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Radiofrequency Neurotomy for Sacroiliac Joint Pain: A Prospective Study

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Abstract

Background: The sacroiliac joint (SIJ) is an important cause of chronic low back pain, implicated in 15% - 30% of all cases. While radiofrequency neurotomy (RFN) is the interventional treatment of choice for spinal pain originating from the facet joints, fewer studies have investigated its potential for treating SIJ pain, and its long-term efficacy is unknown. Objectives: To obtain a real-world view of RFN treatment outcomes for SIJ pain by conducting an observational study within a community pain practice, among a heterogeneous patient group receiving standard-of-care diagnostic workup and treatment. Study Design: A prospective, observational study, with data collection over five years, was conducted at the authors' private practice. Patients & Methods: A cohort of 215 patients underwent fluoroscopically guided SIJ RFN of the dorsal and lateral branches of S1-S3 and the descending branch of L5. All patients had previously had their diagnosis of SIJ pain confirmed by controlled comparative analgesic blocks of relevant nerves, and recorded pre-procedure pain levels on the 11-point Numerical Rating Scale (NRS). Outcome measures included pain, and a Likert scale to measure alterations to analgesic use, changes to paid employment status and patient satisfaction. Results: We demonstrate an average pain reduction of 2.3 ± 2.1 NRS points following RFN (baseline pain score of 6.9 ± 1.7 to a follow-up average of 4.6 ± 2.7 NRS points; $p \leq 0.01$). At a mean follow-up period of 14.9 ± 10.9 months (range 6 - 49 months), an overall 42.2% of patients reduced their analgesic use. Of the patients for whom employment capacity was applicable (82 patients), 21 patients reported an improvement. Overall, 67% of patients were satisfied with their outcome of post-RFN treatment. No complications occurred. Limitations: This observational study had no independent control group and only included a single study site. Conclusions: RFN is a safe and effective treatment for pain confirmed to originate from the sacroiliac joint.

Keywords

RFN, Radiofrequency Denervation, Radiofrequency Ablation, Sacroiliac Joint Pain, Patient Outcome Measures

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1. Introduction

The sacroiliac joint (SIJ) is a diarthrodial joint adapted for pelvic stability [1]. It has matching articular surfaces separated by a joint space containing synovial fluid and enveloped by a fibrous capsule, but it is characterized by the discontinuity of the posterior capsule and an irregular articular surface that prevents excessive movement and enhances stability. While the anterior junction is a true synovial joint, ligamentous connections and associated musculature define and support the posterior joint, with the long dorsal sacroiliac ligament, the sacrotuberous ligament, latissimus dorsi, gluteus maximus, piriformis and the thoracolumbar fascia, all contributing to stability [1]-[5]. The SIJ is thought to be one of the leading sources of mechanical low back pain, with approximately 15% - 30% of low back pain cases originating from the joint [6]-[11].

The SIJ is richly innervated with nociceptive fibers [12] [13]. However, the limited studies of nerve supply have yielded variable findings, and consequently, innervation of the SIJ remains contentious [4]. The anterior portion may be innervated by the sacral plexus, whereas spinal nerves may serve to innervate the posterior joint. Several sources of innervation have been suggested, including the ventral rami of L4 and L5, the superior gluteal nerve, and the dorsal rami of L5, S1 and S2 [2]. One group has argued that the innervation of the joint derives almost exclusively from the sacral dorsal rami, while another has also identified nerve fibers within the surrounding ligaments, and within the joint capsule itself [2] [14]. One study has specifically investigated the nociceptive innervation of the sacroiliac joint, by measuring calcitonin gene-related peptide (CGRP) immunoreactivity as a marker of nociceptive innervation in rat models. This study confirms the presence of nociceptive innervation in the rat sacroiliac joint, with the highest density of nociceptive fibers found in the dorsal aspect of the cranial portion of the joint, indicating that this part of the sacroiliac joint may be the most significant source of pain [15].

There are several causes of chronic SIJ pain, including direct trauma, and joint dysfunction as a consequence of axial compression failure and/or overload. Such cases may result from leg length discrepancy, gait abnormality, repetitive joint strain, or scoliosis [1] [2] [6].

