patients with pain radiation below the knee and on chronic opioid therapy, which is consistent with studies evaluating RFA outcomes for other regions.^{119,194,299,300} Since $<30\%$ of SIJ complex-associated LBP produces pain distal to the knee and there is a high false-positive rate for diagnostic injections, many of these patients may be misdiagnosed.⁷⁹ Baseline opioid consumption has been shown to decrease the likelihood of treatment success in other studies assessing the

effectiveness of RFA interventions for chronic LBP as well as other chronic pain conditions.^{194,301,302}

Pre-procedure pain intensity, duration of symptoms, and age ≥ 65 years also increased the odds of failure in the study by Cohen et al.¹¹⁹ It is not uncommon for duration of symptoms, a hallmark of greater disease burden, to be negatively correlated with outcomes,²⁹¹ which can be a consequence of neuroplasticity or refractory psychosocial issues.^{303,304} In a retrospective study by Amatto et al., the authors also found younger age to be associated with a higher odds for success for SLBRFA.²⁸⁵ Whereas age has not traditionally been found to be a negative predictor for outcome,²⁹¹ it may play a larger role in SLBRFA outcomes given that older patients are more likely to have IA as opposed to EA sources SIJ complex pain. These results suggest that while no single demographic or clinical variable strongly influences outcome, selecting patients without risk factors for treatment failure may improve success rates.¹¹⁸ One limiting factor is that many studies employed only anterior-posterior fluoroscopic views, raising questions regarding the accuracy of prognostic injections.³⁰⁵

In contrast to the finding that older age is associated with SLBRFA treatment failure, a recent multi-center randomized study comparing standard medical management (SMM) to internally cooled SLBRFA reported that age ≥ 65 years was associated with reduced pain in both the SMM and internally cooled (ic) SLBRFA groups.¹⁴ The study also reported a trend toward higher BMI being associated greater pain reduction. One possible explanation for this may be that posterior EA structures (innervated by the sacral lateral branches) contribute to a greater amount of total SIJ complex pain in patients with higher BMI. Although duration of symptoms has consistently been associated with reduced effectiveness, the investigators of this multi-center clinical trial found that patients with long-standing (mean duration >115 months) SIJ complex pain can be effectively treated with SLBRFA.¹⁴

Prognostic/diagnostic procedures

Number and type of injections

The SIJ is complex with numerous potential pain generators. The sacral lateral branches do not run at a consistent depth or location on the sacrum. Therefore, single-site, single-depth SLBBs may fail to consistently anesthetize the nerve supply. The use of multi-site, multi-depth SLBBs may more effectively target the sacral lateral branches. Dreyfuss et al. reported the use of multi-site, multi depth SLBBs resulted in staining of 91% of targeted nerves in cadavers. The authors also reported a 70% clinical success rate, defined as no evoked pain following EA (interosseous and dorsal sacroiliac ligament) and dorsal IA SIJ entry when using this technique. Most patients, however, did report pain upon joint distension. Given these findings, the authors concluded that IA or single-site, single-depth SLBBs may not reliably predict ideal candidates for SLBRFA compared to multi-site, multi-depth SLBBs.¹¹⁷ Among RCTs, all three studies that used prognostic SLBBs reported positive outcomes at the primary endpoint.^{14,16,22}

Dual injections are thought to decrease false-positive rates and increase diagnostic accuracy, though a false-positive rate with dual injections ranging between 12.5% and 26% has been reported.^{298,306,307} Most studies to date have used single injections or IA corticosteroid injections as selection criteria for SLBRFA, possibly leading to inappropriate patient selection.²⁹⁸

Yet, the few studies that have been performed do not show that more rigorous selection criteria lead to better SLBRFA outcomes. Cohen et al. reported no correlation between a positive SLBB, multiple positive SIJ injections, or percent pain relief (50%-79% vs $\geq 80\%$) from diagnostic injection(s) and SLBRFA outcomes.¹¹⁹ Several other studies also suggest no association between the use of multiple prognostic injections and SLBRFA outcomes.^{294,308,309} In the recent study by Amatto and colleagues, the authors found no differences in outcome stratified by single or double blocks (SIJ or lateral branch), 2 vs 1 SLBB, and 50% vs 80% cutoff thresholds, though in univariate analysis those who experienced $<80\%$ pain relief with only a single SLBB fared slightly worse.²⁸⁵

Predictive modeling

Predictive modeling utilizing large sets of data is a growing resource that may help predict responders to pain procedures. The Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) guidelines highlight the association of certain phenotype domains (psychosocial, pain variability and quality, sleep and fatigue, quantitative sensory testing (QST) and sensory profiling, and condition pain modulation) as areas of interest when adapting predictive modeling profiles.³¹⁰

Summary:

- Older age (≥ 65 years), longer duration of symptoms, higher baseline pain levels, and opioid use are associated with negative outcomes; Grade C evidence, low level of certainty.
- Considering the innervation of the nerves targeted during SLBRFA, there is deductive evidence that anterior intra-articular pathology and, like nearly all pain therapies, poorly controlled psychopathology (eg, depression, catastrophizing) and central sensitization are associated with treatment failure; Grade C evidence, low-to-moderate level of certainty.
- Although studies have reported positive outcomes using both prognostic intra-articular and extra-articular injections, the preponderance of evidence supports the use of prognostic SLBBs to select SLBRFA candidates; Grade C-B evidence, low level of certainty.

Recommendation:

- Currently, there are no single, stand-alone clinical, imaging, or injection-based factors that strongly predict the outcome of SLBRFA; future studies will need to identify patient phenotypes of success and failure

Q17. What is the ideal technique and evidence for performing sacral lateral branch radiofrequency ablation?

Significant variation in the posterior sacral neuroanatomy poses challenges to successful treatment with SLBRFA.¹¹³ There are numerous techniques described for SLBRFA treatment. The largest fluoroscopic anatomical study to date correlated the location of the sacral lateral branches of 40 hemipelves to the published SLBRFA techniques.¹²² It found that standard monopolar techniques published at the time of the study did not reliably capture the sacral lateral branch nerves; thus, such techniques are not anatomically valid and

should not be used. Several bipolar strip lesion techniques, and one icRFA technique using new targets published in 2018³¹¹ were considered anatomically valid, achieving expected 100% capture of the lateral branches in 95% or more of the specimens. The Simplicity probe (multi-electrode radiofrequency cannula) technique was not considered anatomically valid, as the described technique can result in the probe being too far from the periosteum where the nerves lie, thus eluding capture.¹²² This is consistent with the fact that the only clearly negative sham-controlled trial of SLBRFA used this technology.²⁴

Sensory stimulation used to guide denervation during radiofrequency treatments has been described in clinical studies.^{25,312} However, this technique is not described in fluoroscopic anatomical detail, and thus, cannot be validated anatomically. There is clear evidence of lack of sensitivity of electrical stimulation for identification of electrode contact or close proximity to sensorimotor nerves.³¹³ In the lumbar spine where there is usually one medial branch being targeted; two prospective studies provide conflicting evidence for a correlation between sensory stimulation and lumbar facet RFA outcomes.^{314,315} For SLBRFA, where multiple nerves carrying sensory information can converge on a single foramen, obtaining concordant sensory stimulation for a single nerve even at low thresholds cannot guarantee interruption of nociception.

In animal and *ex vivo* models, the size and type of RFA probe tip used and the lesioning parameters influence the size and shape of the ablation zone formed, which are critical in determining procedural success.^{269,316,317} To date, however, most ablation zone measurements of RFA techniques have been made using *ex vivo* chicken breast or bovine liver models.^{269,316,317} *Ex vivo* study of RFA lesion characteristics is intrinsically limited by lack of blood perfusing through the subject tissue. Chicken breast and bovine liver are homogeneous tissues without adjacent osseous structures, which makes them suboptimal surrogates for predicting in vivo response to SLBRFA. In vivo tissue effects of icRFA and standard monopolar RFA procedures in rats have been studied with MRI prior to sacrifice and verification through histological analysis.³¹⁸ Structural changes with icRFA may outlast those lesions created with conventional RFA. This has been shown in retrospective data analyses but has not been formally studied in clinical trials, though one study found that among successful SLBRFA procedures, there was a slower success drop-off rate with icRFA compared to conventional.^{319,320}

A small, in vivo human study of icRFA MRI lesion size showed significant lesion morphology variability at the same targets and between different target locations.³²¹ Notably, the icRFA coagulation zone volume was significantly smaller at perforaminal sacral locations compared to lumbar medial branch target locations [0.6915 (± 1.08) vs. 1.685 (± 2.51) cm³] despite using the same size probe tip (4 mm) and lesion parameters. It was determined that icRFA probe placement very close to bone negatively altered the shape and reliability of the ablation zone. Although this study was small, it is known that bone disperses radiofrequency energy, with these results providing a potential explanation for inconsistent results of SLBRFA outcomes associated with icRFA and other RFA techniques.

As noted above, icRFA, especially using the targets defined in 2018,¹²² and several bipolar strip lesion techniques appear to be the most anatomically-valid SLBRFA techniques, though these findings are based on *ex vivo* lesion size data, with limited clinical data to confirm or challenge these assumptions. The theoretically increased capture rate, and ensuing improved effectiveness, are particularly important given the anatomical variability in the number and location of sacral lateral branches. One non-randomized study compared treatment outcomes following SLBRFA using a bipolar strip lesion technique to a historical comparison group who had received icRFA.³²² The investigators observed a higher proportion of treatment responders (based on at least 50% reduction in NRS pain score) in the bipolar strip lesion group compared to the icRFA group for up to 12 months post-procedure. In two additional studies that compared SLBRFA outcomes stratified by RF electrode type, one study found a trend for superiority of icRFA over conventional SLBRFA, while the other found better outcomes with an 18-gauge quadripolar electrode inserted perpendicularly compared to a 16-gauge longitudinal approach and an 18-gauge bipolar perpendicular approach, which was attributed to an enhanced ability to navigate and accommodate the undulant lateral sacral crest topography.^{119,285} This is consistent with studies for other conditions demonstrating that larger lesions lead to better RFA outcomes.^{319,323,324} For the sacral lateral branches, the proximity of the nerves to the undulating osseous surface of the sacrum and thick dorsal ligaments requires further in vivo study to determine the best RFA technique(s) for successful nerve capture.

Clinical studies use heterogeneous selection criteria, which limit comparison of SLBRFA techniques to a degree. Due to several factors including selection and RFA technique heterogeneity, a recent systematic review downgraded the original “high” quality evidence rating to “moderate” quality evidence that SLBRFA provides clinically-significant reductions in pain and disability for up to one year.¹²¹ The authors of this review then examined the data for only anatomically valid techniques. There were three sham-controlled RCTs. The quality rating was downgraded one level due to concern for bias and heterogeneous selection criteria but upgraded by one level for large attributable effect sizes. The authors determined there was high-quality evidence that SLBRFA effectively reduces pain and disability for up to one year when using anatomically-valid perforaminal icRFA and bipolar strip lesioning techniques. Figure 2 illustrates three among many different RFA techniques used to target the innervation of the SIJ.

Summary:

- For the anatomically-valid techniques (including specifically icRFA monopolar lesion techniques and bipolar strip lesion techniques), SLBRFA improves pain and disability for at least 6 months post-treatment; Grade B evidence, moderate level of certainty.
- Without excluding anatomically-invalid techniques, the evidence for improving pain and disability is Grade C, low level of certainty.
- Given differences in outcome likely related to neuroanatomical variability, there is direct and indirect evidence

supporting techniques that create large lesion sizes; Grade B evidence, moderate level of certainty.

Q18. What are the most common complications with sacral lateral branch radiofrequency ablation and how can they be minimized?

Potential and reported complications of sacral lateral branch radiofrequency ablation

SLBRFA has been shown in numerous studies to improve quality of life in well-selected patients if performed safely and in a technically sound manner. Because it is elective, aggressive prevention of complications is paramount. Adequate data collection regarding complications and research on preventing complications is critical to establishing and maintaining patient and clinician confidence in the safety of this procedure.

Data on complications from SLBRFA are usually collected and reported as part of clinical studies. Although common complications are usually self-limiting, rarer but more serious or even catastrophic complications may need to be garnered from sources such as large databases, quality and safety reports (ie, from the Food and Drug Administration) or even from autopsy reports. In theory (never before reported), and based on proximal anatomy, such complications could include rectal perforation or injury to nerves of the sacral plexus innervating the bladder or bowel.

In addition to the theoretical potential for injury to the sacral plexus and rectum, SLBRFA may cause predictable complications such as RFA of other peripheral nerves, skin burns, infection, hematomata, localized neuritis, sensory disturbance at the skin due to denervation of cutaneous nerves branching from sacral lateral branches, and a localized increase in persistent pain following thermal lesioning.

A systematic review by De Salvatore et al. reported on complications in the analyzed studies that included the largest and most rigorous RCTs performed, finding that the majority related to post-procedure local complications such as increased localized pain, transient paresthesias and hematomata.³²⁵ No serious complications were reported.

