Turk Neurosurg, 2026
DOI: 10.5137/1019-5149.JTN.49271-25.2

Original Investigation

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Received: 10.06.2025
Accepted: 27.10.2025
Published Online: 16.01.2026

Intra-Articular vs Medial Branch Pulsed Radiofrequency in the Management of Lumbar Facet Joint-Related Low Back Pain: A Prospective Randomized Trial

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ABSTRACT

AIM: To compare the efficacy of intra-articular PRF (IA-PRF) and medial branch PRF (MB-PRF) in the treatment of facet joint-related low back pain.

MATERIAL and METHODS: In this prospective observational study, 116 patients with ≥50% pain relief after diagnostic intra-articular anesthetic injection were included. Patients underwent IA-PRF (n=60) or MB-PRF (n=56). Pain and disability were assessed using the Numerical Rating Scale (NRS) and Oswestry Disability Index (ODI) at baseline and 1 and 6 months post-treatment.

RESULTS: Both groups showed significant improvements in NRS and ODI scores at 1 and 6 months ($p<0.001$). In the IA-PRF group, NRS scores improved from 6.55 ± 0.65 to 3.23 ± 0.43 (1 month) and 3.70 ± 0.46 (6 months); ODI scores improved from 49.70 ± 3.75 to 25.13 ± 1.66 and 26.90 ± 2.13, respectively. In the MB-PRF group, NRS scores decreased from 6.43 ± 0.66 to 3.13 ± 0.33 (1 month) and 3.57 ± 0.49 (6 months); ODI scores decreased from 49.18 ± 3.49 to 24.71 ± 1.34 (1 month) and 26.68 ± 2.20 (6 months). No significant intergroup differences were observed at follow-ups ($p>0.05$). No complications occurred.

CONCLUSION: IA-PRF and MB-PRF are effective and safe in treating LFJ-induced pain after 6 months of follow-up. Significant pain control and functional improvement were achieved with both methods, with no significant difference between them regarding clinical efficacy. Our findings suggest that treatment selection should be individualized according to patient characteristics. Randomized studies with large samples and long-term follow-up are needed to improve the level of evidence in this field.

KEYWORDS: Chronic low back pain, Intra-articular pulsed radiofrequency, Lumbar facet joint (LFJ) pain, Medial branch pulsed radiofrequency, Pulsed radiofrequency

ABBREVIATIONS: LFJ: Lumbar facet joint, **IA:** Intra-articular, **IA-PRF:** Intra-articular pulsed radiofrequency, **MB-PRF:** Medial branch pulsed radiofrequency, **NRS:** Numerical rating scale, **ODI:** Oswestry disability index, **PRF:** Pulsed radiofrequency

INTRODUCTION

Lumbar facet joint (LFJ)-induced pain is one of the important causes of chronic low back pain and is a common condition in clinical practice (12). The prevalence of facet joint-related low back pain reportedly varies between 15% and 45% (16,17,24). Degenerative changes of the facet joints increase especially with age and contribute to the pathogenesis of mechanical low back pain (22). Since facet joint pathology is difficult to differentiate from other causes of lumbar pain, the diagnosis is mostly based on a combination

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of the patient's clinical symptoms, physical examination findings, and interventional methods, especially diagnostic injections (6). Although the presence of pathologic changes can be demonstrated with imaging methods, the correlation between radiologic findings and clinical pain is reportedly poor (13).

Intra-articular local anesthetic injections for diagnostic purposes are frequently used in the confirmation of LFJ-induced pain (7). A ≥50% pain reduction after diagnostic injection is reportedly be indicative of facet-induced pain (8,25,30). Therefore, only patients who showed significant pain relief after diagnostic intra-articular injection were included in the present study.