Diagnosis of SIJ pain is difficult. A variety of diagnostic criteria such as focal tenderness over the posterior superior iliac spine and examination of pain referral zones are commonly used, despite limited validity [7] [8]. Diagnosis can be further confused by referred pain to the lower leg, foot, ankle and groin, which may lead to a diagnosis of intervertebral disc or facet joint pain [7] [16]. In an evidence review, Vanelderen *et al.* conclude that it is difficult to distinguish sacroiliac joint pain from other forms of low back pain based on history and physical exam alone, though combined batteries of tests may help ascertain a diagnosis [17]. In this context, the reference standard for diagnosing SIJ pain is observation of pain relief provided by controlled comparative analgesic blocks of the joint [4] [5] [12].

The conservative management of SIJ pain typically involves anti-inflammatory medication, muscle strengthening and pelvic stabilizing exercises. In refractory cases, more aggressive treatments may be considered, including intra-articular injections of anesthetic and corticosteroid, and neurolysis of the nerve supply using radiofrequency neurotomy (RFN) [18]-[20].

Radiofrequency neurotomy has been used in the treatment of chronic back pain arising from the intervertebral discs and facet joints, and in cases of SIJ injury or inflammation [18] [20]-[26]. A recent systematic review of the treatment of facetogenic pain has reported RFN to be the “gold standard” treatment for such pain, supported by class 1B+ evidence [27]. A meta-analysis has also shown that RFN is an effective treatment for SIJ pain at three months and six months, though this study acknowledges a paucity of literature on the subject [28]. The long-term efficacy of SIJ RFN remains unknown.

The current study was thus undertaken to obtain a real-world view of RFN treatment outcomes for SIJ pain by conducting an observational study within a community pain practice, among a heterogeneous patient group receiving standard-of-care diagnostic workup and treatment.

2. Patients & Methods

2.1. Patients

This study recruited 215 patients (85 male and 130 female), all of whom were to receive fluoroscopically guided RFN for SIJ pain, the diagnosis having already been confirmed by dual comparative diagnostic local anesthetic blocks. Diagnostic injections were sterilely administered under fluoroscopic guidance to patients presenting with

prominent deep somatic pain over the SIJ. They incorporated a contrast fluid to clearly outline the region and to ensure non-vascular needle placement in the SIJ and deep interosseous ligament (DIL) and were followed with injection of a combination of 1.5 ml 0.5% bupivacaine (1.5 ml 2.0% lidocaine for control blocks) and 0.5 ml betamethasone into the SIJ and/or DIL. Control blocks comparing short- and long-lasting injectate were used to assess for respective pain relief concordant with the anesthetic used, to ensure diagnostic accuracy. Blocks were only performed on the day if patients were experiencing their baseline pain levels to minimize the introduction of confounding factors and to prevent skewing of pre-treatment pain scores.

In assessing diagnostic blocks, pain was measured on an 11-point Numerical Rating Scale (NRS) pre-injection and then incrementally over the following 1 - 2 weeks. Substantial decreases in presenting SIJ pain score (>80% pain reduction), from 2 hrs following the SIJ/DIL injection, were deemed indicative of SIJ pain. Patients receiving short-term pain relief from the injections, concordant with expected anesthetic effect of the administered agent, were selected to proceed to SIJ RFN. It should be noted that local anesthetics can, in addition to their expected short term effects, provide long-term symptomatic relief by mitigating excessive nociceptive processing, reducing neurotransmitter release, increasing blood flow to ischemic nerve tissue and other mechanisms [4]. Though such an effect can contribute to a false-positive diagnosis of SIJ pain, affected patients in this study did not proceed to RFN.

