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A Systematic Review

A Systematic Review of Sacroiliac Joint Interventions

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Background: The sacroiliac joint is an accepted source of low back pain with or without associated lower extremity symptoms. The diagnosis and management of sacroiliac joint pain and the role of interventional techniques have been controversial.

Objective: To evaluate the clinical usefulness of sacroiliac joint interventions in the diagnosis and management of sacroiliac joint pain.

Study Design: A systematic review using the criteria as outlined by the Agency for Healthcare Research and Quality (AHRQ), Cochrane Review Group Criteria, and QUADAS criteria for diagnostic studies.

Methods: The databases of EMBASE and MEDLINE (1966 to November 2004), and Cochrane Review were searched. The searches included systematic reviews, narrative reviews, prospective and retrospective studies, and cross-references from articles reviewed. The search strategy included sacroiliac joint pain and dysfunction, sacroiliac joint injections, interventions, and radiofrequency.

Results: The results of this systematic evaluation showed that for diagnostic purposes, there is moderate evidence showing the accuracy of comparative, controlled local anesthetic blocks. Prevalence of sacroiliac joint pain was demonstrated to be 10% to 19% by a double block paradigm. The false-positive rate of single, uncontrolled, sacroiliac joint injections was reported as 20%.

For therapeutic purposes intraarticular sacroiliac joint injections with steroid and radiofrequency neurotomy were evaluated. Based on this review, there was moderate evidence for short-term and limited evidence for long-term relief with intraarticular sacroiliac joint injections. Evidence for radiofrequency neurotomy in managing sacroiliac joint pain was limited or inconclusive.

Conclusions: The evidence for the specificity and validity of diagnostic sacroiliac joint injections was moderate.

The evidence for therapeutic intraarticular sacroiliac joint injections was limited to moderate.

The evidence for radiofrequency neurotomy in managing chronic sacroiliac joint pain was limited.

Keywords: Low back pain, sacroiliac joint pain, axial pain, spinal pain, diagnostic block, and sacroiliac joint injection

Descriptions of the sacroiliac joint as a source of low back pain date back to the early 1900's. It was not until after 1934, when Mixter and Barr (1) described disc herniation as another source of pain in the lumbar spine, that it's prominence as a major source of back pain declined (2-4). Until recently, the evidence for the sacroiliac joint as a pain generator had been only empirical, derived from successful treatment of patients with sacroiliac joint pain with certain clinical symptoms and physical findings (5). The sacroiliac joint is unable to function in isolation; anatomically and biomechanically it shares all of its muscles with the hip joint. Ligamentous structures and the muscles they support affect much of the stability of the sacroiliac joint. These include the very strong interosseous ligaments as well as the iliolumbar, sacrotuberous and sacrospinous ligaments. The result is very limited motion of the sacroiliac joint under normal circumstances. The sacroiliac joint is also closely associated with the piriformis, gluteus, erector spinae, and quadratus lumborum muscles (4, 6). Sacroiliac joint pain may be the result of direct trauma, unidirectional pelvic shear, repetitive and torsional forces. Chou et al (7), after looking retrospectively at 54 patients with sacroiliac joint pain, found that trauma (44%) and cumulative or repetitive injury (21%) were inciting events for the development of sacroiliac joint pain and that 35% of patients had idiopathic or spontaneous onset of their pain. Of those with idiopathic or spontaneous etiologies for their sacroiliac joint pain, greater than 50% of patients had prior lumbar surgery.

The sacroiliac joint is a diarthrodial joint. The sacroiliac joint receives innervation from the lumbosacral nerve roots (8-13). Fortin et al (9), based on an anatomic study on adult cadavers, concluded that the sacroiliac joint is predominantly, if not entirely, innervated by sacral dorsal rami. Murata et al (8) illustrated that the sensory nerve fibers to the dorsal side of the sacroiliac joint were derived from the DRGs of the lower lumbar and sacral levels (from L4 to S2), and those to the ventral side from the DRGs of the upper lumbar, lower lumbar, and sacral levels (from L1 to S2). Vilensky et al (12) showed the presence of nerve fibers and mechanoreceptors in the sacroiliac ligament.

Referral patterns of sacroiliac joint provocation or irritation have been published. Fortin et al (14) successfully generated a pain referral map using provocative injections first of dye, then local anesthetic into the sacroiliac joint in 10 asymptomatic volunteers. Fortin et al (15) also evaluated the applicability of a pain referral map as a screening tool for sacroiliac joint dysfunction. In a retrospective study, Slipman et al (16) demonstrated sacroiliac joint pain referral zones. Schwarzer et al (17) found the only distinguishing pattern of the patients who responded to sacroiliac joint injections to be

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Table 1. *Domains and elements for diagnostic studies developed by the Agency for Healthcare Research and Quality (AHRQ)*

Domain[#]	Elements*
Study Population	• ***Subjects similar to populations in which the test would be used and with a similar spectrum of disease***
Adequate Description of Test	• ***Details of test and its administration sufficient to allow for replication of study***
Appropriate Reference Standard	• ***Appropriate reference standard ("gold standard") used for comparison***
Blinded Comparison of Test and Reference	• ***Independent, blind interpretation of test and reference***
Avoidance of Verification Bias	• ***Decision to perform reference standard not dependent on results of test under study***

[#] *Key domains are in italics* **Elements appearing in italics are those with an empirical basis.* **Elements appearing in bold are those considered essential to give a system a Yes rating for the domain.** Adapted from ref 39

groin pain ($p < 0.004$).

