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Oriainal Article

Multi-Approach Radiofrequency for Sacroiliac Arthropathy

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Abstract:

Background: *Sacroiliac joint pain is one of the common cases of back pain that has different management modalities. Radiofrequency ablation is one of the trending approaches that includes different techniques.* ***Objective****: To investigate pain healing in a three-month follow-up after a combined radiofrequency approach.*

Patients and method: *A cpmparative study included 19 patients with sacroiliac joint pain who underwent underwent a multi-approach radiofrequency treatment from 2020 to 2023 in Par Hospital (Erbil, Iraq) were studied prospectively. Pain relief of more than 50% following intra-articular injection was one of the inclusion criteria. All patients underwent a multi-approach radiofrequency including thermal radiofrequency ablation of lateral branches of the dorsal ramus, L4-L5 and L5-S1 facet joints denervation, and pulsed radiofrequency of L4 and L5 DRG. Before the procedure, as well as 4 and 12 weeks after the procedure, the patient's pain was measured and recorded with the Numeric Rating Scale (NRS). Data analysis was done with SPSS statistical software at a significance level of 0.05..*

Results: *The mean patients' age ws 60.1± 10.9 years, , Almost 68% were females. There was a significant decrease in the NRS after the procedure in week 4 (mean difference: 3.16 ± 1.7) and week 12 (mean difference: 4.58 ± 1.2) compared to the preoperative NRS (P< 0.001). A significant decrease was observed from week 4 to week 12 after the procedure (mean difference: 1.42 ± 1.53), (P=0.001). None of the patients reported any complications during follow-up. In total, 52.6% and 94.7% of the patients showed ≥50% pain reduction in the 4th and 12th week, respectively*

Conclusion: *The use of a multi-approach radiofrequency technique in the present study promises a more stable effectiveness, although longitudinal clinical trial studies should be conducted for more accurate conclusions.*

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1. INTRODUCTION

Sacroiliac joint pain accounts for approximately 25% of all instances of lower back pain (1). This joint, referred to as the sacroiliac joint (SIJ), contains synovial fluid and is responsible for the perception of pain in its anterior region through connections to the lumbosacral trunks, the obturator nerve, and the gluteal nerves. In contrast, the extra-articular structures are primarily associated with the posterior sacral network (PSN), which includes the fibers of the S1-S3 and L5 dorsal rami. Pain can originate from any part of the joint or any of the posterior extra-articular elements of the PSN (2, 3). For the management of SIJ pain, a conservative approach is usually adopted first, and in the absence of a suitable response, a wide range of treatment options including medication therapy, chiropractic interventions, joint injection of anesthesia and/or steroids, and surgery can be considered (4, 5). However, effective treatment of SIJ pain is not easily achieved due to the complex anatomical structure of the joint and the variety of innervation. After successfully managing SIJ pain in the first patient in 2001 (6), radiofrequency ablation, which has been relatively popular in the last decade, has been evaluated and confirmed in various studies (7, 8). It is a minimally invasive procedure using light sedation or local anesthesia.The nerve is treated with thermal energy delivered through a device inserted via a needle as part of its mechanism of action. There are several radiofrequency ablation techniques, such as pulsed, thermal, and cooled radiofrequency, with thermal radiofrequency being the most commonly used. Pulsed radiofrequency utilizes lower energy and a reduced temperature compared to thermal radiofrequency. In contrast, cooled radiofrequency employs internally cooled probes to expand the size of the lesion, increasing the likelihood of complete denervation (9). Prior research has explored the outcomes of various radiofrequency approaches, with some studies introducing alternative radiofrequency techniques to enhance sacroiliac pain management by modifying specific aspects (10). In this particular study, our focus was on assessing pain relief during a three-month follow-up after implementing a combined approach. This approach includes radiofrequency ablation of the lateral branch of the dorsal ramus, denervation of facet joints, and pulsed radiofrequency treatment for the L4 and L5 dorsal root ganglion (DRG).

2. PATIENTS AND METHODS

This was a prospective comparative clinical study conducted at Par Hospital in Erbil, Iraq, during the period spanning from 2020 to 2023, involving a cohort of 19 patients afflicted with sacroiliac joint pain who had undergone radiofrequency treatment. The patients we examined uniformly presented with a constellation of symptoms that included in addition to low back pain, radiating leg pain and discomfort localized in the gluteal region.

