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An Overview on Management Options of Sacroiliac Joint Pain

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Abstract

The sacroiliac (SI) joint is among the most common sources of chronic low back pain, accounting for 15%–30% of patients presenting chronic low back pain. The differential diagnosis of SIj region pain includes pain generated from the lumbar spine, the SIj, and the hip joint. The origins of SIj dysfunctions are controversial and pain generation from this joint has been questioned. The complex anatomic structures, nerve innervation, and functional bio mechanisms of the SI region make it challenging to diagnose and treat the SI joint as a pain source. In addition to physical therapy and medication for treating SI joint pain, multiple interventional measures including steroid injection, radiofrequency ablation, prolotherapy, and SI joint fusion have been proposed with various efficacies. This article describes the etiology, risk factors, and diagnostic methods as well as different treatment modalities, focusing on interventional pain management options for patients suffering from SI joint pain.

Keywords: Sacroiliac joint, Pain, Radiofrequency.

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1. Introduction

Optimal treatment of SI joint pain consists of an interdisciplinary approach and should include conservative (pharmacological treatment, cognitive-behavioral therapy, manual medicine, exercise therapy, and rehabilitation treatment, and if necessary, psychological evaluation and management) as well as interventional pain management techniques [1]. Physical therapies primarily address the underlying cause. In SI joint pain attributed to postural and gait disturbances, targeted exercise therapy and manipulation can reduce pain and improve mobility. There are numerous randomized trials showing efficacy for muscle relaxants, non-steroidal anti-inflammatory drugs, and antidepressants for back pain, but none have specifically addressed individuals with SI joint involvement. Although anecdotal evidence supports spinal manipulation, one study found that individuals with positive SI joint provocation tests did not fare better than other patients with chronic low back pain [2].

In patients with true leg length discrepancies, partial correction with shoe inserts may provide benefit. One randomized study, performed to evaluate whether radiofrequency denervation added to a standardized exercise program and psychological support if indicated is more effective than only standardized exercise and psychological support alone, showed a statistically significant but clinically questionable improvement in pain intensity 3 months after the intervention for the SI joint treatment arm [3]. Ankylosing spondylitis (M. Bechterew) is an inflammatory rheumatological disorder that affects the vertebral column and the SI joint. Controlled studies have demonstrated analgesic efficacy for immuno modulating agents in ankylosing spondylitis and other spondylarthropathies. However, no conclusions can be drawn with respect to their specific efficacy for SI joint pain [4].

2. Interventional management

Patients with SI joint pain resistant to conservative treatment are eligible for interventional management such as intra- and peri-articular injections or radiofrequency ablation (RFA) treatment [1].

- Corticosteroid injections
- Intra-articular injections

Randomized controlled trials evaluating intra-articular injections report good pain relief for up to 6 months. Maugars et al. treated 13 SI joints in 10 patients: 6 joints with intra-articular corticosteroids, and seven joints with physiological saline solution. After 1 month, pain reduction of >70% was noted for five of the six SI joints treated with corticosteroid, whereas no benefit was noted in the placebo group. Subsequently, all control group patients and two in the treatment group who had short-term pain relief received a repeat injection with corticosteroid. After 1, 3, and 6 months, significant pain reduction was observed in 86%, 62%, and 58% of patients, respectively [5]. In a study by Visser et al. Fifty-one patients with SI joint-related leg pain were randomized to treatment with intra-articular corticosteroid injections ($N = 18$), physiotherapy ($N = 15$), or manual therapy ($N = 18$). The effect of the treatment was evaluated after 6 and 12 weeks. Overall, 56% experienced a successful treatment, with physiotherapy achieving success in 20% of 15 patients, manual therapy resulting in a 72% success rate in 18

patients, and intra-articular injection yielding a positive outcome in 50% of 18 patients. However, in those treated with steroid injections, only 28% ($N = 5$) of patients experienced clinically relevant pain relief after 12 weeks [6]. Chen et al. compared intra-articular SI joint platelet-rich plasma (PRP) injections with intra-articular corticosteroids. Although pain scores decreased over time for both the corticosteroid and PRP groups, the corticosteroid group showed statistically significantly greater improvements in pain than did the PRP group during the 6-month follow-up. At 1 month, 80%, of participants in the corticosteroid group reported ≥50% pain relief, and 70% at 3-month follow-up [7].