The rationale for the use of sacroiliac joint blocks as the tool for the diagnosis of sacroiliac joint pain is based upon the fact that sacroiliac joints are richly innervated and have been shown to be capable of being a source of low back pain and referred pain in the lower extremity (8-17). There are no absolute historical, physical, or radiological features to provide definitive diagnosis of sacroiliac joint pain (16-25). Nevertheless, Broadhurst and Bond (25) reported 77% to 87% sensitivity with three positive provocative sacroiliac joint maneuvers. Laslett et al (18) found that when patients had three or more positive provocative sacroiliac tests, they were 28 times more likely to have significant pain relief following a diagnostic sacroiliac joint injection. Patients with pain above the L5 spinous process are less likely to have pain originating from the sacroiliac joint (18, 19, 25). Thus, a corroborative history and physical examination can enter into the differential diagnosis of sacroiliac joint pain but cannot make a definitive diagnosis of sacroiliac joint syndrome (26, 27). In spite of reports of the efficacy of plain films (21, 28, 29), computed tomography (22), single photon emission computed tomography (30), bone scans (31, 32), nuclear imaging (33-36), and magnetic resonance imaging (37) in delineating radiographic sacroiliac joint abnormalities, there are no definitive corroborative radiologic findings identified thus far in patients with sacroiliac joint syndrome (5, 27). Associations have been made between a history of prior spinal surgery and sacroiliac joint pain. Katz et al (38) retrospectively evaluated low back pain patients who had prior lumbosacral fusion and found that 32% to 61% of those patients possibly had sacroiliac joint pain. Diagnostic blocks of a sacroiliac joint can be performed in order to determine that the sacroiliac joint is the source of the patient's pain. The sacroiliac joint can be anesthetized with intraarticular injection of local anesthetic performed under fluoroscopy with confirmation of dye spread throughout the joint space. Similarly, intraarticular injections with steroid and radiofrequency neurotomy have been employed to manage chronic sacroiliac joint pain as therapeutic interventional techniques. However, there has been no systematic evaluation of the evidence of diagnostic sacroiliac joint injections or therapeutic sacroiliac joint injections. Hence this systematic review was undertaken to assess the level of evidence for diagnostic sacroiliac joint blocks and therapeutic sacroiliac joint interventions involving intraarticular injections and radiofrequency neurotomy.

Table 2. *Items utilized for assessment of quality of individual articles of diagnostic studies by QUADAS tool*

Item	
1.	Was the spectrum of patients representative of the patients who will receive the test in practice?
2.	Were selection criteria clearly described?
3.	Is the reference standard likely to correctly classify the target condition?
4.	Is the time period between reference standard and index test short enough to be reasonably sure that the target condition did not change between the two tests?
5.	Did the whole sample or a random selection of the sample, receive verification using a reference standard of diagnosis?
6.	Did patients receive the same reference standard regardless of the index test result?
7.	Was the reference standard independent of the index test(i.e. the index test did not form part of the reference standard)?
8.	Was the execution of the index test described in sufficient detail to permit replication of the test?
9.	Was the execution of the reference standard described in sufficient detail to permit its replication?
10.	Were the index test results interpreted without knowledge of the results of the reference standard?
11.	Were the reference standard results interpreted without knowledge of the results of the index test?
12.	Were the same clinical data available when test results were interpreted as would be available when the test is used in practice?
13.	Were uninterpretable/intermediate test results reported?
14.	Were withdrawals from the study explained?

Adapted from ref 40

Search Strategy

The databases of EMBASE (1966 – November 2004), PubMed/MEDLINE (1966 to November 2004), and MD Consult were searched. A Cochrane Database search was performed. The searches included systematic reviews, narrative re-

Table 3. *AHRQ's key domains and elements for systems to rate quality of randomized controlled trials*

Domain*	Elements#
Study Question	• **Clearly focused and appropriate question**
Study Population	• **Description of study population**
	• **Specific inclusion and exclusion criteria**
	• Sample size justification
Randomization	• *Adequate approach to sequence generation*
	• ***Adequate concealment method used***
	• *Similarity of groups at baseline*
Blinding	• ***Double-blinding (e.g., of investigators, caregivers, subjects, assessors, and other key study personnel as appropriate) to treatment allocation***
Interventions	• **Intervention(s) clearly detailed for all study groups (e.g., dose, route, timing for drugs, and details sufficient for assessment and reproducibility for other types of interventions)**
	• Compliance with intervention
	• Equal treatment of groups except for intervention
Outcomes	• **Primary and secondary outcome measures specified**
	• Assessment method standard, valid, and reliable
Statistical Analysis	• ***Appropriate analytic techniques that address study withdrawals, loss to follow-up, missing data, and intention to treat***
	• Power calculation
	• Assessment of confounding
	• Assessment of heterogeneity, if applicable
Results	• **Measure of effect for outcomes and appropriate measure of precision**
	• Proportion of eligible subjects recruited into study and followed up at each assessment
Discussion	• **Conclusions supported by results with possible biases and limitations taken into consideration**
Funding or Sponsorship	• ***Type and sources of support for study***

*Key domains are in italics #Elements appearing in italics are those with an empirical basis. Elements appearing in bold are those considered essential to give a system a Yes rating for the domain. Adapted from ref 39

views, prospective and retrospective studies and cross-references from articles reviewed, the search strategy included sacroiliac joint pain and dysfunction, sacroiliac joint injections, and sacroiliac joint radiofrequency. One reviewer assessed the quality of the articles for inclusion. Three reviewers evaluated the studies. A list was generated of the abstracts reviewed. If there were no clear exclusion criteria within the abstract then the full article was reviewed. Those articles were then outlined for their study population, outcome and quality.