Patients were adult of both genders, had a history of chronic axial lower back pain lasting for a duration exceeding six months and they were manifested with physical signs and symptoms indicative of sacroiliac joint pain upon clinical examination. Patients who had previously attempted conventional treatments such as physical therapy or pharmaceutical interventions without achieving satisfactory pain relief were also eligible.

Notably, individuals needed to demonstrate substantial pain relief, exceeding 50%, for a minimum of six hours after receiving a diagnostic intra-articular sacroiliac injection. This injection consisted of 3 mL of 0.25% bupivacaine and 20 mg of methylprednisolone acetate. Every patient underwent an extensive and well-rounded multi-approach radiofrequency intervention. This comprehensive treatment regimen encompassed several key components, including the application of thermal radiofrequency ablation to the lateral branches of the dorsal ramus. Additionally, patients received denervation procedures targeting the L4-L5 and L5-S1 facet joints. Pulsed radiofrequency therapy was also employed to treat the L4 and L5 dorsal root ganglia (DRG). This diligent approach allowed us to comprehensively evaluate the efficacy of the multi-approach radiofrequency treatment in addressing sacroiliac joint pain and alleviating the associated symptoms.

Thermal radiofrequency ablation of lateral branches

The C-arm fluoroscopy was harnessed to provide visual access to the sacroiliac (SI) joint and sacral foramen. In a meticulous procedure spanning multiple levels, specifically L4, L5, S1, S2, and S3, the insertion of needles was conducted for the purpose of thermal radiofrequency ablation targeting the lateral branches of the dorsal rami. Notably, these needles were dual-function, serving not only for the ablation process but also facilitating the administration of local anesthetics and steroids upon the conclusion of the procedure. The precise number of lesions at the sacral levels was contingent on the preference of the attending physician, with either one or two lesions created as per their discretion. For these

interventions, A 22-G SMK-C10 cannula, equipped with 5-mm active tips sourced from Radionics (Burlington, MA), was introduced in a manner parallel to the nerve course.

The cannula came into contact with the bone within the sacral ala groove, enabling the initiation of the primary dorsal rami lesion for L5. In the case of S1-S3 lateral branch denervation, the positioning of the cannula was meticulously calibrated. This placement was achieved within a range of 1 to 3 mm from the periphery of the foramen, executed in a semi-circumferential pattern perpendicular to the bone. Procedurally, the lesion location on the right side was set between the 1:00 and 5:00 o'clock positions, while the corresponding sites on the left side were delineated between 7:00 and 11:00. To verify the accuracy of electrode placement in proximity to the target nerve, electrical stimulation at a frequency of 50 Hz was employed, with concurrent sensory thresholds ranging from 0.2 to 0.8 V. A separate assessment was undertaken at a frequency of 2 Hz to ensure the absence of leg muscle contractions. The proactive administration of 1 to 2 mL of 2% (or 1%) lidocaine through each cannula was an integral prelude to the lesioning process, serving the purpose of mitigating thermal discomfort. It's noteworthy that electrostimulation was systematically applied to all cannulae before the introduction of local anesthesia to preempt the inadvertent diffusion of anesthesia to neighboring needles, which could potentially interfere with sensory assessments. These electrodes were methodically inserted into the cannula, and a precisely timed 90-second 801C lesion was initiated through the application of a radiofrequency generator (*Cosman G4 version 2.1.0, Cosman Medical, Inc., Burlington, MA, USA*)

Facet joints denervation

In the process of conducting facet joint denervation, we employed 22G radiofrequency electrodes, along with needles featuring 100 mm active tips, which were sourced from NeuroTherm, based in Wilmington, MA, USA. These specialized instruments were meticulously positioned within the medial branch of the dorsal ramus associated with the L3/4-L5/S1 facet joints. To ensure precision and accuracy in placement, a comprehensive series of sensory and motor tests were executed, involving electrical stimulation at specific parameters. These tests encompassed sensory assessments at 50 Hz, with voltage settings ranging from 0 to 1 V, as well as motor assessments at 2 Hz, with voltages spanning from 1 to 10 V. Subsequent to the completion of these vital tests, we proceeded to introduce a 1 mL quantity of ropivacaine hydrochloride (comprising 20 mg within a 10 mL solution)

through the cannula. This served to facilitate local anesthesia in the targeted area. Following this preparatory step, the radiofrequency electrode was once again inserted into the cannula. It was at this stage that we initiated the thermal ablation process, administering high-frequency radio waves at 80°C for a duration of 90 seconds. This crucial step was facilitated through the utilization of the aforementioned radiofrequency generator, allowing for the creation of the desired lesion.