2.1. Extra-articular and combination injections

There is similar, if not stronger evidence supporting peri-articular corticosteroid infiltrations. Luukkainen et al. randomized 24 patients to receive either peri-articular corticosteroid with local anesthetic ($n = 13$) or local anesthetic and saline ($n = 11$). One month after the intervention, VAS pain scores decreased significantly in the corticosteroid group compared to the control patients [8]. In an earlier double-blind study, Luukkainen and colleagues demonstrated superiority of periarticular SI joint injections to saline 2-month post-injection in 20 patients with spondyloarthropathy [9]. In a large, double-blind comparative-effectiveness study comparing landmark-guided to fluoroscopically guided intra-articular injections, Cohen et al. reported comparable benefit between subjects with intra-articular and extra-articular spread at 1-month, though on some outcome measures individuals in whom intra-articular spread was noted fared better at 3 months.

In this study, only 8% of landmark-guided injections were intra-articular [10]. There have been several non-randomized trials comparing intra-articular to peri-articular injections. In an observational study performed in 50 patients, reported superiority for peri-articular lidocaine injections compared to intra-articular injections immediately post-procedure. A quasi-randomized study (via laterality) performed in 96 patients reported superiority for peri-articular over intra-articular injections through 3-month follow-up. Two studies that included one small observational study and a retrospective analysis, reported comparable benefit for SI joint injections administered within and outside of the joint cavity. Other studies showed superiority for combination intra- and extra-articular SI joint injections with corticosteroid and local anesthetic compared to intra-articular injections alone [11].

2.2. Radiofrequency ablation (RFA) treatment of the SI joint

The efficacy of RFA treatments of the SI joint is demonstrated by numerous observational, retrospective, and randomized controlled studies. However, the selection criteria, definitions of success, RFA techniques (conventional monopolar, bipolar, multielectrode combination mono- and bipolar, and monopolar cooled), and parameters (ie, temperature, duration, and location of RFA treatment), and imaging techniques (fluoroscopy, CT, ultrasound) have varied widely between studies [12].

2.3. Radiofrequency treatment technique of the SI joint

- RF treatment of the SI joint is performed with fluoroscopic imaging after a positive diagnostic/prognostic block. The patient may be lightly sedated. The C-arm is positioned in a similar fashion to that for lateral branch blocks, with the same considerations for the nerves targeted. For S1, slight ipsilateral oblique angulation can often increase visualization of the posterior foramen.
- Larger gauge electrodes associated with increased capture rates, which is important given the variability in the location of lateral branches. Although sensory electro stimulation at 50 Hz is often performed, because there may be up to four lateral branches converging on the sacral foramina, many physicians forego sensory stimulation and opt for an extensive lesioning strategy seeks to encompass entire lateral margin of foraminal opening, as injecting local anesthetic before lesioning at one area may prevent stimulation at other areas.
- This may involve inserting RF cannulas at a caudad-cephalad (longitudinal) angle so that the 10 mm active tip envelops more of the lateral foraminal border. Right S1 rami laterales are usually found between the “2 o'clock and 5:30 o'clock” positions on the lateral side of the posterior neuroforamen, right S2 between 1:30 and 5:30, and right S3 rami laterals between 1:00 and 3:30. For S4, the nerve target is generally high on the foraminal border, for example, between 12:30 and 2:00.
- In view of the small lesion size created by conventional electrodes, and the widespread variability in the location and number of nerves converging on each foramen, multiple lesions are usually necessary. Before performing the RF treatment, motor stimulation should be performed to ensure the absence of leg or sphincter contraction. If present, the needle position is too close to the spinal nerve root and repositioning is necessary. After correct positioning of the electrode, the RF probe is inserted and a 120 s RF treatment at 80°C is made. [13]

