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REVIEW ARTICLE

Radiofrequency Neurotomy for Sacroiliac Joint Pain: Twelve Month Outcomes and Comparison Between Two Techniques

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ABSTRACT

Background: Radiofrequency neurotomy (RFN) is an effective treatment option for patients with severe sacroiliac joint (SIJ) pain.
Aims: We evaluated the 12-month clinical outcomes between patients (n=93) having RFN of the lateral branches of S1-S3 compared to patients (n=89) undergoing the same procedure augmented with RFN of the L4 medial branch and L5 dorsal ramus.
Methods: This was a retrospective chart review. Following diagnostic intra-articular anesthetic injections and multi-site multi-depth lateral branch nerve blocks to establish SIJ pain, patients underwent bipolar ablation of the S1-S3 lateral branches using the Nimbus multitined electrode. The second group of patients underwent supplementary monopolar RFN of the L4 medial branch and the L5 dorsal ramus. Pain severity and global Pain Disability Quality of Life Questionnaire-Spine (PDQQ-S) scores were obtained prior to RFN and at 12 months.
Results: There were 61% and 59% average 12-month improvements in SIJ-related pain severity and global PDQQ-S scores, respectively, in the overall study group ($P<0.001$ for both comparisons). Efficacy was moderately better for patients with augmented ablation that captured the L4 medial branch/L5 dorsal ramus. For example, 12-month average pain reduction was 54% and 66%, and PDQQ-S improvement was 56% and 62% for patients treated with S1-S3 lateral branch RFN and the augmented RFN procedure, respectively. The percentage of patients exhibiting ≥ 50% improvement in pain severity at 12-months was 73% (68 of 93) and 88% (78 of 89) ($P=0.016$) for the same study groups.
Conclusion: RFN of the S1-S3 sacral lateral branches using an anatomically accurate bipolar strip lesion technique produced a sufficient lesion topography to provide highly significant pain reduction and improvement in PDQQ-S at 12-months follow-up. Including the L4 medial branch and L5 dorsal ramus in the RFN treatment protocol may offer more complete denervation of all afferent pain pathways and provide additional clinical benefit.

Keywords: radiofrequency, sacroiliac, pain, neurotomy, Nimbus, bipolar

Introduction

Although often clinically overlooked and underappreciated, extensive empirical research has established that the sacroiliac joint (SIJ) can function as a pain generator that can act as both a primary and a contributing source of chronically severe low back pain.[1, 2] The degree of physical impairment and the corresponding decline in quality of life in SIJ patients that fail to respond to conservative care are worse than in many chronic health conditions, and similar in symptom severity to other orthopedic conditions requiring surgery.[3]

Patients suffering chronic low back pain of SIJ origin, resistant to conservative care measures, have experienced substantial symptom amelioration following radiofrequency neurotomy (RFN). Targeted RFN of specific SIJ innervation segments has been shown to produce clinically significant and durable improvements in pain severity, physical functioning, and a reduction in the need for opioid analgesics.[4-9] In the recently published best practice guidelines issued by the American Society of Pain and Neuroscience (ASPN), lateral sacral branch RFN for the treatment of posterior sacral ligament and joint pain received a grade of II-1 B based on the compilation of published clinical findings reflecting moderate to substantial clinical benefit as demonstrated in well-designed clinical trials.[10]

The SIJ is innervated from several sources including the ventral rami of L4 and L5, the dorsal rami of L5, S1, S2, and S3, as well as the superior gluteal nerve.[11] While dorsal innervation is a well-recognized primary pathway, in fact, it has been estimated that as many as 20% of patients receive innervation of the SIJ ventrally.[12]

For the treatment of SIJ pain, RF-generated thermal energy can be used to create lesions at the superior lateral portions of the S2 and S3 foramina, the medial branches of the higher dorsal rami in the lumbar region, at the sacral ala, and the sacroiliac junction to effectively interrupt nociceptive signals.[13] In a cadaveric anatomical study of SIJ innervation, Roberts et al[14] identified the importance of targeting the lateral branches of S1-S3 for lesioning, with the recognition of the contributions of L5 through S1. Consequently, in the standard RFN procedure, electrodes are typically placed periforaminally along the S1-S3 lateral branch nerves instead of the S1-S3 dorsal ganglia to prevent injury to the ventral nerve roots. Importantly, L5 has been shown to be an independent contributor to SIJ innervation. This may explain the mechanism in certain clinical cases who present with significant low back pain above the L5 level with or without typical SIJ pain below L5. Thus, as proposed by Cohen et al[15, 16], the standard SIJ RFN procedure can be expanded to capture the medial branch of L4 and the L5 dorsal ramus in an attempt to broaden the treatment efficacy.