Inclusion Criteria

Types of studies

Study designs that used controlled and uncontrolled studies of sacroiliac joint injections were included.

Types of participants

Subjects with low back pain with or without leg pain for at least 3 months; participants had tried and failed conservative management; pain sufficient to be referred to a pain specialist/spinal injectionist for the diagnostic injection. Prior radiographic imaging excluding an anatomic cause for the patient's symptoms.

Types of interventions

Local anesthetic injections; placebo controlled injections; double injections with a screening lidocaine sacroiliac joint injection followed by a bupivacaine confirmatory injection; sacroiliac joint injections with local anesthetic and steroid; and radiofrequency neurotomy.

Types of Outcome measures

Pain relief was the main outcome measured. The pain relief had to be at least 50%.

Exclusion criteria

Types of studies

Case reports; descriptive reports

Types of participants

Participants with pain symptoms for < 3 months; sacroiliac joint injections performed on animals.

Types of interventions

Single injections; non-fluoroscopic /non-radiographically guided injections, surgical interventions (fusions, fixations)

Methodological Quality

Methodological quality of articles was assessed by the criteria established by AHRQ (39), criteria described for QUADAS (40), and Cochrane Review Group for randomized trials (41). The details of application of these criteria are illustrated in Tables 1 to 5. Inclusion and exclusion criteria were used as described elsewhere (42-44).

Table 4. *Methodologic quality criteria list (key items of internal validity) of Cochrane Musculoskeletal Review Group*

Patient selection
1. *Treatment allocation*
Was the method of randomization described and adequate?
Was the treatment allocation concealed?
2. *Were the groups similar at baseline regarding the most important prognostic indicators?*
Intervention
3. Was the care provider blinded?
4. Was controlled for co-interventions which could explain the results?
5. Was the compliance rate (in each group) unlikely to cause bias?
6. Was the patient blinded?
Outcome measurement
7. Was the outcome assessor blinded?
8. Was at least one of the primary outcome measures applied?
9. Was the withdrawal/drop-out rate unlikely to cause bias?
Statistics
10. Did the analysis include an intention-to-treat analysis?

Adapted from ref 41

Table 5. *AHRQ's key domains and elements for systems to rate quality of observational studies*

Domain*	Elements#
Study Question	• **Clearly focused and appropriate question**
Study Population	• **Description of study populations**
Comparability of Subjects†	• *Use of concurrent controls*
Exposure or Intervention	• **Clear definition of exposure**
	• Measurement method standard, valid and reliable
	• Exposure measured equally in all study groups
Outcome Measurement	• **Primary/secondary outcomes clearly defined**
Statistical Analysis	• **Assessment of confounding factors**
Results	• **Measure of effect for outcomes and appropriate measure of precision**
Discussion	• **Conclusions supported by results with possible biases and limitations taken into consideration**
Funding or Sponsorship	• ***Type and sources of support for study***

** Key domains are in italics*

#Elements appearing in italics are those with an empirical basis. Elements appearing in bold are those considered essential to give a system a Yes rating for the domain. For purposes of this systematic review, the bold elements were considered, and to be included studies needed to have at least 5 of the 8 essential elements.

†Domain for which a Yes rating required that a majority of elements be considered.

Adapted from ref 39

Analysis of Evidence

Qualitative analysis was conducted using five levels of evidence as shown in Table 6.

For therapeutic intraarticular injections the primary outcome measure was pain relief. Other outcome measures utilized were functional improvement, psychological improvement and return to work. For therapeutic interventions with intraarticular injections short-term relief was defined as less than 6 weeks, and long-term relief was defined as 6 weeks or longer. In contrast, for radiofrequency neurotomy, short-term relief was defined as less than 3 months and long-term relief was defined as 3 months or longer.

For diagnostic interventions placebo controlled or comparative, controlled local anesthetic blocks were considered as satisfactory criteria. The criterion of pain relief was considered as appropriate as described by individual authors.

A study was judged to be positive if the authors concluded that it was positive. If the authors concluded a study as negative, and there was a preponderance of evidence showing the positive nature of the study the conclusion was altered for the purposes of analysis of evidence.