In one of the earliest attempts at SI joint denervation, performed multiple bipolar intra-articular lesions at 90°C, reporting poor outcomes with a technique that targets only the postero-inferior part of the joint. A few years later, a study performed three 90°C monopolar lesions in the ligamentum sacroiliacum posterior and one targeting the L5 ramus dorsalis, which again resulted in poor outcomes. In the first iteration of an extensive lesioning strategy targeting the extrinsic nerve supply, another study performed single 80°C lesions of the L4-L5 rami dorsalis and the S1–S3 (or S4) rami lateralis of the rami dorsalis. Despite obtaining excellent results in this small observational study, this technique would currently be considered inadequate for severing most of the nociceptive input. Several months later, another study published the description of a similar technique except that they excluded the L4 ramus dorsalis and selected more caudal levels based solely on concordant sensory stimulation [14]. Burnham and Yasui performed paraneuroforaminal bipolar RF strip lesions at the level of S1–S3, and a monopolar RF treatment at level of the L5 ramus dorsalis [15].

Other authors described effectiveness of a single strip lesion utilizing a combination of both mono polar and bipolar current transfer with the Simplicity III electrode positioned lateral to S1, S2, S3, and S4 neuroforamina, whereby lesions were created at a temperature of 80–85°C for 60 s, and 85°C for 90 s [12]. Cohen et al. investigated which demographic and clinical variables could be used to predict SI joint RFA outcome. In multivariate analysis, pre-

procedure pain intensity, age 65 years or older and pain referral below the knee were all statistically significant predictors of failure, with a trend toward cooled RFA to provide better outcomes than conventional denervation. Younger patients may be more likely to benefit from L5 dorsal ramus and sacral lateral branch RF treatment because they are more likely than older patients to have an extra-articular, ligamentous source of SI joint pain, which innervated by nerves being lesioned [16]. There are some reports on the use of pulsed radiofrequency (PRF) therapy for treatment of SI joint pain. In study of Vallejo the L4, L5 rami mediales and the S1, S2 rami laterals of the rami dorsales were treated with PRF using parameters 45 V, temperature of 42°C, for 120 s and temperature not exceeding 42°C.

Although another study treated the same levels, they performed 3 PRF treatments on levels S1–S3 and two at L4 and L5, with the time extended to 180 s per cycle based on studies suggesting that longer heating times may be more effective for neuropathic pain. A study used yet another approach, intra articular PRF, whereby 5 cycles of pulsed radiofrequency for 120 s each were applied. Despite these uncontrolled studies, randomized studies for lumbar facet joint pain have consistently failed to demonstrate equivalence to RFA treatment [17-18]. To circumvent anatomical variations in innervations, some investigators have employed internally cooled RF electrodes, which increase the ablative area by minimizing the effect of tissue charring that limits lesion expansion. An extensive lesioning strategy is particularly important for SI joint pain given the widespread variability in the number and location of nerves receiving and conveying nociceptive input [19]**.** In the first study to demonstrate efficacy with cooled RFA, Cohen et al. performed a randomized placebo-controlled study in which a "classic" RFA procedure was performed on the L4 and L5 dorsal rami and cooled RFA was applied to the S1 to S3 or four lateral branches, with S4 being targeted in individuals where the foramen was located level with, below, or just above the bottom of the SI joint.