Interventional approaches come to the forefront in the treatment of LFJ pain in patients who do not get results with conservative methods (6). Conventional radiofrequency ablation (CRF) provides analgesia by thermal damage to the medial branch nerves; however, side-effects such as neuritic pain, dysesthesia and nerve damage may develop with this method (1,5,6). Pulsed radiofrequency (PRF), wherein the temperature does not exceed 42 °C and causes minimal tissue destruction, aims to alleviate pain with neuromodulatory effect (26,27). Although the exact mechanism of action of PRF has not yet been fully elucidated, it is thought to modulate neural transmission and suppress local inflammation through the applied electrical field (27).

Intra-articular PRF (IA-PRF) has recently been proposed as an alternative method for the management of LFJ pain (20,22). IA-PRF reportedly provides significant reduction in pain by directly targeting the joint pathology compared to medial branch PRF (MB-PRF) (20). However, the number of studies directly comparing both methods is limited and there is no consensus regarding which technique is superior; the need for prospective studies on this subject continues.

In this study, we aimed to compare the efficacy of IA-PRF and MB-PRF. In our study, the short-term results of 116 patients whose LFJ-induced pain was confirmed by diagnostic intra-articular injection and subsequently treated with IA-PRF or MB-PRF were evaluated at the 1- and 6-month follow-ups by using Numerical Rating Scale (NRS) and Oswestry Disability Index (ODI) scores. With the findings obtained, it is aimed to contribute to the determination of the optimal interventional approach in the treatment of LFJ pain.

MATERIAL and METHODS

Patient Population

This prospective study was conducted between December 2021 and November 2023 on patients admitted to the algology clinic of our institution with complaints of low back pain and diagnosed with LFJ-induced chronic low back pain and registered in the clinicaltrials.gov database (registration number, NCT06157294). Ethical approval for the study was obtained from our institution (ethics committee decision number, 2002.05.102) and the study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all patients before participation in the study.

Inclusion criteria were defined as the presence of low back pain that persisted for at least 3 months and was considered to have an LFJ origin, no response to previous conservative treatments (analgesic therapy, physical therapy, manual therapy, etc.), pain severity ≥ 6 as assessed by NRS at the time of admission, and subjective pain reduction of ≥50% after intra-articular local anesthetic injection for diagnostic purposes.

Exclusion criteria were as follows: history of previous surgery in the lumbar region, presence of coagulopathy or bleeding diathesis, pregnancy, presence of active infection findings or systemic diseases that may interfere with the interventional procedure, and cognitive impairment such that patients were unable to complete the assessment scales such as NRS and ODI completely and accurately during the follow-up period. A total of 130 patients were initially enrolled in the study. However, 14 patients were excluded from the final analysis owing to loss to follow-up (n=10), incomplete questionnaire data (n=3), or withdrawal of consent (n=1). Consequently, 116 patients were included in the final evaluation (IA-PRF group, n=60; MB-PRF group, n=56). Patients were selected by a researcher not involved in the procedure and were randomized using a computer-generated program. All patients were systematically followed up with NRS and ODI scores at 1 and 6 months.

Procedure

All interventional procedures were performed by a single experienced pain physician, thereby ensuring procedural standardization. All procedures were performed under sterile conditions, in the operating room environment and under fluoroscopic guidance at the levels between L3 and S1, either unilaterally or bilaterally, as determined by clinical and radiologic findings.

In the IA-PRF application, the patient was intravenously accessed and monitored, sterile conditions were provided in the prone position, and the targeted facet joints were determined with appropriate fluoroscopy (Shimadzu Opescope Acteno; Shimadzu Corporation, Kyoto, Japan) angles. A 10-cm-long, 10-mm-active tip, 20-gauge, radiofrequency needle (Cosman RF Injection Electrode; Cosman Medical Inc., Burlington, MA, USA) was advanced into the target joint space. After intra-articular localization was confirmed by fluoroscopic imaging, PRF was applied with radiofrequency generator (G4 radiofrequency generator; Cosman Medical Inc.) using the following parameters: voltage, 45 V; frequency, 2 Hz; pulse width, 20 ms; duration, 6 minutes; and maximum temperature, 42°C. No sensory or motor stimulation was applied during the procedure (Figure 1A).