Results

Diagnostic Sacroiliac Joint Injections

The database search produced 104 article abstracts for review for diagnostic interventions. Of these, 5 articles were reviewed (17, 18, 28, 45, 46). However, 2 were excluded because they were only single injection studies (17, 45). The remaining 3 were chosen for the study. All 3 studies were performed under fluoroscopic guidance and employed a comparative, controlled local anesthetic technique. All 3 used a screening lidocaine injection followed by a confirmatory bupivacaine injection of those who had a positive response. Laslett et al (18), however, used steroid after the lidocaine injection. The study was included for review as it was followed by a bupivacaine injection and those patients who had prolonged pain relief following the steroid were excluded from the study. The only randomized study was the one by Manchikanti et al (46). All patients who were selected for the double block had low back pain and all had positive provocative maneuvers to the sacroiliac joint. In none of these studies was a single provocative maneuver diagnostic for sacroiliac joint pain. In these studies, sacroiliac joint pain was seen in 2% to 18% of the patients evaluated (18, 28, 46). Description of included studies along with methodologic quality criteria are illustrated in Table 7.

Maigne et al (28) studied 67 patients who had chronic ($\geq$ 50 days) unilateral low back pain (VAS $\geq$4) with or without radiation to the posterior thigh with associated pain and tenderness over the posterior sacroiliac joint. The block was successful in 54 patients. Double injections were performed with a screening diagnostic lidocaine injection (2 ml) performed first. Relief of $\geq$ 75% relief was considered a positive result. Nineteen of 54 patients had $\geq$ 75% relief from the screening block

Table 6. *Designation of levels of evidence*

Level I	Conclusive: Research-based evidence with multiple relevant and high-quality scientific studies or consistent reviews of meta-analyses
Level II	Strong: Research-based evidence from at least one properly designed randomized, controlled trial; or research-based evidence from multiple properly designed studies of smaller size; or multiple low quality trials.
Level III	Moderate: a) Evidence obtained from well-designed pseudorandomized controlled trials (alternate allocation or some other method); b) evidence obtained from comparative studies with concurrent controls and allocation not randomized (cohort studies, case-controlled studies, or interrupted time series with a control group); c) evidence obtained from comparative studies with historical control, two or more single-arm studies, or interrupted time series without a parallel control group.
Level IV	Limited: Evidence from well-designed nonexperimental studies from more than one center or research group; or conflicting evidence with inconsistent findings in multiple trials
Level V	Indeterminate: Opinions of respected authorities, based on clinical evidence, descriptive studies, or reports of expert committees.

Adapted from ref 43, 44

and 10 of 19 participants had ≥ 75% improvement from the confirmatory block. Of the 54, 10 or 18.5% were considered to have sacroiliac joint pain. As only patients with a high likelihood of sacroiliac joint pain were included in the study, no determination of the prevalence of sacroiliac joint pain can be made.

Manchikanti et al (46) evaluated 120 patients that presented to the pain clinic with low back pain for ≥ 6 months. All of the participants initially had facet blocks and were negative for facet joint pain. Patients without facet joint pain, but with suspected sacroiliac joint involvement (pain in the sacral region, sacroiliac joint tenderness and positive provocative maneuvers) had a sacroiliac joint injection. They had screening sacroiliac joint injections with 2% lidocaine followed in 3 to 4 weeks by confirmatory bupivacaine blocks. Twenty of 120 patients had sacroiliac joint injections and 6 of 20 patients had a positive response to the screening

Table 7. *Characteristics of reported prospective diagnostic studies*

Study	Participants	Objective(s)	Intervention(s)	Result(s)
Maigne et al (28) AHRQ Score 3/5 QUADAS Score 10/14	77 patients aged 18-75 attending a public hospital with chronic unilateral LBP with or without radiation to the posterior thigh for > 50 days (median 4.2 months). Patients had failed epidural or lumbar facet injections.	Determine the prevalence of sacroiliac joint pain in a selected population of patients with low back pain and assess certain pain provocation tests.	Successful blockade of the sacroiliac joint in 54 patients. A screening block was done with 2% lidocaine and a confirmatory block was performed with bupivacaine 0.5% ≥ 75% relief was considered a positive block.	19/54 patients had > 75% relief with lidocaine. 10/19 patients had relief with confirmatory bupivacaine and were considered to have SIJ pain. There was no statistically significant association between response to blocks and any single clinical parameter. No pain provocation test predicted SIJ pain.
Manchikanti et al (46) AHRQ Score 4/5 QUADAS Score 11/14	120 patients (age 18-90) presenting to the clinic with > 6 months of low back pain and no structural basis for the pain by radiographic imaging. Patients who failed facet blocks, had SIJ tenderness, and positive provocative maneuvers had an SIJ injection.	Determine the frequency of various structures responsible for low back pain.	All patients had facet blocks. Nonresponders who fit criteria had double injection SIJ blocks. The screening block was done with 2% lidocaine and the confirmatory block was performed using 0.5% bupivacaine.	20 patients had clinical diagnosis of SIJ pain. 6/20 had ≥ 75% relief from the lidocaine blocks. 2/6 had ≥ 75% relief from the bupivacaine blocks. The incidence of SIJ pain was 2% of the overall sample and 10% of those suspected to have SIJ pain. The false positive rate was 22%.
Laslett et al (18) AHRQ Score 5/5 QUADAS Score 12/14	62 patients with buttock pain with or w/o LE involvement referred for diagnostic injections. Patients failed prior interventions and had prior imaging studies.	Comparison of SIJ provocative tests and reasoning process using McKenzie evaluation with SIJ double injections.	48 patients had SIJ diagnostic injection with Lidocaine. After symptom reproduction steroid was added. 16 patients had pain relief. 5 remained pain free and 11 had confirmatory blocks and all were positive.	There was a 91% sensitivity and 78% specificity when double SI Joint injection was compared to ≥3 SI Joint pain provocation tests and clinical reasoning.

block. Of those 6 patients, 2 had a positive response to the confirmatory bupivacaine block resulting in a 2% prevalence of sacroiliac joint pain. A definite or positive response was defined as ≥ 80% relief of pain.