Specific complications

Neuritis and other forms of post-procedural pain

As noted above, neuritis is a risk for all ablative procedures and may present as worsening pain of neuropathic quality. In some cases, it can be difficult to distinguish from inflammatory post-procedure pain. In a placebo-controlled trial evaluating icRFA in 28 patients, Cohen et al. reported that a majority of patients experienced temporary worsening of pain lasting between 5 and 10 days attributed to either the procedure itself or temporary neuritis, though only one reported paresthesias.²¹ This study did not use preventative corticosteroids or non-steroidal antiinflammatory drugs before or after lesioning. In a large, multicenter, randomized trial comparing icRFA to standard medical management that did not report on the procedural use of prophylactic corticosteroids, Cohen et al. reported that 11 of 96 patients experienced worsening pain in the lower back or around the SIJ complex, but the presence of neurological symptoms was not reported.¹⁴ In a small, retrospective study by Hegarty evaluating SLBRFA using a 10-cm single mono- and bipolar electrode in 11 women, two patients reported new paresthesias surrounding the SIJ complex, while a third patient reported a

burning sensation 3-months post-procedure that responded to infiltration with local anesthetic and corticosteroid as well as topical lidocaine.³²⁶ The authors recommended post-procedure bupivacaine and corticosteroid as a possible preventive measure to reduce the incidence of neuritis and post-procedural pain. The prevention of neuritis has been evaluated in several studies, most for lumbar medial branch RFA. Although one small, randomized trial found that post-RFA pentoxifylline or corticosteroids reduced the severity of post-procedure pain compared to saline,³²⁷ a larger retrospective study failed to find benefit for post-lesioning corticosteroid injection.³²⁸ In the only study that included patients who underwent SLBRFA with icRFA technology ($n=2$ out of 39 patients and 47 procedures), Fitzpatrick et al. found a 0% incidence of neuritis based on numerical rating scale pain scores and the administration of Douleur Neuropathique 4 Questionnaires (DN4) in both patients who received post-procedure corticosteroids (betamethasone) at ablation sites and those who did not.³²⁹ Although the DN4 score was lower in the non-corticosteroid group (0.1 vs 0.4), both values fell far below the 4-point cutoff required to detect neuropathic pain, and this difference was no longer statistically significant when accounting for repeat procedures. A 2025 systematic review that included two studies not limited to any region concluded that post-RFA corticosteroid administration has not been demonstrated to reduce the risk of post-procedure neuritis.³³⁰

The effectiveness of adjuvants and non-steroidal anti-inflammatory drugs to prevent post-RFA neuritis has been reported, also with mixed results. A large retrospective study performed in 215 patients who underwent lumbar and cervical medial branch RFA found a non-significantly lower incidence of neuritis in individuals taking gabapentin for at least 2 weeks prior to the procedure (7.1% vs 13.2%).³³¹ However, a later retrospective study by Singh et al. conducted in 164 patients found no difference in the incidence of neuritis post-lumbar medial RFA based on whether patients were receiving pre-procedure membrane stabilizers and antidepressants.³²⁸ In a placebo-controlled study performed by Ma et al. in 66 patients, the authors found that 3- and 7-day post-treatment regimens with diclofenac significantly reduced post-procedure pain compared to placebo.³³² Aside from the small, underpowered retrospective study by Fitzpatrick et al.,³²⁹ a major limitation in most of these studies was the failure of the investigative team to discriminate between neuritis secondary to nerve ablation and inflammatory post-procedure-related pain from radiofrequency cannula insertion.

Impact of radiofrequency ablation on existing implanted devices

Monopolar RFA of innervation to the SIJ complex involves the use of electrical current that emerges from the tip of the radiofrequency cannula and flows through the body before exiting through the dispersive electrode (a.k.a., grounding pad). Electromagnetic fields created from the use of short-wave diathermy can result in interference with the functioning of implanted electrical devices (eg, battery and electrical leads) such as deep brain or spinal cord stimulators.³³³ A retrospective chart review examining interference of implantable devices following lumbar medial branch, peripheral nerve, and SIJ complex monopolar RFA found no alteration in implantable device function.³³⁴ Although this single study

did not discuss the location of the implantable device, the safe use of monopolar lumbar medial branch RFA has also been reported in a patient with deep brain stimulators, with one of the implanted pulse generators located in the anterior abdominal wall.³³⁵ Similar to lumbar medial branch nerve RFA, a procedure in which the grounding pad is usually placed on the lower extremity, SLBRFA theoretically carries a lower risk in the case of an implantable device placed in the torso or chest as the dispersive pad can be placed at a distance greater than the recommended 15 cm away from the leads and battery.³³⁶ It may, however, present a greater risk of damage to implanted device placed in the low back or below the iliac crest as many spinal cord stimulators are implanted in the gluteal region, meaning the current will likely pass near the implantable device before exiting at the grounding pad. If using monopolar RFA, placing the grounding pad close to and caudal to the RFA site will reduce the size of the induced electromagnetic field. This will minimize the risk of heating the neurostimulator battery and electrodes. However, placing the grounding pad too close to the RFA site can increase the risk of tissue burns,^{337–339} particularly when using high current, long activation times, and the use of conductive fluid, since the energy has less tissue through which to dissipate.³⁴⁰ There is some evidence that bipolar RFA may be safer than monopolar RFA in patients with implanted devices, with report of its safe use for cervical and lumbar medial branch RFA.³⁴¹ In bipolar RFA, the electromagnetic field is limited to the tissue region between the two electrodes, which is significantly smaller compared to the distance between a monopolar RFA electrode and the grounding pad (when the grounding pad is placed at a safe distance away from the RFA electrode side to prevent a skin burn). In a position paper by IPSIS, the authors recommended consultation with the device manufacturer and cardiologist or electrophysiologist, with consideration of the following: (1) Having on-site support for interrogation of the cardiac device during the procedure in the event that reprogramming of the device is required; (2) Placing a magnet over the device to inhibit triggering the device by RFA; and (3) Removing the magnet or using external defibrillator/pacing electrodes in case cardiac arrhythmias occur during the RFA procedure.³⁴²

Radiofrequency ablation in proximity to surgical hardware

In the context of lumbosacral or SIJ fusion, the interventionist may encounter posterior surgical hardware during a SLBRFA procedure. Indeed, SIJ complex pain is more prevalent in patients with arthrodesis of L5 to the sacrum, as the SIJ complex becomes the “adjacent segment” accepting greater forces post-fusion compared to when the L5-S1 segment (or additional lumbar segments) remains mobile. As such, the interventionist must be aware of safety considerations when SLBRFA is performed in this context, as an RFA electrode may be placed in close proximity to posterior surgical hardware.³⁴³ Cadaveric and human studies have demonstrated that direct contact of an RFA electrode with pedicle screws results in heating^{344,345} of metal. In a 2015 cadaveric study, investigators observed significant temperature changes in pedicle screws and surrounding soft tissues when an RFA electrode directly contacted a screw, compared to control conditions. The thermal impact was more pronounced with titanium screws than with stainless steel. Specifically,

titanium screw heads exhibited temperature increases of 6.66°C, and screw tip temperatures increased by 16.72°C when the RFA electrode was positioned directly over the screws and heated to 80°C for 90 s. Alternatively, stainless steel screw heads demonstrated temperature increases of 4.4°C at the head and 2.46°C at the tip under similar conditions.³⁴⁴ A 2016 human study evaluated temperature changes at posterior surgical hardware during lumbar medial branch RFA procedures.³⁴⁵ A temperature probe was inserted via a cannula adjacent to posterior hardware to monitor temperature changes during each RFA procedure. The investigators observed that pedicle screw head temperatures increased in six out of the 10 RFA procedures. Notably, in two cases, temperatures escalated to 42°C, necessitating termination of the procedure. The clinical implications of this depend on hardware location. If hardware is contained completely within corticated bone, it is unlikely that adjacent soft tissues (including neural structures) would be heated. However, in cases of hardware malpositioning (for example, a pedicle screw that breaches the spinal canal), heating of the hardware may be of concern. Separately, in a patient with minimal tissue (either due to intrinsic body habitus or weight-loss following surgery) separating the head of a pedicle screw from the skin, screw heating could cause a skin burn. Notably, this risk remains theoretical (never before reported in the published literature). Regardless, in order to optimize patient safety, and consistent with IPSIS recommendations,³⁴⁶ interventionists should avoid direct contact between the RFA electrode and posterior hardware.

Bleeding and anticoagulation

As noted above, the risk of clinically-relevant bleeding is exceedingly low, even with the large cannulas associated with icRFA and single-cannula combination mono- and bipolar lesions. The ASRA guidelines do not directly address anticoagulation and SLBRFA, but do not recommend withholding anticoagulation for low-risk procedures such as SLBBs or IA SIJ injections. However, the ASRA and ASIPP guidelines currently consider lumbosacral RFA and lumbosacral transforaminal injections to be intermediate risk; therefore, if finder needles are used during a SLBRFA to locate the foramina it may be considered an intermediate-risk procedure.^{347,348} For physicians considering use of finder needles, this theoretical increase in risk should be weighed against possible enhancement in procedural accuracy. When performing a SLBRFA without a finder needle, it can be considered the same risk as a peripheral joint or nerve block procedure. The ASRA guidelines generally recommend stopping anticoagulants, including non-steroidal, anti-inflammatory drugs (NSAIDs), before intermediate-risk procedures, while the ASIPP guidelines tend to be slightly more liberal (ie, stopping NSAIDs and aspirin is a shared decision based on weighed risks and benefits). Both sets of guidelines recommend stopping warfarin and platelet aggregation and thrombin inhibitors. The risk of periprocedural thromboembolic events must be weighed against the risk of epidural hematoma. When anticoagulants are held before pain procedures, the risk of a serious thromboembolic event is estimated at between 0.2% and 0.5%,^{349,350} far exceeding the risk of a serious complication from bleeding.^{348,350} There are very few (<5) reports of hematoma (several with unclear etiology) following lumbar transforaminal

epidural corticosteroid injections, and none during S1 or S2 injections, or that resulted in permanent neurological sequelae.^{351–355} Alternatively, for lumbar and sacral RFA procedures, there are no reported cases of epidural or foraminal hematomas, and no reports of serious sequelae from bleeding complications. Furthermore, guidelines from IPSIS conclude that the risks clearly outweigh the benefits from withholding anticoagulants for lumbosacral RFA and transforaminal procedures based on evidence from large cohort studies.^{349,350,356–359} As such, the risk: benefit ratio favors continuing rather than withholding anticoagulant and antiplatelet agents for SLBRFA procedures when technically sound and safe technique is implemented.

Prevention of complications

Safety precautions for SLBRFA based on synthesis of recommendations from reviews cited above:

Preoperatively

- Use an adequate consent process to advise patients of common, non-serious, but painful complications including transient localized increase in pain, painful paresthesias, or hematomata.
- Manage anticoagulant and antiplatelet risks on an individual patient level following a shared decision-making model, favoring continuation of these agents (ie, exceptions can be considered when multiple finder needles placed into the foramina are needed).
- Review existing imaging preoperatively to identify any anatomical variations which may require accommodation during the procedure.
- RFA can be performed safely in patients with SCS, cardiac pacemakers and surgical metalware if direct contact with the implant is avoided. Use of bipolar rather than monopolar RFA may be considered to limit the size of the electromagnetic field, which might disrupt or heat an implanted device in close proximity.
- Patients with impaired glucose tolerance should be warned of the potential for transient hyperglycemia if corticosteroids are used to prevent neuritis.

Intraoperatively

- Use sound, aseptic technique.
- Optimize fluoroscopic imaging (typically by introducing relative cephalic tilt, and possibly ipsilateral tilt at S1) such that the sacral foramina can be visualized adequately, and thus needle trespass can be avoided.
- Maintain a safe distance between the lateral margin of each sacral foramina and the RFA needle/electrode during the entire procedure.
- Sensory testing has limited safety value or therapeutic value when an aggressive lesioning strategy accounting for multiple lateral branches is employed. Its use is at the discretion of the interventionalist. Motor stimulation testing can be used if there is concern for foraminal proximity that could result in the heating of the neural elements within the foramen during lesioning. If employed, place hand on or clearly observe the lower extremity during motor stimulation to ensure there is no muscular contraction in the lower leg. Stimulation of sacral nerves

innervating the bowel and bladder may be ascertained via patient communication.

- Ensure a grounding pad has been correctly placed in full contact with a large area of the skin remote from the lesion site.
- Routinely check lateral radiographic views to ensure that the RFA probes remain on the dorsal surface of the sacrum, avoiding the sacral plexus and rectum.
- Avoid direct contact of the RFA probe with posterior surgical hardware in relevant situations.

Summary:

- There is weak evidence supporting non-steroidal anti-inflammatory drugs to prevent or treat neuritis; Grade C evidence, low level of certainty.
- There is insufficient evidence for the use of corticosteroids and membrane stabilizers, which themselves carry risks, in the prevention or treatment of neuritis; Grade I evidence.
- In patients on anticoagulants, consultation with an anticoagulation specialist or review with the patient's prescriber should be conducted to determine the risk of stopping anticoagulants. However, in most cases, anticoagulants may be continued during SLBRFA; Grade C-B recommendation, moderate level of certainty.
- SLBRFA can be safely used in patients with implanted devices, with bipolar lesioning conferring an increased measure of safety; Grade B recommendation, moderate level of certainty.
- Radiographs in multiple views should be checked to ensure that RFA electrodes avoid contact with surgical hardware; Grade B recommendation, moderate level of certainty.
- Sensory stimulation confers minimal safety value, and limited therapeutic value when employing an aggressive lesioning approach that accounts for multiple lateral branches; Grade C evidence, low level of certainty.
- Motor stimulation can be used in conjunction with observation of lower extremity movement and patient feedback (eg, to detect bowel or bladder sensations) to reduce the risk of collateral nerve injury; Grade C recommendation, low level of certainty.