In MB-PRF, the patient was placed in the prone position and the anatomical localization of the targeted medial branch was determined under fluoroscopic guidance. A 10-cm-long, 10-mm-active tip, 20-gauge, radiofrequency needle was inserted at the intersection of the superior articular process and the transverse process. After the needle position was confirmed with lateral and oblique fluoroscopic projections, paresthesia and contraction in the lumbar region with sensory

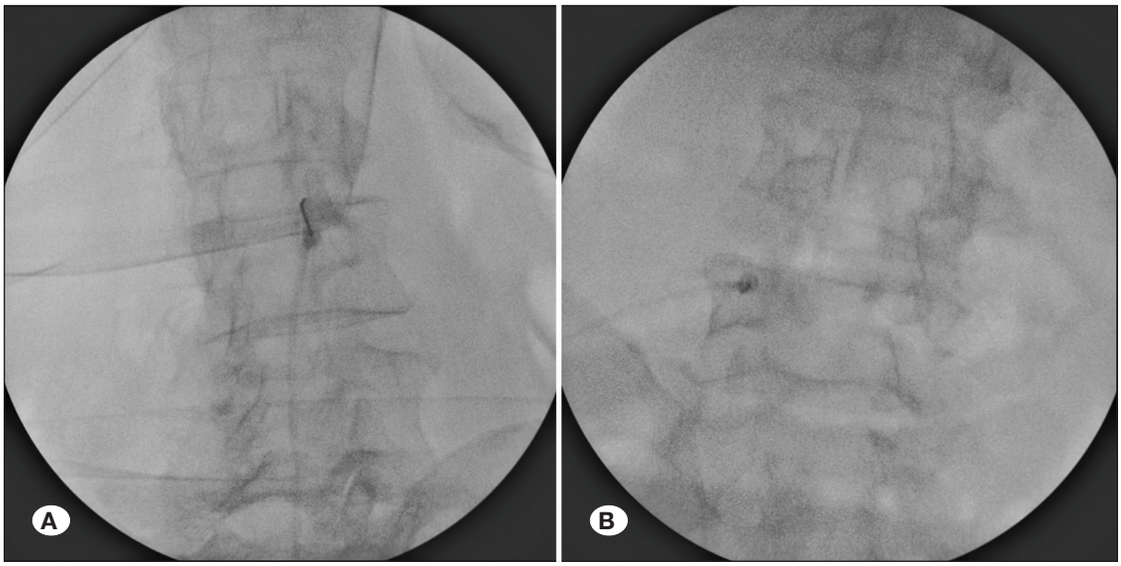

Figure 1: Fluoroscopic images demonstrating PRF techniques for lumbar facet joint pain. **A)** Anteroposterior fluoroscopic image demonstrating IA-PRF, with the cannula advanced into the facet joint space at the L3–L4 level. **B)** Anteroposterior fluoroscopic image showing appropriate placement of the radiofrequency cannula targeting the L5 medial branch for MB-PRF. (**IA-PRF:** intra-articular pulsed radiofrequency, **MB-PRF:** medial branch pulsed radiofrequency, **PRF:** pulsed radiofrequency)

stimulation under 0.5 V and muscle contraction with motor stimulation were observed to confirm the accuracy of nerve localization. PRF was then applied with the same parameters (maximum temperature, 42 °C; voltage, 45 V; frequency, 2 Hz; pulse width, 20 ms; and duration, 6 minutes) (Figure 1B).

After both procedures, patients were discharged on the same day after post-procedural controls and no additional medical treatment was given except for standard post-procedural recommendations.

Clinical Evaluation Criteria

Clinical evaluations of the patients were performed using NRS and ODI scores. These scales were administered to all patients before treatment, and at the 1- and 6-month follow-ups and the data were recorded prospectively.