Laslett et al (18) sought to validate a specific clinical examination and reasoning to diagnose sacroiliac joint pain by confirming the diagnosis by diagnostic injections. They evaluated 62 patients who presented to the clinic with buttock pain with or without lower extremity pain for diagnostic injections. Patients with pain above L5 and those with midline or symmetric pain were excluded. The patients had a clinical examination by a physical therapist who was blinded to the imaging studies. A radiologist who was blinded to the results of the clinical examination performed double sacroiliac joint injections. The screening sacroiliac joint injection performed with lidocaine (< 1.5 mL) was considered a positive injection if the injection provoked familiar pain and resulted in ≥ 80% pain relief. Once the injection recreated the patient's familiar pain, steroid was then injected into the joint. Forty-eight patients had the screening lidocaine injection. Sixteen of 48 had ≥ 80% pain relief. Of those, 5 remained pain free and were then excluded. Eleven patients went on to have the confirmatory bupivacaine injections, all of them were positive. Of note, 10 of 11 sacroiliac joint injections met the clinical examination criteria for having sacroiliac joint pain and the diagnostic accuracy of the clinical examination and clinical reasoning process was found to be superior to the sacroiliac joint pain provocation tests alone. The steroid added to the screening aspect of this study makes it more difficult to interpret. In addition, the patients studied were not consecutive; consequently, this study was subject to verification bias. Thus, 10 of 62 (16%) patients studied had sacroiliac joint pain as defined by pain relief following a double local anesthetic injection.

Accuracy

Sacroiliac joint blocks have been shown to have face validity. Low volumes of local anesthetic selectively injected into the target joint after dye verification of the needle position may anesthetize the joint. Appropriate precautions need to be observed to ensure there is no extravasation to adjacent structures (62).

Sacroiliac joint blocks also have been shown to have construct validity. However, to have construct validity, sacroiliac joint blocks must be controlled. Single diagnostic blocks carry a false-positive rate of 20% (28). Patients are liable to report relief of pain after diagnostic block for reasons other than the pharmacological action of drug administration (47). Consequently, it is imperative to know in every individual case whether the response is a true positive. The validity of controlled comparative local anesthetic blocks for facet joint diagnostic blocks was confirmed with placebo controlled diagnostic blocks (47, 48).

False positive rate of diagnostic sacroiliac joint injection was evaluated in two groups of patients, with a false positive rate of 20% (28) and 22% (46). It is also possible to have extravasation of the local anesthetic if care is not taken to avoid spill over into adjacent structures (62).

Prevalence

This review led to inclusion of two studies (28, 46) utilizing controlled local anesthetic blocks.

Schwarzer et al (17) utilized a single local anesthetic block. Thus, the value of this evaluation is unknown. Pang et al (45) also utilized single block with a prevalence report of 10% of chronic low back pain patients. Laslett (18) used a double block paradigm but confused the data by following the lidocaine injection with steroid, which made the blocks more therapeutic in nature. Indeed 5 patients remained pain free throughout the study and had to be eliminated. Maigne et al (28), even though utilizing a double block paradigm that validated the diagnostic ability of the test with false-positive rates, failed to provide the prevalence rate in chronic spinal pain populations, as it was performed in a select group of patients with suspicion of sacroiliac joint pain. Finally, Manchikanti et al (46) showed a low prevalence of sacroiliac joint pain with a double block paradigm. The study was performed in patients suffering with low back pain and negative for other sources of pain.

Even though short-term relief from sacroiliac joint injection is considered as a gold standard for the diagnosis of sacroiliac joint pain, there was no blinded comparison of the test or reference standard in evaluation of these investigations .

Level of Evidence

Based on the present evaluation of three controlled trials (18, 28, 46), the evidence for sacroiliac joint diagnostic blocks in diagnosing pain of sacroiliac joint originwas moderate.

Therapeutic Sacroiliac Joint Interventions

Sacroiliac joint pain may be managed by intraarticular injections, or neurolysis of sacroiliac joint innervation.

Intraarticular Blocks

Our search criteria yielded 28 reports describing the effectiveness of these interventions. From these, 6 relevant evaluations were selected for review and evidence synthesis (49-54). Of these, two studies were randomized (49, 50), 3 were prospective evaluations (51-53), and one was a retrospective evaluation (54).