Surgical treatment

Q19. How effective is surgery for the treatment of sacroiliac joint complex pain?

One of the earliest descriptions of surgery for SIJ pathology was by Smith-Peterson and Rogers in 1926.³⁶⁰ The authors of that study suspected that the SIJ was an underappreciated anatomic site of pain, and that better understanding was needed. It was not until almost a century later that the number of publications describing surgical treatment of SIJ pathology significantly increased. Open fusion techniques involve either anterior or lateral approaches to the SIJ. More recently, minimally-invasive lateral and posterior techniques have been introduced to achieve arthrodesis (see [Figure 3](#) illustrating 2 locations for minimally invasive rod placement). The following is a summary of available literature evaluating the efficacy and effectiveness of surgery for SIJ complex pain.

Open surgery

Early indications for open surgery included history and physical (typically at least three positive provocative tests), and

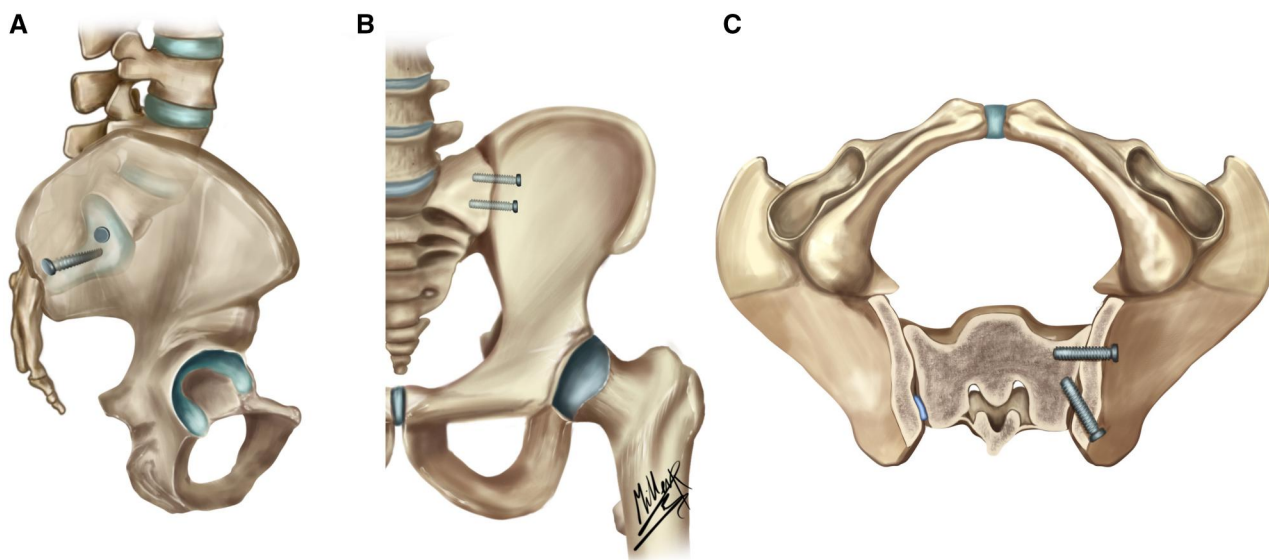


Figure 3. Animated drawing showing possible locations for instrumentation used for sacroiliac joint fusion, as well as a posterior sacroiliac joint bone allograft placement. (A) A lateral screw and a posterior-lateral screw are each shown, transfixing the sacroiliac joint. (B) Two lateral screws are shown transfixing the sacroiliac joint. (C) On the left side of this image, bone allograft is shown within the posterior limb of the sacroiliac joint; on the right-side of the image, both lateral and posterior-lateral screws are shown, transfixing the sacroiliac joint.

subsequent studies added positive response to at least one local anesthetic SIJ injection.

Sham-controlled randomized controlled trials

We identified no published RCTs comparing open surgery for fusion of the SIJ to sham surgery.

Pragmatic randomized controlled trials

We identified no published RCTs comparing open surgery for fusion of the SIJ to an active treatment.

Observational studies

We identified four cohort studies. In 1926, Smith-Peterson and Rogers described an open, lateral approach to fuse the joint with bone transport from ilium through the SIJ in 26 patients.³⁶⁰ Twenty-five of the 26 patients returned to their original occupation. Two were deemed treatment failures due to continued postoperative pain. Buchowski et al. reported on a series of 20 patients who underwent open anterior plating, in which all patients demonstrated statistically significant improvement in all SF-36 categories—except for General Health and Mental Health, and 17 of the 20 had radiographic evidence of joint fusion.³⁶¹ Sixty percent of the cohort stated that they would choose to have the surgery again. Slinkard et al.³⁶² and Murakami et al.³⁶³ published case series of open, anterior plating for fusion of the SIJ. In the former, the average ODI in 19 patients significantly decreased by 17.9 ± 25.4 ($P = .007$).³⁶² The open plating technique described by Murakami et al. resulted in a mean change in VAS pain score in 21 patients from 84.4 to 26.6 ($P < .001$), and the Roland Morris disability questionnaire score for 17 patients decreased from 21.2 to 7.2 postoperatively ($P < .001$).³⁶³

We found two retrospective case-control studies comparing open anterior fusion to lateral minimally-invasive surgical (MIS) fusion. In a study involving 263 patients, Smith et al. found that 82% patients achieved a clinically significant pain score improvement (2 points on a 0-10 NRS) at 24 months in

the lateral MIS group compared to only 50% in the open group.³⁶⁴ Ledonio et al. reviewed 63 patients with a minimum 12-month follow-up after SIJ fusion using an open anterior vs an MIS lateral approach. The authors reported statistically significant improvements in ODI in both the open and MIS groups. The average change in VAS pain score at 12 months was -2.7 in the open group and -6.2 in the MIS group.³⁶⁵ Both studies reported increased blood loss, operative time and hospitalization length in the open anterior approach group compared to the lateral approach group.^{364,365}

Minimally-invasive lateral approach

Criteria for surgery in the following studies included history and physical (typically at least 3 positive provocative tests), and many modern studies added positive response to at least one local anesthetic SIJ injection.

Sham-Controlled randomized controlled trials

We identified one single-blind, sham-controlled study ($n = 63$) evaluating percutaneous lateral SIJ fusion by Randers et al. that demonstrated no statistically significant improvement in pain scores at 6-months post-procedure.²⁸⁸ The sham group was placed under anesthesia, an incision made, and the procedure was “simulated” without implant placement. The average improvement in VAS pain score for the treated group was 2.6 vs 1.7 in the sham group. Patient-reported impression of change revealed that 45% of participants in the operative group felt they were “better” or “much better” after surgery vs 31% in the sham group. Other outcomes reported included average ODI in the surgery group of 47% vs 50% in the sham group, and a “Timed Up and Go” test of 10.6 s in the surgery group vs 11.7 s in the sham group. None of these differences were statistically significant.

Pragmatic randomized controlled trials

We identified four publications stemming from the iMIA study (iFuse Implant System Minimally Invasive Arthrodesis),

a RCT comparing lateral MIS fusion to nonsurgical management for refractory SIJ complex pain involving nine European medical centers. In the first publication, Dengler et al.³⁶⁶ reported on improvement in referred leg pain (RLP) related to SIJ dysfunction over 6 months in patients conservatively managed or treated by MIS SIJ fusion. Overall, there was a 76.2% prevalence of RLP in the study population. After 6 months, the VAS pain score (0-100 mm) in the operative group decreased from 58 to 13.5 but was unchanged in the conservatively managed group. The 6-month outcomes for the primary outcome measure, self-reported reduction in LBP, were reported in 2017.²⁸⁷ The VAS pain score in the operative group decreased from 77.7 to 34.4, which favorably compared to a reduction from 77 to 67.8 in the CM group ($P < .001$). The difference in ODI score at 6 months was 19.8% ($P < .001$), with the SIJ fusion group also reporting less disability. One-year data from the iMIA trial was reported by Dengler et al.³⁶⁷ on 52 participants at 12-month follow-up, while the fourth publication reported on 103 participants at 24-month follow-up.³⁶⁸ Treatment success, defined as a 20-point or greater improvement in VAS pain score (0-100 scale), occurred in 79% (37 of 47) of the operative patients, but fewer than 25% (11 of 46) of conservatively treated participants at the 24-month endpoint. Statistically significant improvements in mean VAS pain and ODI scores were reported in the SIJ fusion compared to the nonsurgical management group at both 12 and 24 months. Of note, the publications resulting from these studies were sponsored by industry, increasing the risk of bias.

There are two published studies for the INSITE trial, which was a prospective, multicenter, parallel group, unblinded RCT comparing minimally-invasive fusion with triangular titanium implants to conservative management. The 12-month outcome study of 148 subjects (102 with fusion, 46 with CM) revealed a clinically important improvement in ODI ($\geq 15\%$) in 73.3% of surgical patients vs only 13.6% in the CM group, which was sustained until the end of trial at 12 months.³⁶⁹ EuroQol-5D, a validated instrument evaluating generic quality of life, improved by 0.29 points ($P < .001$) in the SIJ fusion group but only 0.06 points ($P = .17$) in the NSM group ($P < .001$) at 6 months. Thirty-five of 46 patients in the CM cohort crossed over at 6 months, and their collective improvement after surgery mirrored that in the operative group. The 24-month outcomes were similar, with 83.1% of operative patients experiencing clinical improvement in their VAS pain scores vs $< 10\%$ in the CM group ($P < .01$).¹⁴⁶ The ODI scores at 24 months were also much better in the SIJ fusion group vs the CM group (68.2% improved $> 15\%$ vs 10%). Similar to the iMIA study, the publications resulting from these studies were sponsored by industry.

Observational studies

Numerous published series are available regarding the effectiveness of the lateral MIS fusion approach. Details relevant to each of these studies are provided in Table 19. A retrospective study of 137 patients compared outcomes of conservative medical management vs SIJ complex denervation by SLBRFA vs the lateral MIS fusion approach with 6-year follow-up.³⁷⁰ Patients were selected in this study based on at least 3 of 8 positive provocative SIJ tests and a positive response to an IA injection. The authors reported minimal improvement in pain

and function at long-term follow-up with conservative medical management, an intermediate response to denervation by SLBRFA, and significant improvements in VAS pain and ODI scores in the surgical group. The surgical group was more likely to be working (70.4%) than the conservatively managed (19%) and SI denervation (34%) groups ($P < .01$ for both). Similarly, the percentage of patients taking opioids in the surgery group was initially 63%, and decreased to 7.4% at last follow-up, which favorably compared to the conservative management only group (49% to 82%) and the SI denervation group (55% to 85%), which both increased usage of opioid medications. A caveat to this study is that while IA injections are used to identify patients with degenerative joint changes—an indication for surgery—they have not been validated to identify EA posterior ligamentous pathology, which is the primary indication for denervation. Multiple case series (summarized in Table 19, section 2c) provide additional evidence of statistically significant improvements in pain relief and/or functional measures with operative treatment.^{145,371–382} In a retrospective study comparing cylindrical threaded implants to triangular titanium implants, both groups experienced a statistically significant improvement in VAS pain and ODI scores at 6 months when compared to their preoperative scores.³⁷² Of note, most of the available literature for MIS lateral fusion involves the use of triangular titanium implants, with most publications disclosing sponsorship by industry.

Minimally-invasive posterior approach

Criteria for surgery in the following studies included history and physical (typically at least three positive provocative tests), with most recent studies requiring a positive response to at least one local anesthetic IA SIJ injection.

Sham-Controlled randomized controlled trials

We identified no published RCTs comparing the posterior MIS approach for fusion of the SIJ to sham surgery.

Pragmatic randomized controlled trials

We identified no published RCTs comparing the posterior MIS approach for fusion of the SIJ to an active treatment.

Observational studies

Details relevant to each of these studies are provided in Table 19. In brief, we identified a case series of 19 patients treated with a posterior distraction screw. The authors reported an improvement in VAS pain intensity (mean preop 8.5 to 6 postoperatively) and ODI (64.1 to 57.0%, $P = .19$) scores at a mean follow-up of 13 months. Additionally, 79% of patients indicated that they would “go through the procedure again in order to achieve their current results.”³⁸³ Another report of 171 patients with a posteriorly placed MIS SIJ distraction screw demonstrated improvement in VAS pain and ODI scores over the 24-month study period.³⁸⁴ Further, 73.3% of patients reported they felt better or much better at 24 months than prior to surgery, and when asked if they would recommend the surgery to a friend, 79% said “yes” at 12 months, and 78.5% replied affirmatively at 24 months. The results of five additional studies investigating the effectiveness of a specific posterior SIJ stabilization system have been published, all funded by the device manufacturer. Deer et al. reported results on 111 participants, of whom 47% experienced at least 80% pain relief at an average follow-up of 12 months.³⁸⁵ A second

Table 19. Clinical studies evaluating sacroiliac joint fusion outcomes.