Statistical Analysis

The distribution of the data obtained in the study was evaluated with histograms and Q-Q graphs; nonparametric analysis methods were preferred for the data that were found not to show normal distribution. Friedman's test was applied for repeated measurements within groups, and in cases where a significant difference was found, pairwise comparisons were made with Wilcoxon signed-rank test. The Mann–Whitney U test was used for intergroup comparisons. Chi-square test was preferred for the analysis of categorical variables. The significance level was accepted as $p<0.05$ in all statistical analyzes. Statistical analyses were performed using JASP software (Version 0.19.3; The JASP Team, Amsterdam, The Netherlands).

RESULTS

Overall, 116 patients were included in the study. Of these, 60 patients were in the IA-PRF group and 56 patients were in the MB-PRF group. The mean age was 59.2 ± 8.17 years in the IA-PRF group and 58.5 ± 8.28 years in the MB-PRF group, and there was no statistically significant difference in age between the groups ($p=0.632$). Gender distribution (IA-PRF: 56.7% female; MB-PRF: 53.6% female, $p=0.738$) and side of administration (right-left-bilateral) ($p=0.831$) were similar between the groups (Table I).

Clinical Variation within Groups

In the IA-PRF group, the mean NRS score reflecting the pain level was 6.55 ± 0.65 before treatment, 3.23 ± 0.43 at 1 month and 3.70 ± 0.46 at 6 months. In the same group, the mean ODI score was 49.70 ± 3.75 at baseline and decreased to 25.13 ± 1.66 at 1 month and 26.90 ± 2.13 at 6 months. When the change over time was analyzed with Friedman test, a statistically significant difference was found in both NRS and ODI scores ($p<0.001$ for both). Pairwise comparisons using the Wilcoxon test showed a significant decrease between pretreatment and both 1-month and 6-month values ($p<0.001$).

Similarly, in the MB-PRF group, the mean pretreatment NRS score was 6.43 ± 0.66, which decreased to 3.13 ± 0.33 at 1 month and 3.57 ± 0.49 at 6 months. ODI scores were 49.18 ± 3.49 at baseline, 24.71 ± 1.34 at 1 month and 26.68 ± 2.20 at 6 months. In the within-group analysis, the change over time was found to be significant for both NRS and ODI using Friedman's test ($p<0.001$) and in pairwise comparisons using Wilcoxon test, statistically significant improvements were obtained at both follow-up times compared to baseline ($p<0.001$). The mean values of the changes in NRS and ODI scores over time in both groups are presented in Figure 2.

Table I: Demographic Characteristics of the Patients

Variable	IA-PRF (n=60)	MB-PRF (n=56)	p-value
Age, years (mean ± SD)	59.2 ± 8.17	58.5 ± 8.28	0.632
Sex, n (%)			0.738
Female	34 (56.7)	30 (53.6)	
Male	26 (43.3)	26 (46.4)	
Side, n (%)			0.831
Right	31 (51.7)	28 (50.0)	
Left	22 (36.7)	23 (41.1)	
Bilateral	7 (11.6)	5 (8.9)	

IA-PRF: *Intra-articular pulsed radiofrequency,* ***MB-PRF:*** *Medial branch pulsed radiofrequency.*