Methodological Quality

Of the two randomized trials selected for review, one study (49) was excluded due to lack of long-term follow-up (1 month), and injection was periarticular. Consequently only one randomized trial (50) was available for review. Among the 3 prospective evaluations (51-53), one evaluation (51) was excluded as it failed to meet inclusion criteria with evaluation of short-term relief. The second evaluation was in the German language (52). Consequently, only one study (53) was included in the evidence synthesis. However, both prospective studies (50, 53) evaluated spondyloarthropathy. Since there were no other studies [except one retrospective study (54)] evaluating non-inflammatory sacroiliac joint pain, it was decided to include these two studies. Further, the only study evaluating non-inflammatory sacroiliac joint pain (54) was included, even though they studied some patients with pain of 6 weeks duration.

One retrospective evaluation (54) was included. These studies are listed in Table 8.

Study Characteristics

The characteristics of reported studies are listed in Table 8.

Maugars et al (50) performed a double-blind study in 10 patients; 13 articulations, suffering with painful sacroiliitis. Six sacroiliac joints were injected with steroid and 7 were placebo injections. At 1 month, 5/6 sacroiliac joints were inject-

Table 8. *Study characteristics of included reports of therapeutic intraarticular sacroiliac joint injections*

Study	Participants	Objective(s)	Intervention(s)	Outcome(s)	Results Short-term relief < 6 weeks Long-term relief ≥ 6 weeks
Maugars et al (50) Randomized, controlled trial AHRQ Score 6/10 Cochrane Score 6/10	10 patients/13 articulations with painful sacroiliitis.	To assess the effectiveness of sacroiliac corticosteroid injections in spondyloarthropathy.	Sacroiliac joint injection with steroids or placebo.	86% of patients had a good result at 1 month, 62% at 3 months, and 58% at 6 months.	Positive short-term and long-term
Hanly et al (53) Prospective evaluation AHRQ Score 5/8	19 patients with symptoms of LBP were studied. 13 had radiographic evidence of sacroiliitis. The remaining 6 patients had normal imaging studies and thus were considered to have mechanical low back pain.	To evaluate changes in articular symptoms, spinal mobility, and global function over 6 months after intraarticular injections of long acting corticosteroid into the sacroiliac (SI) joints of patients with inflammatory low back pain.	All patients received bilateral SI joint injections of triamcinolone hexacetonide (40 mg/joint) under computer tomographic guidance.	Both groups of patients showed a transient improvement in stiffness and pain, spinal mobility, and general health status that was most pronounced at 1-3 months after intraarticular therapy. This did not reach statistical significance ($p > 0.05$) and by 6 months followup all outcome variables had reverted to pretherapy levels in both groups.	Positive - short term Negative - long term
Slipman et al (54) Retrospective evaluation AHRQ Score 6/8	31 patients were included; each patient met specific physical examination criteria and failed to improve clinically after at least 4 wk of physical therapy. Each patient demonstrated a positive response to a fluoroscopically guided diagnostic sacroiliac joint injection.	To investigate the outcomes resulting from the use of fluoroscopically guided therapeutic sacroiliac joint injections in patients with sacroiliac joint syndrome.	Therapeutic sacroiliac joint injections were administered in conjunction with physical therapy.	Patients' symptom duration before diagnostic injection averaged 20.6 mo. An average of 2.1 therapeutic injections was administered. Follow-up data collection was obtained at an average of 94.4 wk. A significant reduction ($P = 0.0014$) in Oswestry disability score was observed at the time of follow-up. VAS pain scores were reduced ($P < 0.0001$) at the time of discharge and at follow-up. Work status was also significantly improved at the time of discharge ($P = 0.0313$) and at follow-up ($P = 0.0010$). A trend ($P = 0.0645$) toward less drug usage was observed.	Positive short-term and long-term

ed with corticosteroid, (in comparison to 0/7 of the placebo group), described a relief of ≥ 70%, ($P < 0.05$). Six out of the seven sacroiliac joints of the placebo group and 2 patients from the corticosteroid group who either failed the first injection or whose pain returned, were reinjected with corticosteroid. At 1 month, 12/14 (85.7%) had good results and patients were still significantly better at 3 months (62%) and 6 months (58%).

Hanly et al (53) studied changes in articular symptoms, spinal mobility, and global function over 6 months after intraarticular injections of long acting corticosteroid into the sacroiliac joints of 19 patients with low back pain. Thirteen (68%) had radiographic evidence of sacroiliitis and were considered to have inflammatory low back pain, 6 patients (32%) had normal imaging studies and thus were considered to have mechanical low back pain. All patients received bilateral SI joint injections of triamcinolone hexacetonide (40 mg/joint) under computer tomographic guidance. Outcome variables included the duration of low back morning stiffness back pain (by visual analog scale, McGill Pain Questionnaire), spinal mobility (chest expansion, Schober test, 10 cm segments test, finger-fibula distance), and self-report health status (SF-36). The resulting improvement in stiffness and pain as well as improved spinal mobility were transient and were most pronounced at 1-3 months after the injections. This did not reach statistical significance ($p \geq 0.05$) and by 6 months follow-up all outcome variables had reverted to pretherapy levels in both groups. Based on these preliminary observations, SI corticosteroid injections were considered to be ineffective in the management of patients with inflammatory spondyloarthropathy.