Authors	No. of patients	Fusion method	Definition of success and primary outcomes	Other results
1. Open Surgery				
(Design) Buchowski, 2005 ³⁶¹ (Observational)	20	Anterior SIJ plate	Radiographic fusion-17/20	60% would have surgery again; Statistically significant improvement occurred in all SF-36 categories except for General Health and Mental Health;
Ledonio, 2014 ³⁶⁵ (Retrospective comparative-effectiveness)	63 patients (open: 36; MIS: 27) w/ minimum 1-yr f/u	Open ant plate vs TTI	Compared EBL, OR time, LOS, ODI between approaches	Open surgery patients had higher EBL, LOS and OR time than MIS patients; ODI scores not different between groups
Murakami, 2018 ³⁶³ (Observational)	27 pts followed for at least 5 years	Anterior SIJ plate	Modified McNab Criteria: 21 unilateral pts-7 had excellent, 11 good, and 3 had fair outcomes; 4 ant and post fusion-1 excellent, 1 good, 1 fair, and 1 poor outcome; 2 pelvic ring fusions-1 good and 1 poor outcome.	Union on CT 27/27 at 1yr; in 21 unilateral pts, VAS pain score decreased from 84.4 to 26.6
Slinkard, 2013 ³⁶² (Observational)	19 pts (12 with lumbar fusion, 7 without), with at least 12-month f/u	Open ant plate	ODI and SMFA: Avg pre-op (63.1) and final (45.2) ODI and SMFA (decrease from 47.7 to 36.0) significantly changed at final follow-up;	No significant difference for prior fusion patients in either measure.
Smith, 2013 ³⁶⁴ (Retrospective comparative-effectiveness)	263 pts followed for a minimum of 12 months (149 open and 114 MIS)	Open technique (any) vs TTI	12- and 24-month pain scores and operative parameters. MCID achieved in 86% and 82% in the MIS group at 12 and 24 months, respectively, vs 61% and 50% in the open group at 12 and 24 months	Open surgery required longer surgical time and was associated with greater blood loss and loss of sensation.
Smith-Peterson, 1926 ³⁶⁰ (Retrospective)	26	Lateral open transarticular noninstrumented fusion	Undefined, but 23/26 (89%) experienced no pain at variable follow-up periods.	25/26 (96%) returned to previous occupation, 2/26 reported as "failures"
2. Minimally-invasive Lateral Approach				
2a. Sham-controlled RCTs				
Randers, 2024 ²⁸⁸	63 (32 rec'd surgery vs 31 who rec'd sham), followed for 6 months	Sham vs TTI	≥2 pts on VAS pain scale (Surgical group 16/32, (50%); Sham group 13/31 (42%), $P > .05$	Avg VAS pain improvement at 6 months: 2.6 in surgery vs 1.7 in sham group; "better" or "much better" 45% in surgery vs 31% in sham group ($P = NS$)

(continued)

Table 19. (continued)

Authors	No. of patients	Fusion method	Definition of success and primary outcomes	Other results
2b. Pragmatic RCTs				
Dengler, 2016 iMIA trial ³⁶⁶	100 (49 rec'd CM vs 51 who rec'd TTI), followed for 6 months	CM vs TTI	Primary outcome referred leg pain (RLP). After 6 months, CM group had no meaningful change in RLP. RLP VAS pain score in TTI group decreased from 58 to 13.5. Difference in change in self-rated LBP at 6 months. Mean LBP improved by 43.3 points in the SIJF group vs 5.7 points in the CM group	Referred leg pain present in 76% of pts at baseline.
Sturesson, 2017 iMIA trial ²⁸⁷	103 (51 rec'd CM vs 52 who rec'd TTI) followed for 6 months	CM vs TTI	Mean LBP improved by 43.3 points in the SIJF group vs 5.7 points in the CM group	Mean ODI improved by 26 percentage points in the SIJF group vs 6 points in the CM group
Dengler, 2017 ³⁶⁷	103 (51 who received CM vs 52 who received TTI), followed for 12 months	CM vs TTI	≥20-pt VAS (0-100) pain improvement: 78.8% in TTI vs 22.4% CM	12-month VAS leg pain, ODI, EQ-5D all significantly better in TTI group; 21/49 (43%) of CM pts crossed over to TTI at 6 months and had similar results to TTI group
Dengler, 2019 ³⁶⁸	103 (51 received CM vs 52 who rec'd TTI), followed for 24 months	CM vs TTI	≥ 20-pt VAS (0-100) improvement at 24 mo: 79% in TTI vs 24% CM	Mean VAS pain at 2 yrs improved by 45 in SIJF vs 11 in CM; mean ODI at 2 yrs improved by 26% in SIJ fusion vs 8% in CM; 12-month CT scan in 43/52 SIJF pts; 8 implants had radiolucency (rather than bone apposition).
Polly, 2015 INSITE trial ³⁶⁹	148 (102 rec'd TTI vs 46 who rec'd CM)	CM vs TTI	Improved VAS pain score and no serious adverse event or reoperation at 6 months: 81.4% vs 26.1% in CM)	At 12 mo, VAS SIJ complex pain score improved by at least 2 points in 81.6% of SIJ fusion patients vs 12.5% of CM patients. ODI improved by >15% in 72.4% of SIJ fusion vs 10% of CM group.
Polly, 2016 INSITE trial ¹⁴⁶	148 (102 who rec'd TTI vs 46 who rec'd CM)	CM vs TTI	SIJ complex pain improvement ≥20 points on pain VAS, ODI ≥ 15% over 2 years. In SIJF group, 83.1% improved vs <10% for CM group.	In SIJF group, 68.2% met ODI improvement threshold vs <10% in CM group.
2c. Observational studies				
Al-Khayer, 2008 ³⁷¹	9	Hollow modular anchorage screw	Change of at least 10% on ODI and 2 points on 0-10 VAS for pain Mean ODI decreased from 59 preoperatively to 45 postoperatively; Mean VAS (0-10) pain score decreased from 8.1 preoperatively to 4.6 postoperatively	Mean patients' satisfaction was 6.8 on a 0-10 VAS scale
Claus, 2020 ³⁷²	156 (n = 74) with threaded implant and 82 with TTI)	Cylindrical threaded implant (CTI) vs TTI	VAS pain score, ODI, and Short Form-12 at 6 months and 1 year. No difference in outcomes between the groups at 6 or 12 months.	In both cohorts, there was a significant improvement in all outcomes at 6 months when compared with preoperative values.

(continued)

Table 19. (continued)

Authors	No. of patients	Fusion method	Definition of success and primary outcomes	Other results
Cummings, 2013 ³⁷³	18 unilateral SIJF pts with 12 mo f/u	TTI	VAS ≥ 2 pt: 90% at 1 yr; ODI $\geq 12.8\%$: 89% at 1 yr	1/18 (5.6%) "not satisfied", 2/18 (11%) would "definitely not" have SIJF again
Duhon, 2013 ³⁷⁵	94 (only 32 with 6-month f/u)	TTI	Success = VAS pain score $\Delta \geq 2$, no device complications, no neurological symptoms, and no reoperation: Successful outcome criteria met in 23/26 (88.5%);	Mean ODI score decreased from 55% to 38.9% at 6 months; 22/26 (85%) somewhat or very satisfied, 22/26 would have procedure again
Duhon, 2016 ³⁷⁴	172 (149 with 24-month f/u)	TTI	Success = VAS pain score decrease of at least 2 points, no device complications, no neurological symptoms, no reoperation: Successful outcome criteria met in 127/159 @ 12 months (79.9%) and 119/149 (79.9%) at 24 months.	Pain improved from a baseline of 79.8 (12.8) points to 26.0 (26.7) points at 24 months; ODI improved from a baseline of 55.2 (11.5) percentage points to 30.9 (20.5) at 24 months
Hermans, 2022 ¹⁴⁵	29	TTI	VAS pain score ≤ 3 (0-10 scale): 9/29 (31%) had a successful outcome at 12 months	Statistically significant change in VAS pain score and EQ-5D at 1-yr f/u (VAS score decreased from 7.83 to 4.97 and EQ-5D from 0.27 to 0.5; 23/29 (79%) "agreed" or "totally agreed" that their complaints were reduced after surgery; 24/29 (83%) would have surgery again
Giannikas, 2004 ³⁷⁷	5	Open, lateral, Cloward bone plug fusion	Pain relief and normalization of SI tests-4/5 (80%) no pain	1/5 with no pain relief yet solid fusion of SIJ on CT
Khurana, 2009 ³⁷⁸	15	Hollow Modular anchorage screw	SF-36 and Majeed's functional scoring system; The mean SF-36 improved from 37 to 80 for physical function and from 53 to 86 for general health; mean Majeed's score improved from 37 to 79 postoperatively.	Avg. follow up 17 months; 2/15 with fair results had fusion on CT scan
Kube, 2016 ³⁷⁹	18 pts w/ 20 SI fusions	Simmetry Screw(s)/ MIS lateral screw	53% had a 20 pt or greater reduction in VAS (0-100 mm) back pain score at 1 yr; 69% had a 20 pt or greater reduction in VAS leg pain at 1 yr; 57% had a 15% or greater decrease in ODI.	Avg VAS leg pain score decreased from 63.6 to 27.7 at 12 mo; 88% had successful radiologic fusion at 12 months
Rajpal, 2019 ³⁸⁰	24 pts followed for an avg of 19 months	MIS Lateral Screw (Rialto)	VAS (0-10) pain score: Mean VAS back pain score decreased from 6.6 to 3.7	VAS leg pain score decreased from 4.8 to 1.5; 88% would have surgery again
Sachs, 2013 ³⁸¹	40 pts with 1-yr follow-up after TTI	TTI	Improvement in VAS pain score: Mean preoperative VAS pain score decreased from 8.7 to 0.9 at 12 months	100% would have surgery again

(continued)

Table 19. (continued)

Authors	No. of patients	Fusion method	Definition of success and primary outcomes	Other results
Schmidt, 2021 ³⁷⁶	19 pts (24 SIJF), followed for an avg of 58 months	TTI	Decrease in VAS pain scores and SF-36. Preoperative VAS score decreased from 7 to 3 ($P = .001$); SF-36 physical domain increased from 40 to 55 ($P = .016$)	All other SF-36 domains not significantly different
Vanaclocha, 2018 ³⁷⁰	137 pts followed for an avg of 6 yrs (63 with conservative treatment, 47 who rec'd SI denervation, 27 who had SIJF)	CM vs Radiofrequency denervation vs TTI	VAS and ODI scores: After 4 yrs, no CM or denervation pt had $\geq 15\%$ ODI improvement, all SIJF had $\geq 15\%$ improvement	Pain relief in all groups at 1 month; however, relief was sustained in the SIJF group only
Whang, 2019 INSITE ³⁸²	103 (93 available at 5-yr follow-up)	TTI	Study success defined as VAS pain score (0-100) improvement of at least 20 points in the absence of severe device-related or neurologic adverse event or revision surgery in 76 subjects at 60 months: 81.7% successful outcomes	Mean SIJ complex pain score decreased from 81.5 to 27.1; ODI decreased from 56.3 to 29.9; 85% said they would definitely undergo the procedure again at 24 months, 75% at 60 months
3. Minimally-invasive Posterior Approach				
3a. Sham-controlled RCTs				
3b. Pragmatic RCTs				
3c. Observational studies				
Calodney, 2024 ³⁸⁷	122 pts	LinQ (bone allograft posterior SIJ stabilization system)	Responders met the following criteria: VAS pain score improvement ≥ 20 mm; Absence of implant-related serious adverse events; Absence of neurologic worsening related to the lumbosacral nerve roots Absence of surgical reintervention. Responder rate at 12 months (composite outcomes) when excluding lost to follow-up: 73%. Responder rate at 12 months (composite outcomes) when treating lost to follow-up as treatment failure: 54%.	When excluding participants lost to follow-up, at 12 months, 61% of participants reported at least 50% improvement in pain and 69% of participants reported an ODI improvement of at least 15 percentage points. In a worst-case scenario analysis, these proportions decreased to 46% for pain and 51% for ODI responders, respectively.