2.2. Sacroiliac Joint RFN Procedure

Under fluoroscopic guidance, 18 gauge, 1 cm active tip RFN needles were positioned parallel to the targeted nerves. To ensure needles were positioned properly, the c-arm fluoroscope was positioned AP with a cephalic tilt, so that the S1 to S3 foramen was visible. Once all needles were positioned, the c-arm was moved to a lateral position, allowing final adjustments to be made so that the S1 to S3 needles were laying flat along the dorsal surface of the sacrum. Once the needles were in the correct position, 2% lidocaine was injected. Using the active RFN needles at 90 degrees C for 90 seconds, a series of lesions were made from the inferolateral corner to the superolateral corner of the S1 to S3 foramen. To ensure proper denervation, the dorsal, lateral and L5 descending branch were all targeted. The RFN needles were then placed horizontally, inferolaterally to the S1, S2 and S3 foramen, approximately 5 - 10 mm off the bone, and a further lesion created, to capture the lateral branches that were off the bone. Following the RFN procedure, the joint and ligaments were again injected with cortisone.

2.3. Outcome Measures

Ethical approval to carry out data collection was obtained from The Avenue Human Research Ethics Committee. Data was collected from 215 patients over a five-year period. Pre-procedure pain levels were measured on the 11-point NRS prior to RFN. Demographic data including age, gender, mode of injury and number of previous RFN procedures undergone for the same condition was also collected. At an average follow-up period of 14.9 ± 10.9 months (range 6 - 49 months), pain levels were measured on the 11-point NRS, and Likert scales were administered to measure perceived changes in analgesic use (increased, no change, slight decrease, moderate decrease, extreme decrease) and capacity for paid employment (decreased capacity, no change, increased capacity), along with patient satisfaction with treatment outcome (unsatisfied, neutral, satisfied).

Statistical analysis was performed using the non-parametric, unpaired Mann-Whitney U-test and paired samples t-test, with a P value of <0.05 considered statistically significant. Pearson's correlation using a two-tailed significance was used to determine if there was any correlation between study factors. These tests were performed using IBM SPSS Statistics 18 (IBM, Armonk, NY, USA).

3. Results

3.1. Patient Demographics

The cohort comprised 85 male and 130 female subjects with average ages of 56.8 ± 15.5 (24 - 88) years. Of the 215 patients, 63 had undergone repeat injections (**Table 1**), with the majority (42/63) having one previous RFN procedure for the same diagnosis. The cause of the SIJ pain varied between patients, ranging from overload/work injuries (27.9%) to falls/slips and motor vehicle accidents, whilst a large segment (34.6%) could not accurately note the cause of their pain (**Table 2**).

Table 1. Patient demographics: number of previous sacroiliac joint (SIJ) radiofrequency neurotomies (RFNs).

Number of previous SIJ RFNs	Patients (n)
None	152
1	42
2	14
3	5
4	2

Table 2. Patients' mode of injury.

Mode of injury	Proportion of patients
No incident	34.6%
Overload/work injury	27.9%
Fall/slip	16.9%
Motor vehicle accident	8.1%
Other	12.5%

3.2. Treatment Effects: Pain, Analgesia Use and Patient Satisfaction

To quantify the effect of RFN on SIJ pain, the difference in pre-procedure and post-procedure NRS scores was determined for each patient. Overall, 124/215 (57%) of patients reported pain relief with a mean reduction of 2.3 ± 2.1 NRS points noted at follow-up (baseline pain score of 6.9 ± 1.7 to a follow-up average of 4.6 ± 2.7 pain scale points; $p \leq 0.01$).

To examine the therapeutic benefit of RFN for SIJ pain treatment, patient analgesia use and patient satisfaction were also assessed (**Table 3** and **Table 4**, respectively). Of the 160 patients using opioids to manage their pain, 76/160 (47.5%) reported a reduction in their medication use, with 41/76 noting this decrease as extreme, on a 5-point Likert scale. Of the remaining patients, 35/160 (21.9%) reported increasing their analgesic intake, whilst 49/160 (30.6%) had no alterations of their medications when surveyed at follow-up.

Over 66% of the 215 patients included in the study were satisfied with the outcomes of the RFN procedure (**Table 4**). In patients who reported satisfaction with the SIJ RFN procedure, a statistically significant ($p < 0.05$) mean reduction in pain of 2.9 ± 2.8 NRS points was also observed. This was greater than the pain relief seen in patients who were unsatisfied with the procedure (mean reduction of 1.1 ± 2.1 NRS points). A strong correlation exists between patient satisfaction and pain relief ($r = 0.745$; $p = 0.001$), as determined by a Pearson analysis (**Table 5**). A moderate, inverse correlation was noted between increased patient satisfaction and reduction in analgesic use ($r = -0.460$; $p = 0.001$).