Utilizing RFN in bipolar modality to create large strip lesions, with a more medial placement of the RF probe, has been found to be ideal to ensure that the lateral branches of S1-S3 are captured with an optimally larger sized lesion.[10] Indeed, bipolar techniques have been demonstrated to capture a greater proportion of the S1-S3 lateral branches than traditional monopolar techniques, likely due to the small lesion size created by monopolar devices.[14]

In this article, we provide clinical outcomes in patients with refractory SIJ pain who underwent S1-S3 lateral branch bipolar RFN with the Nimbus electrosurgical RF multitined expandable electrode, which provides a much larger zone of coagulation in volume than standard RFN electrodes. Additionally, we evaluated patients who were treated using the same RFN procedure augmented with monopolar RF ablation of the L4 medial branch and the L5 dorsal ramus.

Methods

The primary objective of this retrospective chart review was to evaluate the magnitude and durability of improvement in 12-month clinical outcomes between patients (n=93) having RFN of the lateral branches of S1-S3 compared to patients (n=89) undergoing the same procedure augmented with RFN of the medial branch of L4 and the L5 dorsal ramus. Patient data were collected in 2016 for the 2-year period spanning January 2014 to December 2015. Two hundred seventeen (217) patients underwent SIJ RFN during this interval with complete 12-month outcomes available in 182 cases. There were 103 female and 79 male patients with an average age of 52 years. All cases exhibited persistently-severe pain and disability of SIJ origin that was resistant to conservative measures. Specifically, all patients presented with more than 3 months of intractable pain that was greater than 5 of 10 in severity by numeric pain rating scale (NPRS), index pain below the belt-line and positive Fortin's finger test. This study was conducted in adherence to the concepts promoted in the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement.[17]

Employing patient selection criteria as proposed by Mitchell et al,[18] the SIJ was determined to be the putative pain source in each case by employing fluoroscopically-guided contrast-confirmed intra-articular anesthetic injection with greater than 70%

relief of index pain. Based on the recommendations of Dreyfuss et al,[19] confirmatory multi-site multi-depth lateral branch nerve blocks with greater than 70% relief of index pain was required prior RFN. A 70% pain relief threshold was chosen based on the findings of Derby et al[20] who reported that this level of post-nerve block pain amelioration was associated with a greater percentage of pain relief, duration of relief, patient satisfaction, and pain medications reduction following RFN.

One group of patients underwent bipolar ablation of the S1-S3 lateral branches using a multitined expandable electrode (Nimbus® electrosurgical RF multitined expandable electrode, Stratus Medical, Magnolia, TX USA) (Figure 1).[21] The second group of patients underwent a modified technique where monopolar RFN of the L4 medial branch and the L5 dorsal ramus were captured with the multitined electrode in addition to the S1-S3 lateral branch bipolar RFN (Figure 2). To create the bipolar strip lesion of the S1-S3 lateral branches the distance separating all cannulas were equidistant (~15 mm). The temperature was set at 85° C for 150 seconds (up to 30 seconds ramp + 120 seconds at temperature). For the second cycle, cathode and anode pairings were alternated. Figure 3 illustrates post-procedural MRI validation of RFN lesion size and shape.

Figure 1: The Nimbus Electrosurgical RF Multitined Expandable Electrode (Stratus Medical, Magnolia, TX, USA).