Slipman et al (54), in a retrospective evaluation with independent clinic review, evaluated the use of fluoroscopically guided therapeutic sacroiliac joint injections in patients with sacroiliac joint syndrome. The symptom duration of this patient population was as early as 1.5 months prior to inclusion in the study with an average symptom duration of 20.6 months. They reported a significant reduction ($P = 0.0014$) in Oswestry disability scores at the time of follow-

up. Visual Analog Scale pain scores were reduced ($P < 0.0001$) at the time of discharge and at follow-up. Work status was also significantly improved at the time of discharge ($P = 0.0313$) and at follow-up ($P = 0.0010$). A trend ($P = 0.0645$) toward less drug usage was observed. They concluded that fluoroscopically guided therapeutic sacroiliac joint injections are a clinically effective intervention in the treatment of patients with sacroiliac joint syndrome.

Evidence Synthesis

The present systematic review included one randomized trial (50), one prospective trial (53), and one retrospective evaluation (54). The randomized trial (50) showed positive results both for short-term and long-term. The prospective trial (53) showed positive short-term and negative long-term results in spondyloarthropathy. The retrospective evaluation showed positive results. Thus it was concluded that evidence for intraarticular sacroiliac joint injections was moderate for short-term relief and limited for long-term relief.

Radiofrequency Neurotomy

Percutaneous radiofrequency neurotomy of sacroiliac joint innervation has been described to provide long-term relief. Our literature search yielded 46 reports. There were 4 relevant reports available for review (55-58). Of these, one (55) was prospective, and 3 were retrospective (56-58).

Methodological Quality

The one and only available prospective evaluation (55) was of 3-month follow-up. Consequently, it failed to meet inclusion criteria. All of the three retrospective reports (56-58) met inclusion criteria (Table 9).

Study Characteristics

Ferrante et al (56), in a retrospective report, published the results of a consecutive series of 50 sacroiliac joint radiofrequency denervations performed in 33 patients with sacroiliac joint syndrome. All patients underwent diagnostic sacroiliac joint injections with local anesthetic before denervation. Outcome parameters included changes in visual analog pain scores, pain diagrams, physician examination including tenderness overlying the joint, SI joint pain provocation test, and range of motion of the lumbar spine, and opioid use pre- and post denervation. The defined criteria for successful radio-

Table 9. *Description of studies evaluating radiofrequency neurotomy of sacroiliac joint*

Study	Participants	Objective(s)	Intervention(s)	Outcome(s)	Result(s) Short-term relief < 3 months Long-term relief ≥ 3 months
Ferrante et al (56) AHRQ Score 4/8	33 patients with sacroiliac syndrome.	Radiofrequency (RF) denervation of the sacroiliac (SI) joint has been advocated for the treatment of sacroiliac syndrome, yet no clinical studies or case series support its use.	All patients underwent diagnostic SI joint injections with local anesthetic before denervation.	The criteria for successful RF denervation were at least a 50% decrease in VAS for a period of at least 6 months; 36.4% of patients (12 of 33) met these criteria. Failure of denervation correlated with the presence of disability determination and pain on lateral flexion to the affected side. The average duration of pain relief was 12.0 +/- 1.2 months in responders versus 0.9 +/- 0.2 months in nonresponders ($P <$ or $= 0.0001$).	Negative short-term and long-term
Yin et al (57) AHRQ Score 4/8	14 patients met inclusion criteria for this retrospective study.	To examine the effectiveness of sensory stimulation-guided radiofrequency neurotomy for the treatment of recalcitrant sacroiliac joint pain.	Sensory stimulation-guided sacral lateral branch radiofrequency neurotomy after dual analgesic sacroiliac joint deep interosseous ligament analgesic testing.	Sixty-four percent of patients experienced a successful outcome, with 36% experiencing complete relief. Fourteen percent of patients did not achieve any improvement.	Positive short-term and long-term
Cohen and Abdi (58) AHRQ Score 4/8	9 patients who experienced >50% pain relief underwent RF lesioning of the nerves.	The purpose of this study was to determine the efficacy of reducing SI joint pain by percutaneous RF lesioning of the nerves innervating the SI joint	Nerve blocks of the L4-5 primary dorsal rami and S1-3 lateral branches innervating the affected joint. RF lesioning of the nerves.	13 of 18 patients who underwent L4-5 dorsal rami and S1-3 lateral branch blocks (LBB) obtained significant pain relief, with 2 patients reporting prolonged benefit. At their next visit, 9 patients who experienced >50% pain relief underwent RF lesioning of the nerves. Eight of 9 patients (89%) obtained >/=50% pain relief from this procedure that persisted at their 9-month follow-up.	Positive short-term and long-term

frequency denervation was at least a 50% decrease in VAS for a period of at least 6 months. The results showed that 12 of 33 patients or 36% of the patients met the criteria for successful denervation. The average duration of pain relief was 12.0 $\pm$ 1.2 months in responders versus 0.9 $\pm$ 0.2 months in non-responders ($P \leq .0001$). They also noted that a positive response was associated with an atraumatic inciting event. They concluded that radiofrequency denervation of the sacroiliac joint can significantly reduce pain in selected patients with sacroiliac joint syndrome for a protracted time. With a 6-month response of only 36% of the patients this study is judged as negative by the authors of this review.