In patients less than 60 years of age and for whom employment capacity was applicable (82 patients), 21 patients reported an improvement (**Table 6**). The large majority of patients (51/82) reported no change in their capacity for paid employment. A minority 12% (10 patients) reported a decrease in their capacity to work, and interestingly, 6 of these 10 patients also reported poor pain outcomes and increases to their analgesic use.

Further analysis of these outcomes also indicated that responses to the SIJ RFN procedure were not affected by subjects' compensable status. No long-term complications or adverse events were noted in this cohort.

4. Discussion

The therapeutic value of RFN of the medial branches of the dorsal rami and the third occipital nerve for spinal pain is a relatively well established, but controversial, treatment for pain arising from spinal facet joints. The controversy arises from the diversity of published studies on the subject matter, some of which report on poor success using procedures that substantially diverge from the protocols described in published guidelines [29]. There have been few randomized controlled studies demonstrating the effectiveness of lumbar RFN [21] [30] [31]. Only one of these used the strict protocol of diagnosis as described [30], but the other three approximated the protocol. Spinal medial branch RFN has been shown to be valuable and effective when using these estab-

Table 3. Analgesic use at follow-up[†].

Likert scale increment	Sample (%)	Proportion of respondents using analgesics
Extreme decrease	41 (19.1%)	25.6%
Moderate decrease	20 (9.3%)	12.5%
Slight decrease	15 (7.0%)	9.4%
No change	49 (22.8%)	30.6%
Increased use	35 (16.3%)	21.9%
Unsure	5 (2.3%)	-
Not taking opioid analgesics	15 (7.0%)	-
Missing data	35 (16.3%)	-
Total	215 (100%)	100%

[†]Average follow-up period of 14.9 ± 10.9 months (range 6 - 49 months).

Table 4. Patient satisfaction at follow-up[†].

Likert scale increment	Patients (%)	Proportion of respondents
Completely satisfied	48 (22.3%)	26.4%
Very satisfied	40 (18.6%)	22.0%
Satisfied	33 (15.3%)	18.1%
Not completely satisfied	18 (8.4%)	9.9%
Unsatisfied	43 (20.0%)	23.6%
Missing data	33 (15.3%)	-
Total	215 (100%)	100%

[†]Average follow-up period of 14.9 ± 10.9 months (range 6 - 49 months).

Table 5. Correlates of patient satisfaction, pain relief and analgesic use.

Factor 1	**Factor 2**	**Pearson correlation**	**Significance (2-tailed)**
Pain relief	Patient satisfaction	$r = 0.745$	$p = 0.001$
Pain relief	Analgesic use	$r = -0.488$	$p = 0.001$
Analgesic use	Patient satisfaction	$r = -0.460$	$p = 0.001$

Analysis by the Pearson method indicated correlations between patient satisfaction and both achieved pain relief and follow-up pain scores. Post-treatment pain scores also correlated with baseline pain scores.

Table 6. Capacity for paid employment at follow-up[†].

Likert scale increment	Patient sample (%)	Proportion of respondents for whom employment capacity is applicable
Extreme improvement	10 (4.7%)	12.2%
Moderate improvement	3 (1.4%)	3.7%
Slight improvement	8 (3.7%)	9.8%
No change	51 (23.7%)	62.2%
Decreased capacity	10 (4.7%)	12.2%
Not applicable	94 (43.7%)	-
Missing data	39 (18.1%)	-
Total	215 (100%)	100%

[†]Average follow-up period of 14.9 ± 10.9 months (range 6 - 49 months).

lished practice guidelines [32].

The role of RFN for sacroiliac joint pain, however, has been less thoroughly investigated, and the long-term efficacy of the procedure is unknown. This case series therefore aimed to elaborate the efficacy of SIJ RFN as a treatment for sacroiliac joint pain in a real-world setting.