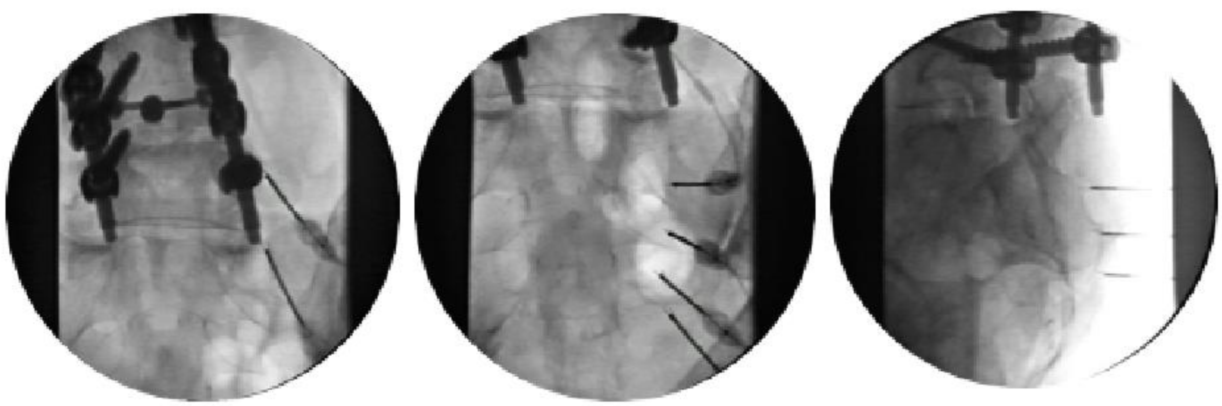

Figure 2: Fluoroscopic images during SIJ RFN in a post-lumbar fusion case with cannula placement adjacent, but not touching, the pedicle screw for L4 lateral branch and in the groove at the base of S1 superior articular process for L5 dorsal ramus (left); cannulas placed from S1 to S4 for strip lesion of lateral branches (middle); and, contralateral oblique safety view showing cannula on bone in the dorsal sacrum (right).

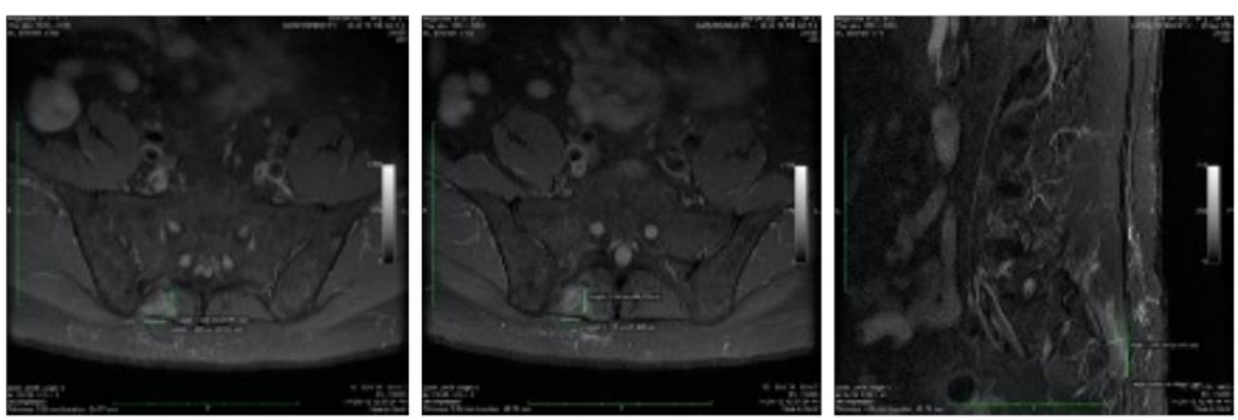

Figure 3: Post-procedure MRI demonstrating validation of lesion size and shape (left, middle, right).

Low back pain severity was determined by 11-point NPRS (0 to 10). To evaluate spine pain quality, related disability, and life satisfaction/quality, we used the Pain Disability Quality of Life Questionnaire-Spine (PDQQ-S).[22] This short composite questionnaire employs two questions for each of the 3 domains with a maximum score of 60. All patient-reported outcome scores were obtained prior to RFN and at 1, 6, and 12 months, post-RFN.

Findings are presented as means (± SDs) and average improvement in clinical outcomes between baseline and 12 months was assessed using the paired t-test, 2-tailed. Responder rates were computed for each study group separately for the minimal clinically important difference (MCID), substantial clinical benefit (SCB), and the patient acceptable symptomatic state (PASS).[23] For the NPRS, the MCID was ≥ 30% improvement over baseline [24], the SCB was ≥ 50% improvement [25, 26], and the PASS was set at ≤ 3 and ≤ 4.[27] For the PDQQ-S, the MCID was a ≥ 17-point improvement.[28] Responder rates for each outcome at the 12-month primary endpoint were compared between study groups using Fisher's exact test (2-tailed).

Results

The entire study group as a whole experienced an approximate 61% improvement (7.2 ± 1.1 to 2.8 ± 1.2 mm), on average, in SIJ-related pain severity from baseline through 12 months of follow-up ($P<0.001$). There was a corresponding improvement in global PDQQ-S scores of 59% (48.4 ± 6.8 to 20.0 ± 8.9), on average, over the same follow-up interval ($P<0.001$) (Figure 4).