(continued)

Table 19. (continued)

Authors	No. of patients	Fusion method	Definition of success and primary outcomes	Other results
Calodney, 2022 ³⁸⁶	69 pts	LinQ (bone allograft posterior SIJ stabilization system)	VAS pain score improvement of at least 20 mm at 6 months: 47 pts (68%), ODI improvement of at least 15% from baseline: 39 pts (57%)	Avg VAS pain improvement was 34.9; avg ODI improvement was 17.7%
Deer, 2021 ³⁸⁵	111 pts	LinQ (bone allograft posterior SIJ stabilization system)	≥ 30% VAS pain score improvement: 102 (92%), and 52 (47%) had ≥ 80% relief	
Endres, 2013 ³⁸³	19 pts	Posterior MIS distraction screw	Not defined; At average 13.2-month follow-up, mean VAS score decreased from 8.5 to 6, mean ODI score decreased from 64.1% to 57.0%.	15/19 (79%) would repeat procedure
Fuchs, 2018 ³⁸⁴	171 pts	Posterior MIS distraction screw	Reduction in VAS pain score and ODI score: VAS decreased from 63% preoperatively to 36% after 24 months; $P < .001$. ODI decreased from 51% to 33% after 24 months; $P < .001$	SF-MPQ improved from an average of 50% preoperatively to 31% after 24 months
Sayed, 2021 ³⁸⁹	110 pts (50 with 12-month data)	LinQ (bone allograft posterior SIJ stabilization system)	NRS Pain score: Decreased from 6.98 to 3.06	

CM, conservative management; CT, computed tomography; CTI, cylindrical threaded implant; EQ-5D, European Quality of Life Index; LOS, hospital Length of Stay; NRS, Numerical Rating Scale; ODI, Oswestry Disability Index; MCID, minimally clinically important difference; MIS, Minimally invasive surgery; Pts, patients; SF-36, Short Form 36; SF-MPQ, Short Form McGill Pain Questionnaire; SIJ, Sacroiliac Joint; SIJF, Sacroiliac Joint fusion; SMFA, Short Musculoskeletal Functional Assessment survey; TTI, Triangular titanium implants; VAS, Visual Analog Scale.

study reported results at an interim 6-month time point. In this study 68% of participants experienced at least a 20-point VAS pain score improvement and 57% of participants reported an ODI improvement of at least 15 points at 6-month follow-up.³⁸⁶ A third study (the final results) reported on 122 implanted participants at 12-month follow-up.³⁸⁷ When excluding participants lost to follow-up, at 12 months, 61% of participants reported at least 50% improvement in pain and 69% of participants reported an ODI improvement of at least 15 percentage points from baseline. In a worst-case scenario analysis counting participants lost to follow-up as treatment failures, these proportions decrease to 46% for pain and 51% for ODI responders, respectively. One recent study evaluating the results of inferior-posterior transarticular MIS SIJ fusion in 36 patients selected based on positive response to an IA corticosteroid injection and at least 3 provocative tests reported a decline in average 0-100 VAS pain score from 79 mm to 23 mm at 12-month follow-up, and a decrease in mean ODI score from 52% to 21% at the same endpoint. The 12-month satisfaction rate in this study was 83%, with successful fusion confirmed in 83% of cases.³⁸⁸ Finally, another study reported the 12-month outcomes of 50 participants following the posterior MIS procedure. At the end of the study, the authors reported an average pain score of approximately 4 points.³⁸⁹

Database reviews

In one database review performed in 4666 patients who underwent minimally-invasive SIJ fusion between 2010 and 2022, the authors found that patients who were opioid-naïve before surgery required fewer postoperative opioids compared to chronic preoperative users, yet continued opioid use one year post-surgery was higher in the MIS SIJF group than in patients undergoing other spine surgeries.³⁹⁰

Summary:

- An open approach to SIJ fusion can provide pain relief and functional benefit in carefully selected patients who are refractory to other therapies; Grade C evidence, low-to-moderate level of certainty.
- There is conflicting evidence (two positive pragmatic RCTs vs one negative sham-controlled RCT) that SIJ fusion via the minimally-invasive (MIS) lateral approach is effective at improving pain and function in carefully selected patients; Grade C evidence, very low level of certainty.
- The MIS posterior approach to SIJ fusion can be considered in patients with refractory intra-articular degeneration with instability who fail to respond to more conservative therapies; Grade C recommendation, low level of certainty.

Q20. How does one best select patients appropriately for sacroiliac joint fusion surgery?

Given the complex anatomy and variable presentation of SIJ complex pain, appropriate selection for surgical intervention is of utmost importance.^{43,79} Surgical intervention for the SIJ should be reserved as a last treatment option, only after all conservative and less invasive interventional options have been exhausted.^{391,392} In a subset of well-selected patients, SIJ fusion can provide pain relief and functional benefit with both open and minimally-invasive fusion techniques.^{370,391-394} Minimally invasive SIJ fusions have been shown to be relatively safe with low revision rates.^{392,395,396} Patient selection for surgical intervention should be based on a combination of clinical history, physical examination, and diagnostic SIJ injections,

after ruling out other sources of pain, and failing trials with nonoperative integrative, pharmacological and interventional treatments.³⁹⁷

Clinical presentation and physical examination

Adequately identifying patients with SIJ complex pain by history and physical exam alone is challenging.³⁹⁸ Whereas no single element of clinical history or physical exam finding is diagnostic of SIJ complex pain, there are some commonalities suggestive of pain originating from the SIJ.^{66,140,282} Historically, patients describe unilateral pain below L5 vertebra, frequently present with a history of trauma, spondyloarthropathy, or lumbosacral fusion, and complain of pain aggravation with sitting or standing.⁶⁶ A combination of physical exam maneuvers can be more reliable than single tests for identifying possible IA SIJ-mediated symptoms.^{140,282,399} Namely, three of six SIJ provocation maneuvers, including Patrick's or FABER, Gaenslen's, thigh thrust, sacral thrust, distraction, and compression should be positive, though recent studies have called into question the validity of physical exam findings.^{73,74,140} In addition to identifying relevant history and physical exam findings to diagnose SIJ complex pain, other sources of pain such as radicular pain, discogenic pain, facetogenic pain, generalized pain disorders such as fibromyalgia, and autoimmune arthropathy should be ruled out.⁴⁰⁰

Failure of nonoperative treatment

According to the International Society for the Advancement of Spine Surgery (ISASS), all patients who are considered for SIJ fusion surgery should have had at least 6 months of SIJ complex pain which impacts quality of life, and have failed nonsurgical treatments including PT, therapeutic exercise, and either an IA SIJ corticosteroid injection, or EA injection or SLBRFA if an EA component is suspected.³⁹⁷

Factors associated with treatment outcome

In a secondary analysis from three RCTs comparing nonsurgical management ($n=97$) to minimally-invasive fusion ($n=316$), predictors of treatment failure after surgery were smoking, opioid use, younger age and shorter duration of pain, with the latter more common in individuals with EA than IA pathology.⁴⁰¹ Separately, the INSITE study reported no association between pain relief associated with the diagnostic IA SIJ injection and pain relief after SIJ fusion, with the parameters of the injection not noted.¹⁴⁶ In a presentation at the 2016 Congress of Neurological Surgeons meeting, decreased postsurgical dyspareunia (a possible symptom of nociplastic pain) and not taking opioids were the only factors associated with a successful SIJ fusion.⁴⁰²

Radiologic findings

Imaging modalities such as plain radiographs, CT, and MRI can be useful for identifying sacroiliitis, SIJ arthropathy, or for monitoring treatment response in inflammatory spondyloarthropathy.^{40,403} However, the absence of imaging abnormalities neither rules out the SIJ as a source of pain nor reduces the likelihood that patients have IA pathology amenable to fusion.^{40,65} In one study performed in 18 patients with moderate to severe ankylosing spondylitis, no association was found between MRI abnormalities and back pain.⁴⁰⁴ In the non-inflammatory spondyloarthropathy population, no imaging modality (including x-rays, CT, and MRI) has been shown to be superior to clinical selection to

diagnose SIJ complex pain, and no imaging modality has been shown to be superior to diagnostic SIJ injections in predicting responsiveness to therapeutic SIJ procedures.⁴⁰⁵ As such, imaging modalities should not be solely relied upon for diagnosing SIJ complex pain or predicting responsiveness to SIJ fusion. However, imaging should be used to rule out other sources of pain, including lumbar radiculopathy, IA hip pathology, autoimmune arthropathy, tumor, or infection.

Diagnostic injections

Diagnostic injections play an important role in confirming SIJ-mediated symptoms.^{8,64,80} However, a single SIJ injection has a high false-positive rate which may exceed 50% in some poorly selected populations.^{8,405} Based on the available literature, dual local anesthetic injections alone (without corticosteroid) result in the strictest criteria for diagnosing SIJ complex pain, while single uncontrolled injections of local anesthetic and corticosteroid result in the lowest specificity.⁸ Using a stricter benchmark for a positive test also decreases the number of responders. For controlled dual anesthetic IA SIJ injections, increasing the threshold from 50% to 80% relief reduces the percentage of positive injections from 45% to 10% based on single studies. When steroid is added to the local anesthetic, the decrease in positive rate is smaller, from 33% to 27%, again based on single studies. For single anesthetic injections, 60%-62% are positive at an 80% threshold, which paradoxically compares with 54%-63% without sedation at a 50% threshold, underscoring differences in selection criteria.⁸ Several SIJ fusion studies used single injections with a 50% pain relief cutoff for the diagnosis of SIJ complex pain; however, most did not specify the volume of anesthetic used for the injection.^{286,287,369,394} As noted above, one study found no correlation between pain relief during diagnostic IA injections and SIJ fusion outcome, with this study employing a 50% cutoff threshold for enrollment.¹⁴⁶ Given that the volume of a symptomatic SIJ joint is only 1-2.7 mL,¹²⁹ low volume diagnostic injections of anesthetic only, with a documented arthrogram and absence of contrast flow to adjacent structures, is the best way to ensure target specificity.⁸

There are significant EA sources of pain near the SIJ that can undermine the specificity of an IA SIJ injection.¹³⁹ The SIJ joint can communicate with the S1 foramen, and there are often defects in the anterior capsule, which can result in anesthetic extravasation outside the SIJ into muscles and/or the lumbosacral plexus, potentially leading to a false-positive response.⁴² Given the anatomic complexity of the joint and necessity of confirming target-specific flow with contrast medium, diagnostic SIJ injections are typically performed using either fluoroscopic or CT guidance, not under ultrasound guidance, which frequently results in EA spread.^{150,154,406} The addition of corticosteroid does not contribute to the diagnostic value of an injection and adds more volume, increasing the chance of a false-positive response from EA spread and/or systemic effects.⁸ In randomized trials evaluating SIJ fusion, all studies have used 50% pain relief as the threshold for designating a diagnostic injection as positive.^{146,286,287} Considering the rate of false-positive injections and the costs and risks of SIJ fusion, strict criteria for a positive anesthetic injection should be used including the use of dual IA SIJ local anesthetic injections.

Summary:

- Appropriate patient selection for SIJ fusion should include a combination of the following; Grade C recommendation, low level of certainty:
 - At least 6 months of non-radicular pain below L5, consistent with SIJ pain.
 - Failure of at least 12 weeks of conservative care (eg, physical therapy, therapeutic exercise, medications) and other nonsurgical interventions.
 - Patients who smoke should be referred for smoking cessation, and those on opioids should ideally be weaned off or tapered down.
 - Physical exam indicating a positive response on at least 3 out of 6 SIJ provocation tests.
 - History and radiologic studies that rule out other possible sources of pain, including generalized pain disorders, lumbar radiculopathy, hip pathology, autoimmune arthropathy, or destructive lesions such as tumor or infection.
 - Positive responses to low-volume, dual prognostic IA SIJ injections (without corticosteroid), under fluoroscopic or CT guidance.
 - Evidence is mixed on using >50% pain relief as the prognostic threshold to select patients for SIJ fusion (two pragmatic RCTs showed effectiveness, but a sham-controlled study did not distinguish fusion from sham outcomes). Given the invasiveness of SIJ fusion surgery, a higher pain relief threshold than 50%, along with documented functional improvement, is recommended to select patients for SIJ fusion; Grade I recommendation (no consensus on number of blocks or specific cutoff was achieved in the working group).

Dissents: IPSIS, NASS and the NASS Fellowship Consortium recommend dual IA blocks with $\geq 75\%$ pain relief to select patients for SIJ fusion.

Q21. What are the most common complications with sacroiliac joint fusion surgery and how can they be minimized?

Over the past 25 years, numerous reports on SIJ fusion have been published, but complication rates remain challenging to ascertain with precision. Studies employing stringent reporting methodologies have documented high numbers of adverse events, although many are unrelated to the procedure itself. Conversely, other studies report low-to-no complications. The most frequently reported complications associated with minimally invasive SIJF generally include lumbosacral radiculitis, persistent pain, and pseudarthrosis necessitating revision. An analysis of SIJF complications from the Manufacturer and User Facility Device Experience (MAUDE) database identified device malposition as the predominant complication, accounting for approximately 50% of all reported complications.⁴⁰⁷ Malposition may lead to nerve and blood vessel injury, and the authors reported the root cause as surgical error, not device related, in 644 of the 1107 (58%) total complications reported in this series. Given the heterogeneity of data analyzed, further evaluation of the complications will be presented by approach and implant(s) used.