One, 3- and 6 months post-treatment, 79%, 64%, and 57% of patients reported ≥50% pain relief, respectively. In the placebo group, only 14% experienced significant improvement at 1-month follow-up, and none experienced significant benefit 3 months post-procedure [20]. Patel et al. randomized 51 patients in a 2:1 ratio who responded to two prognostic lateral branch blocks to receive either cooled RFA or sham RFA of L5 dorsal ramus and S1-3 lateral branches. At the 3-month primary endpoint, 47% of patients in the RFA group experienced a positive outcome, defined as ≥50% reduction in average pain coupled with significant improvement in either the SF-36 bodily pain score or functional capacity measured by Oswestry disability index, versus 12% in the control group [21]. In their most recent multi-center randomized controlled study involving 210 patients who responded with short-term relief to SI joint injections and experienced significant benefit with prognostic lateral branch blocks, Cohen et al. reported the superiority of the cooled RFA over standard medical management, with 52% of patients in the RFA group experiencing a positive categorical outcome at the 3-month endpoint versus only 4% in the control group [22].

3. Prolotherapy

Prolotherapy has been used for approximately 100 years, but its modern applications can be traced to Hackett in the 1950s who coined the term from the word "proles", which means "growth" or "offspring" in Latin under the premise that it induces increased growth of connective tissue from a local inflammatory response setting off the wound healing cascade. It has subsequently been recognized that the tissue response from prolotherapy may also be evoked through stimulating the release of various tissue growth factors [23]. Prolotherapy (injection of dextrose solution) into the SIJ or its supporting structures is intended to strengthen the joint and it supporting fibrous structures. Kim et al. compared the benefits of intra articular prolotherapy to intra-articular corticosteroid. In this study, dextrose injections were found to provide improved analgesia compared to corticosteroid; however, more frequent prolotherapy treatments were needed compared to corticosteroid. Further studies should assess the long-term safety of repeated prolotherapy injections, the volume of dextrose solution and the number of injections to establish long-term SIJ pain relief [24].

3.1. Benefits of Prolotherapy

1. Non-invasive and do not require surgery or injections.
2. Relatively painless.
3. Effective in reducing pain and inflammation.
4. It can help to accelerate healing.
5. Safe and well-tolerated by most patients. [23].

Recent animal studies have demonstrated increased cross-sectional area of connective tissue, and increased load to rupture and increased tissue strength after 10–20% dextrose injections. Furthermore, biopsies of the posterior sacroiliac ligaments of human subjects before and 3 months after prolotherapy with a solution of 1.25% phenol, 12.5% glucose and 12.5% glycerine in lidocaine showed increased collagen and size of the collagen fibers [25]. A recent review of the use of prolotherapy in chronic low back pain concluded that there is conflicting evidence regarding its efficacy but noted that the conclusions were confounded by clinical heterogeneity. We are aware of only two clinical trials focusing on the effectiveness of prolotherapy specifically for SI joint pain. Cusi and coworkers reported on prolotherapy treatment (18% dextrose, 3 injections at 6 week intervals) of 25 patients who were clinically diagnosed with SI joint pain that had been unresponsive to an exercise program. Each continued to receive physical therapy during treatment. Favorable clinical outcomes, based upon functional questionnaires, were reported [26]. In another clinical trial, Kim and colleagues randomized 48 patients with SI joint pain, confirmed by diagnostic block, to prolotherapy (25% dextrose, 2–3 injections at 2 week intervals) or corticosteroid injections (1–2 injections at 2 week intervals). Prolotherapy group demonstrated significantly better outcomes than steroid group in terms of incidence of ≥50% reduction in pain rating at 6 and 15 months post-treatment [24].

3.2. Surgery

The use of SI joint fusion has increased dramatically over the past 15 years. Older retrospective and observational studies of SI joint fusion reported good, equivocal, and poor results for a variety of indications including instability, mal alignment, and degenerative changes, but these studies were characterized by serious methodological flaws including an incomplete description of diagnosis, including the parameters