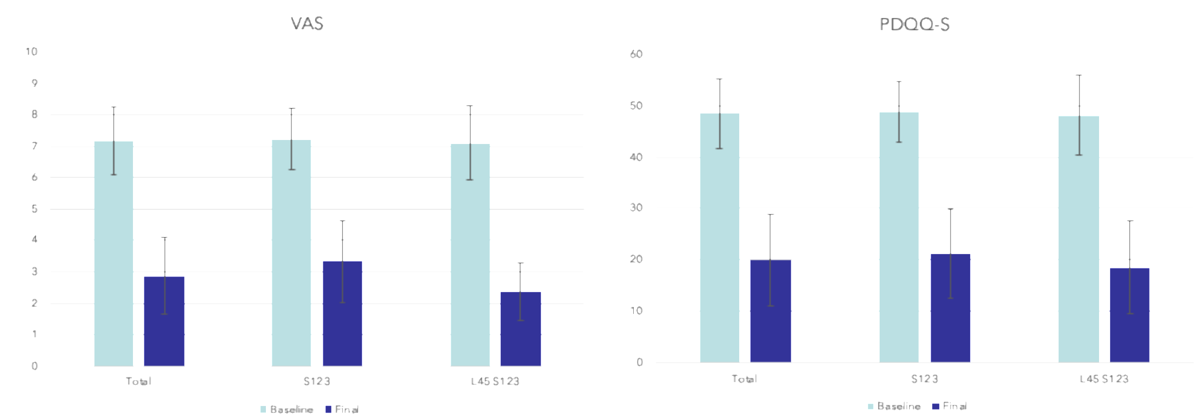

Figure 4: Bar graph illustrating mean (± SD) pain severity and PDQQ-S scores at baseline and 12 months follow-up for the total patient group as well as sub-groups having S1-S3 lateral branch RFN and S1-S3 lateral branch plus L4 medial branch and L5 dorsal ramus RFN.

In patients receiving RFN solely of the S1-S3 lateral branches, there was an approximate 54% improvement (7.2 ± 1.0 to 3.3 ± 1.3 mm), on average, in pain severity and an approximate 56% improvement (48.7 ± 5.8 to 21.2 ± 8.7), on average, in PDQQ-S scores ($P<0.01$ for both comparisons) (Figure 4).

Patient-reported outcomes were moderately better in patients receiving additional L4 medial branch and L5 dorsal ramus RFN. Corresponding improvements in average pain severity and PDQQ-S scores were 66% (7.1 ± 1.2 to 2.4 ± 1.0 mm) and 62% (48.1 ± 9.0 to 18.5 ± 7.8), respectively ($P<0.01$ for both comparisons) (Figure 4).

Responder rate analysis favored patients treated with the augmented RFN procedure. Comparative 12-month responder rates for pain severity improvement were 93% (86 of 93) and 100% (89 of 89) ($P=0.014$) for the MCID, 73% (68 of 93) and 88% (78 of 89) ($P=0.016$) for SCB, 83% (77 of 93) and 100% (89 of 89) ($P=0.0001$) for PASS ≤ 4, and 57% (53 of 93) and 90% (80 of 89) ($P=0.0001$) for PASS ≤ 3 for standard and augmented RFN treatments, respectively.

However, 12-month responder rates for the MCID in the PDQQ-S showed little difference between study groups: 84% (78 of 93) for patients treated with S1-S3 lateral branch RFN and 88% (78 of 89) (P=0.53) for patients with S1-S3 lateral branch and additional L4 medial branch and L5 dorsal ramus RFN. There were no serious procedure-related adverse events.

Discussion

Our findings corroborate and extend previous results in patients with SIJ pain showing clinically significant and sustained symptom palliation for a duration of 12 months following RFN.[6] Clinical improvements after RFN have also been found to be more robust and durable than intraarticular steroid injection for the same patient population.[13] We noted moderately better improvement in clinical efficacy among patients who received supplementary ablation of the L4 medial branch and the L5 dorsal ramus as part of their treatment protocol. The responder rates for pain severity for the MCID, SCB and the PASS were all significantly higher than the group who received S1-S3 lateral branch ablation exclusively. While both study groups exhibited a clinically satisfactory treatment response at 12 months, patients treated with the augmented RFN procedure had particularly favorable findings with 90% of cases reporting a final pain score of 3 or less. This suggests that expanding the standard protocol of S1-S3 RFN with supplementary RFN at L4-L5 may offer more complete denervation of all afferent pain pathways. This has the potential of not only benefiting a larger proportion of treated patients but, importantly, enhancing the treatment effect. This finding should stir interest in exploring different RFN techniques and protocols to optimize the clinical endpoints for patients suffering persistently-severe SIJ pain.[29]

When symptoms related to SIJ dysfunction become unresponsive to conservative care and impair normal physical function and quality of life, minimally invasive SIJ arthrodesis is often recommended.[30] Our findings suggest that this procedure can be averted for at least 12 months with RFN treatment extending the period of palliation for the patient.