Open fusion^{361,362,364,365,376,377}

Two case series from the same institution describe an open anterior approach to the SI joint, involving decortication for fusion and fixation with a 4.5 mm reconstruction plate. Ledonio et al.³⁶⁵ reported complications in 14% of patients (3 out of 22) undergoing open fusion, including a pulmonary embolus and two revisions due to pseudarthrosis, with greater blood loss, operative time, and length of stay compared to minimally-invasive lateral fusion. Another study³⁷⁶ reported a 21% complication rate (4 out of 19 patients), with three reoperations: One pulmonary embolus, one wound hematoma, one non-union, and an overlong screw causing soft tissue irritation. Buchowski et al.³⁶¹ found pseudarthrosis (15%), wound infection (10%), and painful hardware (5%) were the most common complications in their case series of 20 patients. Interestingly, earlier studies by Smith-Peterson et al.³⁶⁰ in 1926 reporting on 26 patients, and Giannikas et al.³⁷⁷ in 2004 describing an open lateral technique without implants in five patients, reported no complications. A retrospective study³⁶⁴ comparing open posterior fusion to minimally-invasive lateral fusion found a 23% adverse event rate (34 events in 149 patients), with trochanteric bursitis ($n=4$), postoperative neuropathy ($n=4$), and leg pain ($n=3$) being the most common complications. Notably, 44% of patients (66 out of 149) in this study required reoperation for implant removal.

Minimally-invasive lateral fusion techniques^{145,364,365,367,368,370,371,373-376,378-383,408}

Multiple reports have described complications related to implantation of a minimally-invasive, laterally placed interference device for fusion of the SIJ.

A prospective, multicenter RCT by Dengler et al.^{367,368} provided comprehensive one- and two-year complication data for SI joint fusion. Out of 101 documented complications in the entire study population (including operative, conservative, and crossover groups), only four of 39 severe adverse events were likely procedure-related: Two cases of increased post-procedural pain, a gluteal muscle hematoma, and a case of nerve impingement requiring revision. Radiographic analysis of 43 patients in the fusion group at 12 months revealed cortical breach by implants in 8.6% (17 patients) of 198 evaluated implants. Three retrospective cohort studies involving triangular titanium implants reported varying complication rates. Smith et al.³⁶⁴ reported no intraoperative complications in 114 patients treated with triangular titanium implants, with postoperative issues including falls ($n=4$), facet joint pain ($n=4$), and cellulitis ($n=3$); four patients returned to the operating room, three for nerve impingement and one for “radiographic findings.” Ledonio et al.³⁶⁵ noted two revisions for implant loosening and one pulmonary embolus in a group of 27 minimally-invasive fusions. Another study by Vanaclocha et al.³⁷⁰ reported only two cases of temporary sciatic pain among 27 minimally-invasive fusions, with no revisions required. Additionally, a case report by Maxwell et al.⁴⁰⁸ described a superior gluteal artery injury following percutaneous lateral SIJ fusion, necessitating open revision and branch ligation due to a large hematoma in the gluteal musculature and a significant hemoglobin drop within 24 h post-operation. Further case series are summarized in Table 20.

Minimally-invasive screw-based fusion techniques^{371,378-380,383}

Screw-based, minimally-invasive SIJ fusion techniques have been reported and are summarized in Table 21. With low numbers, the complications most reported include postoperative pain, hematoma, and infection.

Posterior, minimally-invasive, percutaneous fusion^{385,386,389}

In the published observational studies that used a percutaneous, minimally-invasive, posteriorly implanted device to treat SIJ complex pain, relatively few complications were reported. In one study involving 111 treated patients, there was no comment on complications.³⁸⁵ The only complication noted in another series of 50 treated patients with 12-month follow-up data was a case of device migration, treated with revision.³⁸⁹ A multicenter, prospective series of 122 participants followed for 12 months and treated with the same device reported four serious adverse events although only one was deemed related to the study, which involved an aspiration event after initiation of monitored anesthesia care.³⁸⁷ There was one patient in this study who reported increased SIJ pain.

Summary:

- SIJ fusion procedures are associated with standard postoperative complications such as infection, worsening or new-onset pain at the surgical site, hematoma, pseudarthrosis, and other device-related complications; Grade A evidence, high level of certainty.
- Postoperative neuropathy is a common and procedure-specific complication, likely due to the proximity of the L5 and S1 nerve roots to the operative field and has been reported in both open and minimally-invasive series. Proper evaluation of imaging is paramount to reducing this complication. Postoperative neuropathy appears to be more common with the lateral MIS fusion procedure than with anterior or posterior approaches; Grade C evidence, low level of certainty.
- There is evidence for a higher incidence of hematomas and neuropathic leg pain with open and lateral MIS (screw-based) SIJ fusion than with other minimally-invasive techniques; Grade C evidence, low level of certainty.
- There is a higher rate of device migration with posterior minimally-invasive SIJ percutaneous fusion than with other approaches; Grade C evidence, low level of certainty.

Discussion

Purpose of the guidelines

The present guidelines were developed to clarify evidence-based best practices in the diagnosis and treatment of SIJ complex pain. As a joint complex that interacts with the spine, pelvis, and hip, this structure is biomechanically distinct and innervated in a different fashion from other joints of the axial skeleton. Although it may be tempting to apply principles of spinal facet joint diagnosis and treatment to the SIJ complex,^{28,29} doing so uniformly is inappropriate. Appreciation of the unique characteristics of the SIJ complex is vital to optimizing diagnosis and treatment. Table 22 provides a summary of statements and recommendations, and Figure 4 provides an algorithmic flow chart that can be used to guide treatment.

Table 20. Summary of complications of MIS lateral triangular fusion techniques.

Study	Study type	No. of patients	Implant	Complications noted
Cummings ³⁷³	Retrospective Case Series	18	TTI	0 reported
Dengler ³⁶⁸	Prospective RCT	103	CM vs TTI	Post op CT-198 implants-17 (8.6%) cortical breaches SIIJF cohort complications: • 2 cases of increased SIIJ complex pain • 1 gluteal hematoma • 1 case of new-onset radicular pain (req revision) • 1 revision for hardware loosening Fusion group: • 2 cases of worsening pain w/ implant loosening • 1 case of new-onset leg pain (implant malposition) • 1 hematoma CM group • 1 hardware loosening after crossover fusion • 1 hematoma after crossover fusion • 1 case with 800 mL EBL • 3 cases of excessive pin advancement • 2 cases of post-op buttock pain • 2 wound infections • 1 case of cellulitis • 2 cases of PONV
Dengler ³⁶⁷	Prospective RCT	53	CM vs TTI	
Duhon ³⁷⁵	Prospective Case Series	32	TTI	
Duhon ³⁷⁴	Prospective Case Series	149	TTI	• 3 cases of neuropathic pain (required additional surgery) • 4 cases of hip or SIIJ pain "attributed to implant" • 1 deep wound infection among 6 total infections • 8 revisions • 1 case of wound numbness • 1 case of vascular injury • 1 wound infection • 2 cases of implant loosening • 1 case of nerve root injury (S1)
Hermans ¹⁴⁵	Retrospective Case Series	29	TTI	
Ledonio ³⁶⁵	Retrospective Cohort Study	63	Anterior Plate vs TTI	MIS TTI • 2 pulmonary emboli • 2 cases of nerve irritation requiring revision MIS OPEN SURGERY • 1 pulmonary embolus • 2 revisions for 'failed implant' and 'nerve root irritation'

(continued)

Table 20. (continued)

Study	Study type	No. of patients	Implant	Complications noted
Sachs and Capobianco ³⁸¹	Retrospective Case Series	40	TTI	• 8 cases of facet joint pain • 2 cases of trochanteric bursitis • 1 case of new-onset LBP • 1 case of piriformis syndrome • 3 patients required subsequent lumbar surgery None reported
Schmidt ³⁷⁶	Retrospective Case Series	19	TTI	Open cohort complications: • 21% (trochanteric bursitis, neuropathy and leg pain) • 66 of 149 (44%) had surgery to remove implants MIS cohort complications: • 18% MIS (4 cases each of facet joint pain, falls, 2 cases each of trochanteric bursitis and piriformis syndrome, 1 case of new-onset back pain, 4 infections (1 wound infection, 3 cases of cellulitis), 2 hematomas • 4/114 (4%) had surgery to remove implants • 2 cases of temporary sciatic pain
Smith ³⁶⁴	Retrospective Cohort Study	263	Open technique (any) vs TTI	
Vanaclocha ³⁷⁰	Retrospective Cohort Study	137	CM vs Denervation vs TTI	
Whang ³⁸²	Prospective Case Series	93	TTI	• 3 of 103 had revision surgery • 1 case of trochanteric bursitis

CM, conservative management; PONV, postoperative nausea and vomiting; RCT, randomized controlled trial; TTI, triangular titanium implants.

Table 21. Summary of complications of MIS screw-based fusion techniques.

Study	Study type	No. of patients	Implant	Complications noted
Al-Khayer ³⁷¹	Retrospective Case Series	9	Lateral screw	1 deep wound infection treated with debridement
Endres & Ludwig ³⁸³	Prospective Case Series	19	Posterior screw	None reported
Khurana ³⁷⁸	Retrospective Case Series	15	Lateral screw	No neurological or wound complications, no implant failures/revisions
Kube & Muir ³⁷⁹	Retrospective Case Series	18	Lateral screw	• 1 guide wire fracture • 1 case of prolonged postoperative pain • 2 cases required prolonged surgery time • No postoperative complications
Rajpal & Burneikiene ³⁸⁰	Retrospective Case Series	24	Lateral Screw	• 2 subcutaneous hematomas, which resolved spontaneously • 2 superficial wound infections treated with antibiotics • 1 osteophyte adjacent to implant, later excised

Table 22. Summary of statements and recommendations.

Question	Statement/recommendation	Grade	Level of evidence
Q1	The prevalence of SIJ-mediated chronic LBP is estimated to be 15%-30% in patients with axial pain predominantly below L5.	B	Moderate
	The prevalence of dorsal ligament-mediated pain is unknown but appears to be at least as common as intra-articular pain based on IA vs EA injection responses.	I	N/A
	The prevalence of SIJ complex pain is suspected to be higher in patients with a prior lumbar or lumbosacral fusion, estimated between 33% and 59%.	C	Low
	Chronic LBP after fusion surgery may be related to adjacent segment stress, accelerated degeneration, missed SIJ pain before fusion, or violation of SIJ ligaments/synovium during bone grafting.	C	Low
	Recommendation - Further studies are needed to evaluate the prevalence of dorsal ligament-mediated pain using EA injections and SLBBs.		
Q2	There is low-quality evidence that history (eg, groin pain) and physical exam features (provocative tests) may help predict IA SIJ injection response.	B	Moderate
	There is little data on using history and physical exam features to predict outcomes for patients with EA dorsal ligament pathology.	C	Low-moderate
	Specificity of PE tests (single or clustered) is lower than sensitivity, with negative tests being more predictive than positive ones.	A	High
	Inter-rater reliability of SIJ provocation tests varies widely; FABER test has highest reliability.	C	Low
	History and physical exam can help guide injections. IA injections may still be reasonable even without positive provocation tests when suspicion is strong.	B	Moderate
Q3	Radionuclide bone scan sensitivity (13%-46%) is inadequate for diagnosis though specificity is high (>90%).	D	Moderate
	CT scan shows inadequate sensitivity (57.5%) and specificity (69%) for diagnosis.	D	Low
	MRI: insufficient evidence, low sensitivity and specificity.	I	N/A
	SPECT/CT may show high sensitivity (95%) and specificity (99%) but evidence limited by using exam (not anesthetic injections) as the reference standard.	I	N/A
	SPECT/CT can identify uptake but there is insufficient evidence to distinguish IA SIJ from dorsal ligament pain.	I	N/A
Q4	IA SIJ injections are diagnostically valid for SIJ pain.	B	Moderate
	IA SIJ anesthetic injections have unreliable predictive value for steroid response.	I	N/A
	IA SIJ injections have unreliable prognostic value for SLBRFA.	C	Low
	SLBBs are diagnostic for pain from interosseous ligament, dorsal SIJ ligament, and inferior dorsal SIJ.	B	Low-Moderate
	Insufficient evidence to assess prognostic value of SLBBs vs other criteria.	I	N/A
	Recommendation: Systematic reviews partially support diagnostic validity but more studies are needed.		
	Recommendation: Further pragmatic trials directly comparing diagnostic criteria are warranted.		