Pulsed radiofrequency of L4 and L5 DRG

In the subsequent stage, the determination of the pulsed radiofrequency (PRF) direction involved the meticulous adjustment of the C-arm and the utilization of a metal ruler to pinpoint the precise injection site situated on the medial aspect of the intervertebral foramen. The objective was to reach the closest proximity to the dorsal root ganglia (DRG) of L4 and L5. This maneuver aimed at ensuring that the 10 cm cannula, carefully positioned, would align with the central axis of the intervertebral foramen when observed laterally. Subsequently, the RF probe was replaced to commence the procedure. A sensory test entailed stimulating the area at a frequency of 50 Hz, eliciting a distinctive tingling sensation when the voltage remained below 0.5 V. Furthermore, we pursued a specific target impedance, endeavoring to maintain it below 500 Ω. This goal was accomplished by introducing 0.5-1 ml of saline (0.9% NaCl) through the needle for each patient, serving as a prelude to the PRF treatment. The PRF treatment was executed through a radiofrequency generator, with parameters set at 20 ms, 2 Hz, and 45 V.

The treatment entailed two intervals of 2 minutes each, with a brief interlude in between. Subsequent to the therapeutic procedure, a solution comprising 3 ml of an analgesic complex (comprising 1.5 ml of 2% lidocaine, 5 mg of a betamethasone combination, and 0.5 ml of normal saline) was administered to all subjects.

Following the completion of the procedure, the needle was carefully withdrawn, and the puncture site was gently compressed. Post-procedure, a 15-minute observation period was instituted before the patient was transferred back to their assigned ward.

Assessmnet of Pain intensity

Prior to the initiation of the procedure, the patients were duly instructed to quantify their pain intensity utilizing the Numeric Rating Scale (NRS) which is ranged from 0, signifying "no pain," to 10, indicative of the "worst possible pain." The assessment of NRS pain intensity was recurrently performed at four weeks and 12 weeks subsequent to the procedure.

Statistical analysis:

The amassed data of the patients were analyzed using the statistical package for social sciences (SPSS) version 28 software doe Windows, appropriate statistical procedures and tests were applied according to the type of variables. All analyses, comparisons and correlations were performed at a level of signifciance of, P. value ≤ 0.05, to be signifciant.

3. RESULTS

In this study, we examined a group of 19 patients, with an average age of 60.1 ± 10.9 (range: 28 – 80) years, all underwent a multi-approach radiofrequency treatment to alleviate sacroiliac joint pain. Out of these patients, 13 (68.4%) were females, and 6 (31.6%) were males. Nearly half of the cases (47.4%) required treatment on both sides, while 31.6% underwent left-side radiofrequency, and 21.1% underwent right-side radiofrequency, (**Table 1**).

The average Numeric Rating Scale (NRS) score prior to the procedure was 7.05 ± 0.97, and it reduced to 3.89 ± 1.73 at 4 weeks and 2.47 ± 1.07 at 12 weeks. The mean reduction in NRS at the 4^{th} weeks was 3.16 ± 1.7 point score and at the 12^{th} weeks the mean reduction was 4.58 ± 1.2 point score than its baseline score before procedure. The overall reduction rate at the 12^{th} weeks was 65% ± 13.7%. Pairwise comparison using repeated measure ANOVA test revealed highly significant change at 4 weeks and 12 weeks after procedure compared to the baseline value before procedure, (P. value < 0.001), (**Table 2**). Furthermore, the graphical trend (**Figure 1**) showed almost linear reduction in NRS at the subsequent assessment; a noteworthy decrease observed from the 4^{th} week to the 12^{th} week after the procedure (mean difference: 1..42 ± 1.53, P. value = 0.001). Additionally, none of the patients reported any complication during the follow-up period. From other point of view, generally, 52.6% of the patients experienced a ≥50% reduction in pain at the 4th week, which was significantly increased to 94.7% by the 12^{th} week, (**Table 3**).