A distinct advantage of the use of the multitined electrode in a bipolar distribution is to minimize the number of placements that are necessary to generate a strip lesion, which increases the speed and reduces the technical difficulty of the procedure.[31] The multitined electrode has been validated by post-procedural MRI scans to produce a contiguous lesion when separated by 20 mm. Other commonly-employed RFN procedures such as the *palisade* technique recommend 6-7 placements separated by 10 mm with sequential bipolar pairs activated. This approach is far less efficient, and unless the conventional straight cannulas are aligned in matching three-dimensional geometry, the area of the effective coagulation is unpredictable.[32]

In addition to enhancing the technical ease of the procedure, the Nimbus multitined electrode generates a more expansive ablation zone equating to a larger lesion volume than a conventional RFN electrode.[33] Creating an enlarged zone of coagulation is salient, since anatomical studies have shown high variability in the exact position and course of the sacral lateral branches.[34] The multitined electrode is capable of projecting a wide zone of coagulation onto the boney dorsal surface of the sacrum to increase the chance of successful RFN in capturing even small-diameter nerve branches innervating the SIJ. In the absence of a large RFN-induced area of tissue coagulation, peripheral nerves can regenerate and the painful structures within the SIJ will re-innervate in the matter of a few months, as opposed to at least 12 months of symptom palliation. In fact, studies comparing RFN in bipolar versus monopolar configurations have found that bipolar lesions more reliably captured the sacral lateral branches than monopolar.[35] Figure 5 illustrates benchtop tissue studies demonstrating the extent of the zone of coagulation with the multitined electrode. It will be important to investigate whether these findings establish and prescribe a more anatomically valid technique that can reliably denervate the sources of SIJ pain.

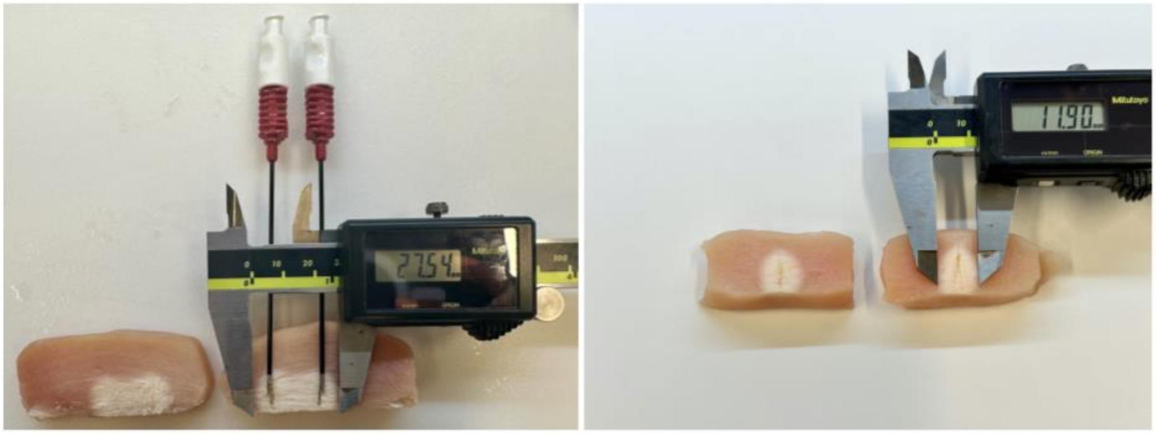

Figure 5: Benchtop tissue study showing a preferred wide zone of coagulation for the bipolar configuration of the multitined electrode with cannulas separated by 17.5 mm (left) and a representative view of a corresponding monopolar lesion (right).

The findings of this investigation are limited by the retrospective design of this study undertaken at a single clinical site. These clinical results should be confirmed by other pain specialists and in additional clinical settings.

Conclusions

RFN of the S1-S3 sacral lateral branches, in a well selected population using an anatomically accurate bipolar strip lesion technique, produced the necessary and sufficient lesion topography to provide highly significant pain reduction and improvement in PDQQ-S at 12-months follow-up. Including the L4 medial branch and L5 dorsal ramus in the RFN treatment protocol may provide additional benefit and further study is encouraged.

Conflict of Interest Statement

JB is an independent advisor to Stratus Medical (Magnolia, TX, USA) and was remunerated for assistance in manuscript development. The authors report no other conflicts of interest.

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