(continued)

Table 22. (continued)

Question	Statement/recommendation	Grade	Level of evidence
Q5	IA SIJ injections should use a maximum of 2.5 mL injectate to avoid capsular rupture and spread; injection may be halted at lower volumes if resistance is met.	B	Moderate
	In patients with combined IA and EA pathology, volumes exceeding 3 mL may sometimes be required to treat dysfunction.	C	Low
	Response to diagnostic IA SIJ injections can be used to select candidates for fusion surgery.	B	Moderate
	Corticosteroids should not be added to diagnostic IA injections as they provide no diagnostic benefit and may increase extra-articular spread risk.	D	Low
	SLBB local anesthetic volumes should be 0.67-1.2 mL per foraminal region at multiple depths to address neuroanatomy.	C	Very Low
Q6	Fluoroscopically guided IA SIJ injections are more accurate than landmark-guided.	B	Moderate
	Landmark-guided IA SIJ injections should not be performed.	A	High
	Image guidance should be strongly considered when extra-articular involvement is suspected.	B	Moderate-High
	Fluoroscopy should include contrast injection to confirm intra-articular placement.	C	Low
	Ultrasound guidance may be used in patients with contraindications to radiation/contrast (eg, pregnancy).	C-B	Moderate
	Evidence insufficient to confirm ultrasound non-inferiority to fluoroscopy.	I	N/A
	Accuracy of ultrasound depends on proceduralist experience and patient BMI.	C	Low
Q7	Insufficient evidence comparing CT to fluoroscopy.	I	N/A
	CT guidance may be considered in advanced degenerative SIJ or failed fluoroscopy cases.	C	Low
	Extra-articular injections with corticosteroid have slightly stronger evidence of efficacy than intra-articular injections for at least one month.	C	Low
	Evidence conflicting on superiority of EA vs IA injections at 3 months.	C	Low
Q8	Preferred IA SIJ injection technique: fluoroscopic guidance, inferior joint access, contrast confirmation, and low injectate volume (<2.5 mL).	B	Moderate
	If inferior access not possible, middle/superior access or CT guidance may be considered.	C	Low-Moderate
	For SLBRFA, fluoroscopic guidance with multi-site, multi-depth SLBBs (targeting S1-S3) is recommended.	C-B	Moderate
	Ultrasound-guided multi-site SLBBs may be considered for prognostic use.	C	Low
Q9	Routine sedation is not recommended for diagnostic or prognostic SIJ/SLB injections due to increased false-positive rates.	B	Low-Moderate
	Routine sedation not recommended for therapeutic injections but may be used in select cases (needle phobia, psychiatric issues, severe vasovagal reactions).	C	Low
	Light or moderate sedation may be used during SLBRFA depending on patient/provider preference.	C	Low
	If sedation is required, the lowest dose of short-acting agents should be used.	A	High
Q10	Physical therapy and structured exercise may provide intermediate-term benefit.	C	Low
	CBT may benefit patients with comorbid psychological issues.	C	Low
	PT combined with CBT does not reduce risk of transition to chronic low back pain.	B	Low-Moderate
	SIJ belts may provide benefit in some patients.	C	Low
	Insufficient evidence for chiropractic therapy effectiveness.	I	N/A
	NSAIDs and SNRIs may help; other antidepressants are not effective.	C	Low
	Insufficient evidence for acute opioid use.	I	N/A
	No benefit from long-term opioid therapy.	D	Low
Q11	Acetaminophen is ineffective for SIJ complex pain.	D	Low
	Insufficient evidence for autologous/allogeneic orthobiologics, HA, prolotherapy (non-dextrose), botulinum toxin, and saline.	I	N/A
	Dextrose prolotherapy may be effective at 6 months.	C	Low
Q12	Platelet-rich plasma may be effective at 3 months.	C	Low
	Insufficient evidence to assess efficacy of cryoablation for SIJ pain.	I	N/A
Q13	Recommendation: Further RCTs and anatomical studies are needed.		
	SLBRFA is effective for ≥ 3 months with $\geq 50\%$ pain reduction.	B	Moderate-High
	SLBRFA is effective at ≥ 6 months when invalid techniques excluded.	B	Moderate

(continued)

Table 22. (continued)

Question	Statement/recommendation	Grade	Level of evidence
Q14	Cadaveric studies show dorsal innervation from S1-S3 in >90% of specimens; L5 and S4 branches are often involved.	B	Moderate
	S1-S3 lateral branches should always be targeted during SLBRFA.	A	High
	Consider targeting L5 and S4 lateral branches for complete denervation.	B	Moderate
Q15	≥50% pain relief should be considered the cutoff for positive diagnostic/prognostic SIJ injections for SLBRFA selection.	B	Moderate
	Insufficient evidence to define EA prognostic cutoff before RFA.	I	N/A
	Mixed evidence for using >50% cutoff to select SIJ fusion candidates.	I	N/A
	Dual prognostic IA SIJ injections without corticosteroid and with higher thresholds recommended for fusion candidate selection.	I	N/A
	SLBBs should use 50% cutoff as prognostic threshold for RFA selection.	B	Moderate
	Therapeutic outcome success should follow IMMPACT/FDA thresholds of ≥2 points or 30% improvement with functional benefit.	B	Moderate
Q16	Older age (≥65), longer pain duration, higher baseline pain, and opioid use predict poorer outcomes after SLBRFA.	C	Low
	Anterior pathology or uncontrolled psychopathology predict treatment failure.	C	Low-Moderate
	Prognostic SLBBs are preferred for selecting SLBRFA candidates.	C-B	Low
Q17	Anatomically-valid techniques (cooled monopolar, bipolar strip lesioning) improve pain/disability ≥6 months.	B	Moderate
	Without excluding invalid techniques, evidence quality drops.	C	Low
	Techniques that create larger lesions are supported for efficacy.	B	Moderate
Q18	NSAIDs have weak evidence for preventing/treating neuritis.	C	Low
	Insufficient evidence for corticosteroids/membrane stabilizers for neuritis.	I	N/A
	Anticoagulation: consult specialist; in many cases anticoagulants may be continued.	C-B	Moderate
	SLBRFA safe in patients with implanted devices; bipolar lesioning may be safer.	B	Moderate
	Radiographs should be checked to ensure electrodes avoid hardware.	B	Moderate
	Sensory stimulation offers minimal safety or therapeutic value.	C	Low
Q19	Motor stimulation can reduce risk of collateral nerve injury.	C	Low
	Open SIJ fusion can provide pain relief and functional improvement in selected patients.	C	Low-to-moderate
	Evidence for minimally-invasive lateral SIJ fusion is conflicting (two positive RCTs vs one negative sham RCT).	C	Very Low
	MIS posterior SIJ fusion may be considered for refractory degeneration with instability.	C	Low
Q20	Appropriate selection should include ≥6 months non-radicular pain, failed ≥12 weeks of conservative therapy, ≥3 of 6 positive provocation tests, exclusion of other causes, and positive dual IA injections.	C	Low
	Evidence mixed on >50% cutoff for SIJ fusion candidate selection; higher thresholds with functional improvement recommended.	I	N/A
Q21	SIJ fusion associated with standard surgical risks (infection, pain, hematoma, pseudarthrosis, device-related issues).	A	High
	Postoperative neuropathy is common, especially with lateral MIS approach.	C	Low
	Higher incidence of hematomas and neuropathic leg pain with open and lateral MIS compared to other approaches.	C	Low
	Posterior MIS SIJ fusion has higher device migration risk than other approaches.	C	Low

CT, computed tomography EA, extra-articular; IA, intra-articular; LBP, low back pain; MRI, magnetic resonance imaging; NSAIDs, Non-steroidal anti-inflammatory drugs; SIJ, sacroiliac joint; SLBB, sacral lateral branch blocks; SLBRFA, sacral lateral branch radiofrequency ablation; SPECT, single photon emission computed tomography.

Epidemiology

Although the prevalence of other specific anatomical sources of LBP have been relatively well defined in select populations (namely, the lumbar facet joint and intervertebral disc),⁴⁰⁹ accurate prevalence estimates are more challenging regarding the SIJ complex given its articular and EA ligamentous components, as well as intrinsic technical challenges in reliably performing diagnostic IA-only injections.⁵ A literature review performed for the present guidelines demonstrated the prevalence of SIJ-mediated chronic LBP to be between 15% and 30%, but the epidemiological studies are methodologically

insufficient to estimate the prevalence of EA ligamentous pain with any precision.

Diagnosis

There are some features pertaining to clinical history (maximal pain within 1 cm of a location just inferomedial to the posterior superior iliac spine,⁵⁷ groin pain,^{43,61,62} and injuries with specific mechanisms,⁶⁴ and lumbosacral fusion,⁶⁵ among others) that may increase the likelihood of a positive response to an IA SIJ local anesthetic injection, suggesting IA-mediated pain, but studies have not typically distinguished

SUSPECTED SIJ COMPLEX PAIN BASED ON HISTORY AND PHYSICAL EXAMINATION

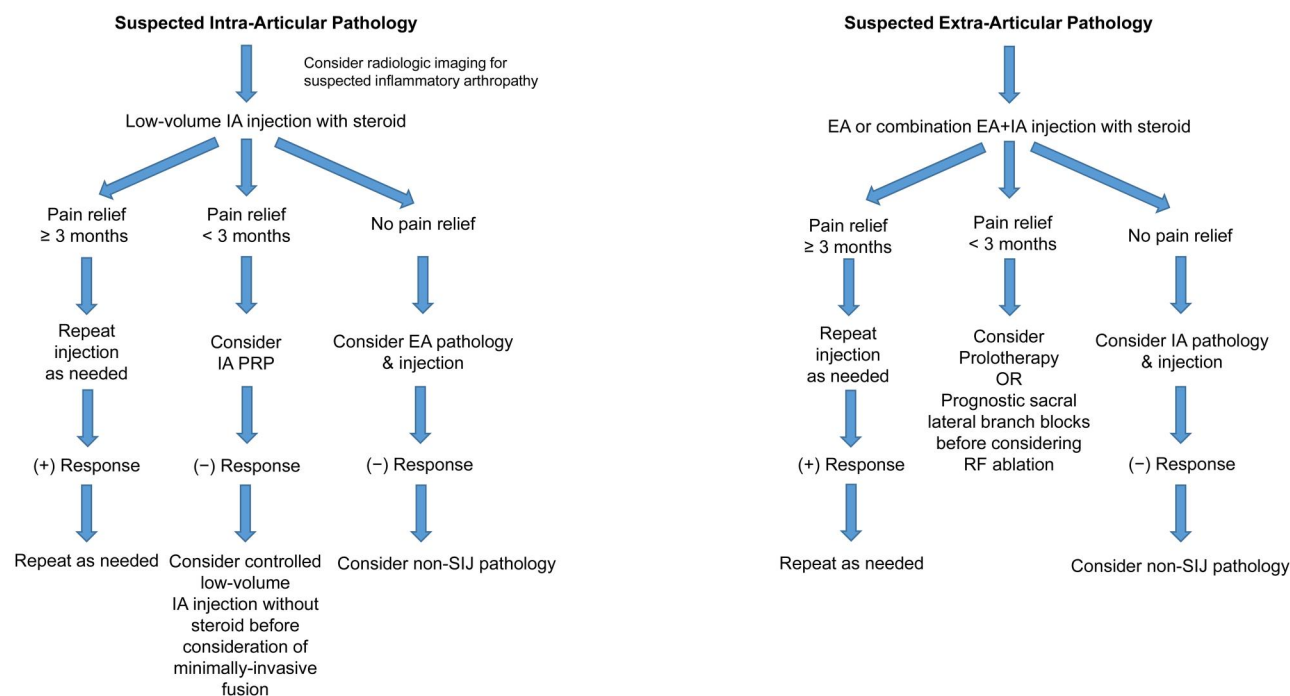


Figure 4. Flow chart demonstrating treatment of suspected sacroiliac joint complex pain based on history, physical exam and response to interventions.

between IA pain and dorsal ligament pain. Whereas a physical examination in isolation is an imperfect tool for diagnosing SIJ complex pain, the sensitivity of individual and clusters of SIJ complex provocation tests is associated with a reasonable negative predictive value for the outcome of an IA SIJ injection. Notably, there remains a lack of research on distinguishing IA-mediated pain from dorsal ligament pain by physical examination. Although the latter may elicit more tenderness due to the closer proximity to skin and younger demographic, this has not been tested in clinical trials.

Imaging is important for ruling out inflammatory, infectious, malignant, and other non-degenerative/biomechanical causes of SIJ complex pain but otherwise has minimal or unclear utility for diagnosing SIJ complex pain. This is the case regardless of imaging modality (radiographs, MRI, CT scan, radionuclide bone scan, SPECT/CT).

Given the limitations of history, physical examination, and imaging, interventional-based diagnosis remains the reference standard for diagnosing and distinguishing between IA-mediated pain and dorsal ligament pain given. Although medial branch blocks represent the reference standard for diagnosing articular lumbar facet joint pain as opposed to IA injection,²⁹ this is not the case for isolated IA pain, wherein IA injection represents the reference standard for diagnosis. Alternatively, SLBBs represent the reference standard for diagnosing dorsal ligament complex pain.¹¹⁶

Conservative and minimally-invasive treatment results

The evidence supporting conservative treatments for SIJ complex pain is limited and largely indirect. While PT, structured exercise, and cognitive behavioral therapy (particularly for

those with comorbid psychopathology) may offer some short-term benefits, the level of certainty remains low. Indirect evidence from LBP studies suggests that NSAIDs and antidepressants may be beneficial, but the efficacy of opioids, especially for long-term use, is not supported. SIJ belts show weak evidence of potential benefit in some patients, while evidence for chiropractic treatment is insufficient. Notably, acetaminophen appears ineffective for LBP in general, with no direct evidence for SIJ complex pain. Given the paucity of high-quality, direct evidence, further research is needed to establish the effectiveness of conservative treatments specifically for SIJ complex pain.

Injection-based treatment

There is reasonable evidence that both IA and EA/ligamentous corticosteroid injections are effective in the short-term for the treatment of SIJ and/or dorsal ligament complex pain, which is in contrast to IA facet joint corticosteroid injection which does not reliably differ from placebo.²⁹ There is presently insufficient evidence to recommend non-corticosteroid-based injection treatments for SIJ complex pain. This is an area in which further study is needed. The accuracy of such injections relies on image guidance by either fluoroscopy or CT. Fluoroscopic guidance provides better accuracy compared to landmark-based injection. Whereas some evidence suggests ultrasound guidance is less accurate than fluoroscopic-guidance for achieving reliable IA injection,¹⁵⁰ the evidence is insufficient to determine non-inferiority.