Moreover, to assess the possible confounding effect of patient's age, sex or the involved side on the outcome (reduction in NRS), we further assessed the correlation between these variables from one side against the overall reduction in NRS at the 12^{th} month from the other side, None of these variables showed a significant effect on the reduction in NRS which reflected the beneficial effect of the procedure independent of patient's age, sex or affected side, (**Table 4**)

Table 1. Baseline characteristics of the studied group (N=19)

Variable		Result
Age (year)	Mean (SD)	60.1 (10.9)
	Median	62.0
	Range	28 - 80
Gender n(%)	Male	6 (31.6%)
	Female	13 (68.4%)
Involved side n (%)	Bilateral	9 (47.4%)
	Left	6 (31.6%)
	Right	4 (21.1%)
Total		19 (100.0%)

SD: standard deviation

Table 2. Comparison of mean NRS before procedure with 4 and 12 weeks after the procedure

Assessment time	NRS	
	Mean	SD
Before procedure	7.05	0.97
4 weeks after procedure	3.89	1.72
12 weeks after procedure	2.47	1.07
Mean reduction after 4 weeks	3.16	1.7
Mean reduction after 12 weeks	4.58	1.2
Overall reduction rate in NRS after 12 weeks	65.00%	13.70%

Pairwise multiple comparisons (post-hoc LSD test) P. values

Pairs	P. value
Before vs. 4 weeks	<0.001
4 weeks vs. 12 weeks	0.001
Before vs. 12 weeks	<0.001

SD: standard deviation
Overall reduction rate = mean reduction in NRS value at 12th week divided by NRS value before procedure x 100%

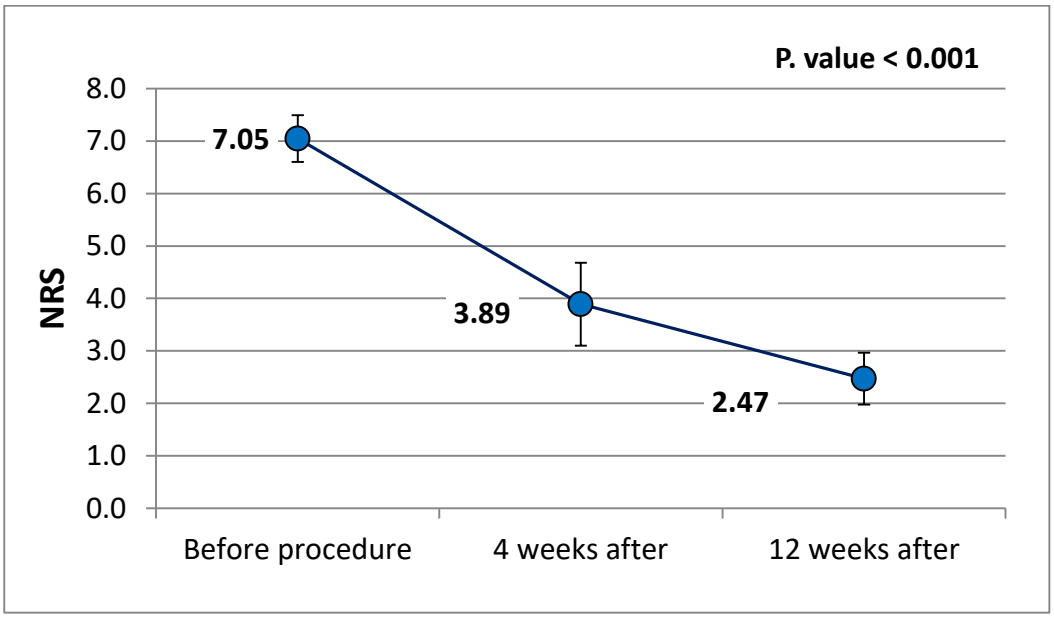

Figure 1. Line-Marker graph showing the trend of change in mean NRS of the 19 patients at 4 and 12 weeks after procedure (P. value <0.001)

Table 3. Pain improvement rate at 4 and 12 weeks after the procedure

Improvement rate	After 4 week n (%)	After 12 week n (%)
≥50% NRS reduction	10 (52.6%)	18 (94.7%)
<50% NRS reduction	9 (47.4%)	1 (5.3%)

Table 4. Results of Bivariate correlation analysis between overall reduction in NRS and baseline characteristics of the patients

	Correlation parameters	
Variable	R	P. value
Age (year)	0.050	0.838
Gender	0.251	0.300
Involved side	0.053	0.830