of diagnostic blocks. Many earlier studies did not even use blocks for diagnosis [27]. One rationale for the recent growth of minimally invasive SI joint arthrodesis techniques is that while fusion may benefit degenerative conditions, the trauma of surgery in many cases outweighs the benefit. In one systematic review that evaluated 40 studies (including 2 randomized controlled trials that compared iFUSE to conservative management), Chang et al. reported significant improvement across multiple domains lasting greater than 1 year, with the 2 RCTs resulting in large improvements in pain (mean difference − 40.5 mm, 95% CI, −50.1 to −30.9; −38.1 mm) and function (mean difference in Oswestry Disability Index −25.4 points, 95% CI, −32.5 to −18.3; −19.8 points). However, the 2 RCTs contained multiple sources of bias and methodological flaws including industry sponsorship, non-blinding of patients (with most of patients allocated to conservative management receiving treatments they already failed), and non-standardization of diagnostic injections, many of which performed with high volumes that exceeded joint capacity [28]. In another systematic review that included six studies, five of which were industry-sponsored, Abbas et al. reported more modest differences in 6-month pain scores (standardized mean difference − 1.5 (95% CI −1.8, −1.1)) and Oswestry disability index (standardized mean difference − 1.1 (95% CI −1.6, −0.5)) b/w SI joint arthrodesis and conservative management [29].

3.3. Image Guidance for Procedures

The SIJ's anatomy presents a clinical challenge for those attempting to perform percutaneous treatments. Image guidance is strongly recommended as SIJ injections have been found to be only 11 % accurate. Sacroiliac injections have historically been performed using CT or fluoroscopic guidance as both have demonstrated accuracy rates greater than 90 %. Fluoroscopic guidance is more commonly used in interventional pain practice because of its lower radiation exposure, lower cost and similar accuracy when compared to CT guidance [30]. Ultrasound guidance during SIJ injections offers multiple potential advantages compared to fluoroscopic and CT guidance including real-time visualization of soft tissue structures and elimination of radiation exposure. However, recent studies have found that ultrasound-guided injections were significantly less accurate compared to fluoroscopic-guided injections (87.3 and 76.7 %). Although accuracy rates will rise with physician experience, ultrasonographic imaging is limited by the bony anatomy of the SIJ [31].

3.4. Complications of interventional management

Although potential complications of intra-articular injections and RF procedures include infection, hematoma formation, neural damage, trauma to the sciatic nerve during intra-articular injections or sacral spinal nerve roots during the placement of "finder" needles during RFA, vasovagal reactions, weakness secondary to extra-articular extravasation to neural structures, and complications related to drug administration such as intravascular uptake, the reported rate of these complications in SI joint treatment is low [32]. For RF treatment of the SI joint, Cohen et al. noted that the majority of 28 patients experienced temporary worsening of pain 5–10 days after the procedure which was attributed to procedure-related tissue trauma and temporary neuritis [20]. In a follow-up study, Cohen et al. [16] reported five complications out of 77 treated patients. These included three cases of temporary paresthesia, one superficial skin infection that resolved with antibiotics and one case of hyperglycemia in a diabetic patient requiring increased insulin use for 3 days. The latter was caused by the corticoid used to prevent procedure-related neuritis, which is a relatively common practice recommended in the lumbar and cervical facet guidelines.

In their study evaluating pulsed RF of the SI joint, Vallejo et al. observed no complications or worsening of pain. Transient buttock dys- or hypo-esthesia and temporary worsening of pain have been frequently reported in other studies evaluating heat radiofrequency of the sacral lateral branches and is likely related to denervation of branches to the skin [17]. In one uncontrolled study evaluating cooled RF treatment, post procedural hip pain lasting up to 5 days was reported in most treated patients ($N = 21$). In another study, several patients reported soreness or numbness at the introducer sites for up to 2 weeks after cooled RF and one subject developed shingles at the introducer site, though this complication was probably not directly related to treatment [33]. Minimally invasive SI joint arthrodesis is considered safer than open fusion, but still carries risks. In a systematic review evaluating 14 studies and 819 minimally invasive fusions, Shamrock et al. reported an 11.1% complication rate, with wound infection being the most common. There was a 1.6% incidence of nerve entrapment, and a revision rate of 2.6%. In a large database review involving 469 patients, Schoell et al. reported an overall complication rate of 16.4% at 6 months, which did not include the 5.3% of patients who developed novel lumbar pathology within 6 months of surgery [34].

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