Radiofrequency ablation-based treatment

It is well established that best practices for selecting individuals for lumbar facet denervation are based on the use of medial branch blocks, not IA facet joint injections.²⁹

Alternatively, the literature review performed for the present guidelines demonstrated that both SLBBs and IA SIJ injections have reasonable prognostic value for the predicting the outcome of SLBRFA; however, there are no data on patients who have undergone SLBRFA without prognostic blocks, or with negative blocks. Whereas SLBBs have greater face validity as a prognostic test, the present evidence indicates that either type of prognostic (SLBB or IA SIJ) injection can be reasonably used (Grade C evidence, low level of certainty). In clinical studies, since they are prognostic, SLBB are almost never used without a preceding positive SIJ injection.

It is well established that the most effective way to achieve facet joint denervation by RFA involves targeting the medial branch nerves with a large-gauge electrode, using a near-parallel technique.²⁹ The literature review performed for the present guideline revealed that, while many techniques have been proposed, only two techniques reliably capture the sacral lateral branch nerves necessary for effective

denervation of the dorsal ligament complex^{121,122}: (1) comprehensive perforaminal large-gauge monopolar RFA; and (2) continuous bipolar-strip lesions lateral to the sacral foramina. For these anatomically valid techniques, there is grade B evidence for improving pain and disability for at least 6 months post-treatment. As such, sacral lateral branch RFA should be performed using one of these two techniques unless future evidence validates additional techniques that provide the same reliability for sacral lateral branch capture.

Sacroiliac joint fusion

Utilization of SIJ fusion has increased substantially in the past two decades. One study that queried Medicare databases found a 2351% increase in utilization of SIJ fusion between 2010 and 2020 in the United States.⁴¹⁰ This trend is likely to continue in the United States given coverage restrictions implemented within the past two years on other treatments for SIJ complex pain for Medicare beneficiaries, including

Table 23. Summary of agreement of committee members and partner societies.

Question	Organization-specific committee members	Organizations ^{a,b,c}
Guidelines en bloc	27 approved	24 endorsed
Prevalence of SIJ pain	27 approved	24 endorsed
Use of history and physical exam to diagnose SIJ pain	27 approved	24 endorsed
Radiological imaging for diagnosis	27 approved	24 endorsed
Diagnostic and prognostic value of IA injections and SLBB	27 approved	24 endorsed
Volume and composition of SIJ IA injections	27 approved	24 endorsed
Accuracy of using anatomical landmarks and imaging for IA injectate spread	27 approved	24 endorsed
Relative effectiveness for IA vs EA SIJ injections	27 approved	23 endorsed, 1 abstained ^d
Technique for IA injections and SLBB	27 approved	24 endorsed
Use of sedation for diagnostic and prognostic blocks and RFA	27 approved	24 endorsed
Effectiveness of non-invasive treatments for SIJ complex pain	27 approved	24 endorsed
Evidence for non-steroid injections for SIJ complex pain	27 approved	24 endorsed
Evidence for cryoablation	27 approved	24 endorsed
Effectiveness of SLBRFA	27 approved	24 endorsed
Targeted nerves for SLBRFA	27 approved	24 endorsed
Cutoff thresholds for selecting patients for SLBRFA and SIJ fusion & designating outcomes	25 approved	24 endorsed the summary, but 3 dissented on cutoff threshold for selecting patients ^e
Ideal candidates for SLBRFA	27 approved	24 endorsed
Optimal technique for SLBRFA	27 approved	24 endorsed
Minimizing the most common complications from SLBRFA	27 approved	24 endorsed
Effectiveness of surgery for SIJ pain	27 approved	24 endorsed
Selecting patients for SIJ fusion	27 approved	24 endorsed the summary, but 3 dissented on a specific cutoff for a positive block before surgery ^e
Identifying and minimizing the most common complications from SIJ fusion	27 approved	25 endorsed

EA, extra-articular; IA, intra-articular; SIJ, sacroiliac joint; SLBB, sacral lateral branch blocks; SLBRFA, sacral lateral branch radiofrequency ablation.

^a The Departments of Defense and Veterans Affairs did not vote on the guidelines but their representatives approved them.

^b The American Academy of Neurology declined to affirm the benefit of the guideline citing lack of relevance to their membership.

^c The American Society of Anesthesiologists, American Academy of Physical Medicine & Rehabilitation and the North American Spine Society “affirmed the benefit” of the guidelines rather than formally endorsed them. For simplicity sake, these votes are listed in the table as “endorsements”, while dissents are listed as such. Since these documents were not formally approved by these societies’ Boards of Directors or Houses of Delegates, they do not represent official or approved statements or policies of these Societies. Although the document is supported by the ASA, variations from the recommendations contained in the document may be acceptable based on the judgment of the responsible anesthesiologist.

^d The Latin American Society for Regional Anesthesia abstained on the issue of stronger evidence for EA than IA injections.

^e NASS, NASS Fellowship Consortium and IPSIS recommend dual SLBBs with $\geq 75\%$ cutoff threshold, and dual IA injections with $\geq 75\%$ cutoff threshold, to select patients for SLBRFA and SIJ fusion, respectively. The multisociety guidelines recommend a single block with $\geq 50\%$ cutoff before SLBRFA to maximize access to care and improve sensitivity and recommend dual IA blocks with “a higher threshold than 50% pain relief” to select patients for SIJ fusion, without designating what that threshold is. For SIJ fusion, all 24 voting societies concurred on the other selection criteria.

SLBRFA. The present review found that the lateral minimally-invasive surgical (MIS) approach to SIJ fusion can be considered in patients with refractory IA degeneration with instability who fail to respond to more conservative therapies (Grade C recommendation, very low level of certainty). Additionally, there is weak evidence that both an open approach to SIJ fusion and the MIS posterior approach can provide pain relief and functional benefit in carefully selected patients who have not responded to other therapies (Grade C recommendation, low level of certainty). Appropriate selection of patients for fusion includes the following criteria: (1) At least 6 months of non-radicular pain below L5, consistent with SIJ complex pain; (2) failure of at least 12 weeks of conservative care that may include PT, therapeutic exercise and medications, as well as nonsurgical interventions; (3) physical exam indicating positive response to at least 3/6 SIJ provocative tests; (4) history and radiologic studies that rule out other possible sources of pain, including generalized pain disorders, lumbar radiculopathy, hip pathology, autoimmune arthropathy, or destructive lesions such as tumor or infection; (5) at least 50% pain improvement following low-volume, dual comparative diagnostic SIJ injections without corticosteroid, under fluoroscopic or CT guidance.

Approval of participating organizations

All voting organizations endorsed or affirmed the guidelines except one; the American Academy of Neurology (AAN) declined to affirm the guidelines citing a lack of relevance to their membership. The American Society of Anesthesiologists (ASA), American Academy of Physical Medicine and Rehabilitation (AAPMR), and North American Spine Society (NASS) affirmed the benefit of the guidelines but did not formally approve them per their bylaws. Whereas the Departments of Defense and Veterans Affairs did not per policy formally review these non-federally sponsored guidelines for endorsement, their representatives approved them. Consensus was obtained on all 21 questions by all committee members, and 18 of 21 questions by the 24 voting organizations who formally endorsed or affirmed the benefit of the guidelines (see Table 23). On one question (stronger evidence for EA than IA injections), one society, the Latin American Society of Regional Anesthesia (LASRA) abstained, believing the evidence was not strong enough to render any recommendation. On 2 recommendations, there were dissensions from 3 participating societies that overlap in membership and leadership: NASS, the NASS Fellowship Consortium, and the International Pain and Spine Intervention Society (IPSIS). These organizations all dissented on the recommendation for $\geq 50\%$ cutoff from a single block to select patients for RFA (which prioritized access to care and enhancing sensitivity at the expense of specificity), instead advocating for $\geq 75\%$ pain relief after 2 SLBBs; for the designation of a positive outcome, all concurred. The second question that these three organizations dissented on was related to the first, with the guidelines recommending dual blocks without steroids and an unspecified threshold exceeding 50% with documented functional improvement to select patients for SIJ fusion (ie, no cutoff percentage designated). The 3 dissenting organizations believe that the percent pain relief required should equal or exceed 75%. On the other selection criteria for SIJ fusion, the organizations concurred.

Guideline context and limitations

As with many areas of medicine, not all clinical questions have been definitively answered; yet, patients, physicians, payers, and regulatory agencies need a structural framework to make decisions and create reasonable policies. The present guidelines provide a foundation for understanding evidence-based best practices in the diagnosis and treatment of SIJ complex pain, but they are also meant to be interpreted through the lens of reasonable judgment by physicians. Clinical practice guidelines are meant to allow for variations in practice, based on case-specific patient scenarios, as well as shared decision-making between the patient and physician. Whereas a “guideline-concordant” decision may be the best choice for one patient, this is not necessarily true for the next patient.

Some of our findings are limited in part by the lack of large high-quality studies, with several of the randomized trials evaluating invasive therapies being sponsored by industry, which are more likely to yield positive results.⁴¹¹ Differences in study design, selection criteria, outcome measures, follow-up, and technique amplify the issues surrounding low sample sizes and power inherent to interventional studies, and limit generalization. Although we included several societies with significant or predominant spine surgeon membership and one spine surgeon on our guidelines, their inclusion on these guidelines is underrepresented. We failed to include any physical therapists or physical therapy societies, which are also important stakeholders.

Conclusions

These international, multi-society clinical practice guidelines provide a framework for evidence-based best practices in the diagnosis and treatment of SIJ complex pain. These guidelines are meant to inform patients, physicians, payers, and regulatory agencies in arriving at clinical care decisions and in creating reasonable policy. The recommendations contained represent consensus amongst 27 different academies, societies, and other organizations (eg, U.S. Departments of Defense and Veteran Affairs) spanning much of North America, Europe, Latin America, Asia, and the South Pacific.

Supplementary material

[Supplementary material](#) is available at *Pain Medicine* online.

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Disclaimer

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Conflicts of interest

Z.L.M.: Research grants (not related to this work): Avanos Medical, Boston Scientific, Presidio Medical, Saol Therapeutics, Spine Biopharma, SPR Therapeutics, Stratus Medical (paid directly to the University of Utah); Consulting (not related to this work): Saol Therapeutics, Stryker, Avanos (all relationships ended 2025). R.W.H.: Cooperative (eg, U grants) NIH grants, NIH grants not related to this work; Nevro, Inc—research funds to the institution (topic—painful diabetic neuropathy) and not related to this work, and State Farm—expert/consulting not related to this work; Avanos Medical research funds to the institution (topic—SIJ Complex Pain) which ended 2023. M.A.: Consulting for Medtronic (self), Abbott (self), Boston Scientific (self); President Elect NANS; Medtronic (Institution for fellowship grants), Abbott (Institution for fellowship grant and research), Boston Scientific (Institution for fellowship grant and research). A.B.: No conflicts to report. A.B.: Honoraria for speaking and advising—Bioventus, Boston Scientific, Medtronic. R.C.C.: Consultant, Johnson & Johnson, 2023, course instructor. A.S.C.: Instructor (travel): International Pain and Spine Society, Instructor (travel): North American Spine Society, Educational Grant (to institution): Medtronic. T.C.D.: No conflicts to report. J.D.A.A.: No conflicts to report. J.L.d.C.: Consulting for Hospital Vera Cruz—Campinas-SP (34 years); Sobramid—Former President and now Director Board; Adora Clinic-Medical Director. S.M.H.: Ex-officio North American Neuromodulation Society. B.C. H.-P.: Vice President, Asociación Mexicana para el Estudio y Tratamiento del Dolor. N.R.K.: Consulting fees from Vertex Pharmaceuticals for unrelated topics; On Board of Directors for non-profit “Neuro Hospitality House” which provides affordable housing to patients receiving neurological cares. Institution receives research funding for unrelated topics from Shiratronics and NIH. L.R.K.: Consulting—FUS mobile (Institution). Vertex (Institution), Averitas (Institution), NIH (Institution); ASRA Pain Medicine BOD; AAPM BOD; SAAAPM BOD. M.F.E.L.B.: No conflicts to report. J.Y.M.: No disclosures to report. D.A.P.: Consulted for Avanos, Boston Scientific, Medtronic, SI Bone, and Wavegate; ASRA Board Of Directors; Pain Diagnostics and Interventional Care has received research support from Avanos, Boston Scientific, Brixton, and Medtronic. D.E.R.:—PainTEQ—Teaching Faculty (Absolute Pain Management)—No stocks/investments. Honoraria for teaching cadaver laboratory training and didactic for civilian physician practices. N.M.S.: Consulting for Averitas, Lohocla, Lundbeck, Salvia, Rapport, Schedule 1, Syneos, Syqe, Vertex (individual); Expert Testimony to various law firms and State of California (Individual and Institution); Board of Directors of American Academy of Pain Medicine (Individual); ShiraTronics (Clinical Trial, Institution). C.C.S.: Research support from Discogen. A.S.: Consulting for State Farm (individual) and Atlas Health (unpaid); PSIS BOD, Vice President (payment

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Pain Medicine, 2025, 26, 817–917

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