R: Correlation coefficient

4. DISCUSSION

The process of radiofrequency denervation targeting lateral branches played a crucial role in our intervention. Eissa and his team delved into the effectiveness of sacroiliac pain relief through Sacroiliac joint lateral branch radiofrequency denervation. According to their report, 60% of patients experienced a reduction of more than 50% in their Numeric Rating Scale (NRS) score after 2 weeks, 1 month, and 3 months of the intervention, and this improvement remained consistent over time (11). However, these findings diverged from the results of our present study. In our research, we observed that pain relief for patients increased progressively over time, from 52.6% in the first month to a striking 94.7% in the third month. Remarkably, only one patient failed to report a pain reduction of more than 50% in the third month. This suggests that the traditional radiofrequency approach might yield more immediate effectiveness compared to our multi-approach radiofrequency in the short term. Nevertheless, the true advantages of our multifaceted approach became evident in the medium term. Dreyfuss and his colleagues have highlighted that the intraarticular component of the sacroiliac joint cannot be effectively blocked through multi-site, multi-depth lateral branch blocks. Their studies indicate that multi-local, multi-depth lateral branch blocks achieve physiological efficacy at a rate of 70% (12). This underscores the potential benefits of adding facet joint denervation and pulsed radiofrequency of L4 and L5 dorsal root ganglia (DRG) to the conventional approach, enhancing pain perception and, subsequently, a more substantial reduction in pain. In our present study, we incorporated pulsed radiofrequency for L4 and L5 DRG. Dutta and his team in 2018 demonstrated that denervation using pulsed radiofrequency (PRF) of the primary L4 and L5 dorsal rami as well as S1-3 lateral branches yielded significant pain relief and functional improvement for SIJ pain patients. They reported that, at 1 and 3 months postoperatively, 100% and 86.7% of patients respectively achieved 50% or more pain relief (13). It's important to note that our radiofrequency approach was distinct, combining three different methods with pulsed radiofrequency specialized solely for L4 and L5 DRG. In our study, 52.6% and 94.7% of patients exhibited a reduction of 50% or more in pain levels at 1 and 3 months after the procedure. While this level of effectiveness was somewhat less than what was observed in the aforementioned study, it's essential to consider the unique aspect of our results. Unlike the conventional approach, where patients experienced a return of pain over time, our study showed a substantial and continuous reduction in pain from the first to the third

month. Cheng et al. conducted a retrospective study demonstrating that the use of radiofrequency ablation techniques for patients with low back pain linked to sacroiliac joint issues resulted in a reduction of pain by over 50% during a one-month follow-up in 60% of patients. However, as time passed, pain levels increased, with 40% of patients experiencing pain at least half of their pre-treatment levels by the third month, and this number dropped below 20% by the 12th month (14). Similar findings were reported in Bayerl and colleagues' study, where there was a significant reduction in pain, as measured on the Numeric Rating Scale (NRS), during the first month following conventional radiofrequency ablation. However, as time progressed from the first month to the 12th month, a gradual return of pain was observed among the patients (15). Furthermore, Ding and his team found that pain levels in the first and third months were nearly identical in patients who underwent either conventional or pulsed radiofrequency ablation (16). This makes the significant improvement in pain from the first to the third month, observed in our study, a unique and notable finding likely resulting from the complexity of our process and the minimal local tissue damage in the operation area. To address the limitations of our study, it's essential to consider the lack of a long-term evaluation spanning from 6 to 12 months. Additionally, we did not have control over the potential treatment modalities that patients might have undergone during the follow-up period, which represents another limitation. To address these limitations in future studies, it is recommended to employ a larger sample size while maintaining control over post-operative conditions. Furthermore, conducting clinical trials with the objective of comparing our multi-approach method with other radiofrequency techniques would provide valuable insights and a more comprehensive understanding of their respective effectiveness.

5. CONCLUSION

In our current study, the use of a combined radiofrequency technique holds the promise of delivering more consistent effectiveness. However, for more precise conclusions, it's imperative to conduct longitudinal clinical trials. During the initial month following the multi-approach radiofrequency intervention, pain relief wasn't as substantial as what previous studies had indicated. On the flip side, by the third month, we observed a greater improvement in pain compared to what was reported in similar studies during the same timeframe.

Ethical Issues: All ethical issues were approved by the authors. Verbal and signed informed consents were obtained from all patients who included in the study before the intervention. Our investigation was executed following the requisite approvals from the local ethics committee.

Conflict of interest: None

Source of funding: Authors declared no funding agency, or organization

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