Yin et al (57), in a retrospective audit and examination of anatomic findings as well as the effectiveness of sensory stimulation-guided radiofrequency neurotomy for the treatment of recalcitrant sacroiliac joint pain, studied 14 patients. They defined success as greater than 60% consistent subjective relief and greater than a 50% consistent decrease in pain score maintained for at least 6 months after the procedure. They reported that 64% of the patients experienced a successful outcome with 36% experiencing complete relief. The authors concluded that a sensory stimulation-guided approach toward the identification and subsequent radiofrequency thermocoagulation of symptomatic sacral lateral branch nerves appears to offer significant therapeutic advantages over existing therapies for the treatment of chronic sacroiliac joint complex pain. Even though this study included only 14 patients that met the inclusion criteria, the authors of the study as well as authors of this systematic review considered this study positive.

Cohen and Abdi (58) performed radiofrequency lesioning on 9 patients who experienced greater than 50% pain relief following nerve blocks of the L4-5 primary dorsal rami and S1-3 lateral branches innervating the affected joint. Eight of 9 patients (89%) obtained 50% or greater pain relief from this procedure that persisted at their 9-month follow-up. The authors concluded that in patients with sacroiliac joint pain who respond to L4-L5 dorsal rami and S1-3 lateral branch blocks, radiofrequency denervation of these nerves appears to be an effective treatment. The authors of this study and the authors of this systematic review considered this retrospective evaluation as positive.

Evidence Synthesis

Based on the available literature, which consisted of 3 retrospective evaluations with small numbers of patients, the evidence for radiofrequency neurotomy in managing chronic sacroiliac joint pain was limited.

Safety and Complications

No complications have been reported in any of the studies included in this review. However, potential complications include infection, hematoma formation, neural damage, trauma to the sciatic nerve, gas and vascular particulate embolism, leakage of the drug from the joint, and other complications related to drug administration. Without fluoroscopy, successful joint injection is documented in only 12% to 22% of the cases (59). Rosenberg, et al (59) also showed that there was epidural spread in 24% of the patients and contrast was noted in the sacral foramen in 44% of the patients. Others (60) also have shown low rate of accurate placement of the needle into the joint without fluoroscopy.

Discussion

This systematic evaluation of diagnostic and therapeutic interventions of the sacroiliac joint showed moderate evidence of accuracy of diagnostic sacroiliac joint blocks with a prevalence of 10% to 19% and a false positive rate of 20 to 22%. This evaluation also showed limited evidence for the therapeutic effectiveness of intraarticular injections and radiofrequency neurotomy in managing sacroiliac joint pain.

The results of this systematic evaluation are similar to previous reports assessing the value and validity of sacroiliac joint injections (43). However, there were no reports of systematic reviews of sacroiliac joint injections. As expected, the literature on diagnostic and therapeutic interventions of the sacroiliac joint is scarce. However the literature on diagnostic sacroiliac joint injections is superior to the literature on therapeutic interventions. Due to the lack of significant literature, the level of evidence was low, even with inclusion of studies of spondyloarthropathies. The relationship of sacroiliac joint pain and its management with and without inflammatory arthropathy is not known. Consequently, it is imperative that previous studies are replicated and high quality evidence produced.

There is no doubt that sacroiliac joints are innervated and are capable of producing low back and referred pain in the lower extremity (8-17). Diagnostic criteria for sacroiliac joint syndrome as defined by the International Association for the Study of Pain (IASP) (21) included pain in the region of the sacroiliac joint with possible radiation to the groin, medial buttocks and posterior thigh; reproduction of pain by physical examination techniques that stress the joint; elimination of pain with intraarticular injection of local anesthetic; and a morphologically normal joint with demonstrable pathognomic radiographic abnormalities. Of this criterion, pain referral patterns have been well described (14-17). However, with regards to the second criterion, the reproduction of pain by physical examination techniques that stress the joint, positive correlations have been reported by some (18, 24, 25), while others have refuted these criterion (17, 19, 20, 26-28). The third criterion, described by IASP as elimination of pain with intraarticular injection of local anesthetic, was demonstrated in multiple evaluations (17, 18, 28, 45, 46). Finally, the last criterion describing a morphologically normal joint without demonstrable radiographic abnormalities or lack of correlation of radiographic abnormalities also has been illustrated (3-5, 22, 23, 29-37, 40). Historically, in the early 1900's, Goldthwait first proposed the sacroiliac joint (2) and facet joints (61) to be potential pain generators. After 100 years, these early propositions have been proven.

The strength of our systematic review is based on its compliance with strict criteria for evaluation of diagnostic tests as established by AHRQ (39), and QUADAS (40). The criteria for therapeutic management also included AHRQ criteria for observational studies. We also applied Cochrane review criteria for one randomized trial. The inability of a physician to provide appropriate and accurate diagnosis for a patient with chronic spinal pain including that of sacroiliac joint pain continues to be frustrating. Even though, some of the recent literature suggests that sacroiliac joint pain can be diagnosed based on provocative maneuvers (18, 25, 26), the authors of this systematic review find this to be far from a reali-

ty. Further studies are required to prove this assertion.

Conclusion

This systematic review showed moderate evidence for the accuracy of diagnostic sacroiliac joint injections in the diagnosis of sacroiliac joint pain. This systematic review also showed moderate evidence for therapeutic intraarticular sacroiliac joint injections and limited evidence for radiofrequency neurotomy in managing chronic sacroiliac joint pain.

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