In the current study, mean pain relief of 2.3 ± 2.1 NRS points was observed, with 57% of patients reporting pain relief. Two previous independent studies have reported broadly comparable results, demonstrating good to excellent pain relief in 64% - 68% of patients at 3 - 6 months post-RFN treatment for SIJ pain [18] [20]. Importantly, our study demonstrates that in a heterogeneous population treated as per standard clinical practice, initial pain relief achieved from RFN is comparable to the published literature. Future studies will require greater longitudinal follow up, given that the temporal efficacy profile of RFN for facet joint pain has been shown to gradually decline over a 24 month period [24].

An important aim of this study was to assess the therapeutic benefit of SIJ RFN by assessing analgesia use and patient satisfaction. There is little evidence in the literature regarding analgesia use following SIJ RFN. This study found a trend for decreased analgesia in 76/160 (47.5%) of all patients using opioids to manage their pain, with 41/76 reporting an extreme decrease. It is important to note that the correlation between pain relief and analgesic medication use is moderate. This, along with the modest decrease in analgesia usage, may be attributable to varying patient attitudes towards habitual self administration of analgesia.

The importance of patient satisfaction should not be neglected, and must be given due consideration when exploring pain management techniques. In the current study, 66% of all patients were satisfied with the RFN procedure. Most notably, and unsurprisingly, a positive correlation ($r = 0.765$) exists between pain relief and patient satisfaction.

Studies of lumbar RFN have shown that complications are rare, making it a low risk treatment for patients with chronic pain [21] [33]. As with lumbar RFN, however, SIJ RFN is an invasive technique, and while low risk, there are several possible complications, including localized pain, dysesthesia and hypoesthesia of the buttocks, infection, hematoma formation, neural damage, trauma to the sciatic nerve, and gas and vascular embolism [33] [34]. Consistent with the rarity of complications in lumbar RFN, no complications were reported in the current study.

There are a number of possible reasons for the limited success of SIJ RFN. Firstly, the diagnosis was based on the results of comparative blocks of the intra-articular portion of the SIJ and the dorsal interosseous ligaments. RFN treats only the lateral branches of the sacral nerves as they emerge from the sacral foraminae and the dorsal rami of L5. The SIJ has other nerve supply, including that from the L5 ventral ramus, the S2 ventral ramus and the sacral plexus [35]. Thus, RFN cannot denervate the entire nerve network that contributes to SIJ pain. Secondly, a positive result was taken as 80% pain relief. The published guidelines were based on a diagnosis for facet joint pain made when pain relief was 100%. It is likely that the softer diagnostic criteria increase the real rate of false-positive diagnoses. Thirdly, the spread of the injectate in the DIL component of the diagnostic block is not reproducible, unlike blocks directed at the spinal dorsal rami; this again increases the possibility of false-positive results. Fourthly, extravasation of injectate from the intra-articular component of the diagnostic block through defects in the ventral or dorsal capsule may go unnoticed and also lead to a false-positive diagnosis. Fifthly, the RFN technique used to denervate the joint is difficult because of the variety of anatomy, not only due to the varying paths of the sacral nerves but also because of the bony contours of the sacrum, making it difficult to definitively perform lesions parallel to the intended target nerve.

The current study is limited by its status as an observational study and the lack of a separate control group, with patients instead serving as their own control, as well as the added inclusion of a small cohort undergoing repeat RFN. Whilst not optimal, future studies only including patients undergoing a single RFN procedure may yield more conclusive results. Nonclinical outcomes, such as cost-benefit analysis and progression to surgery were not explored in the current study. These would be interesting outcomes to pursue in subsequent studies, as would quality of life measures and improved analysis of opioid use. Lastly, results were taken from a single pain intervention clinic, this may have increased efficacy and decreased outcome variability, thus future multi-site studies may provide more conclusive results.

5. Conclusion

Whilst not a permanent means of treating chronic sacroiliac joint pain, SIJ RFN is a temporary treatment for

chronic pain relief that can facilitate patient mobilization and thus rehabilitation. Considering the improved pain relief reported by patients that underwent sacroiliac joint RFN in the present study and the reported low risk of complications, SIJ RFN might be considered as a good pain management option for patients suffering from chronic sacroiliac joint pain, particularly where conservative treatment had failed.

6. Disclosure

No external support or financial assistance has been received for this study. The authors have no financial or other interest in any products used within this report.

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