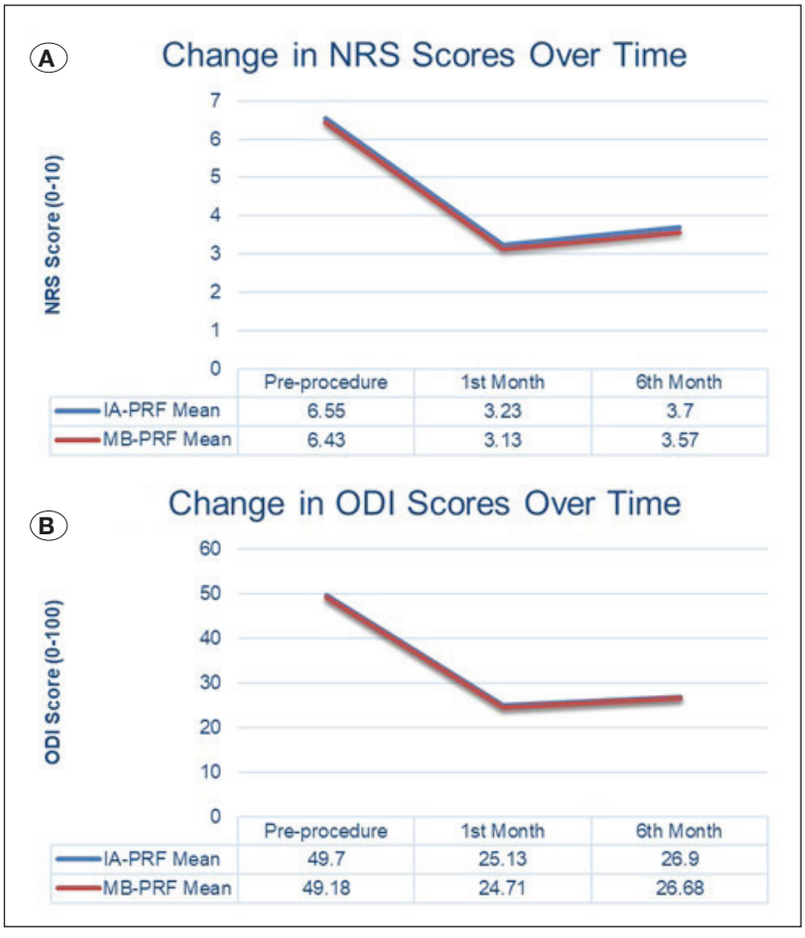

Figure 2: A) Change in NRS scores over time in IA-PRF and MB-PRF groups. **B**) Time course of ODI scores in the same groups. <A statistically significant decrease was found in both groups at the 1st and 6th month follow-ups compared to pretreatment (p 0.001). (**IA-PRF:** intra-articular pulsed radiofrequency, **MB-PRF:** medial branch pulsed radiofrequency, **NRS:** Numerical Rating Scale, **ODI:** Oswestry Disability Index)

Comparison Between Groups

There was no statistically significant difference between IA-PRF and MB-PRF groups in terms of NRS and ODI scores obtained at 1 and 6 months after treatment. At 1 month, NRS scores were 3.23 ± 0.43 in the IA-PRF group and 3.13 ± 0.33 in the MB-PRF group (p = 0.133); at 6 months, these values were 3.70 ± 0.46 and 3.57 ± 0.49, respectively (p=0.153). No significant difference was observed between the groups regarding ODI scores; at 1 month, the mean ODI score was 25.13 ± 1.66 in the IA-PRF group and 24.71 ± 1.34 in the MB-PRF group (p=0.186); at 6 months, it was 26.90 ± 2.13 and 26.68 ± 2.20, respectively (p=0.591).

Table II: Comparison of NRS and ODI Scores Between IA-PRF and MB-PRF Groups at Pre-procedure, 1st Month, and 6th Month

Time Point	Assessment	IA-PRF Mean ± SD (Min – Max)	MB-PRF Mean ± SD (Min – Max)	Intergroup p-value†	Intragroup p-value‡
Pre-procedure	NRS	6.55 ± 0.65 (6-8)	6.43 ± 0.66 (6-8)	0.225	–
Post-procedure 1st Month	NRS	3.23 ± 0.43 (3-4)	3.13 ± 0.33 (3-4)	0.133	**<0.001***
Post-procedure 6th Month	NRS	3.70 ± 0.46 (3-4)	3.57 ± 0.49 (3-4)	0.153	**<0.001***
Pre-procedure	ODI	49.70 ± 3.75 (44-58)	49.18 ± 3.49 (44-58)	0.498	–
Post-procedure 1st Month	ODI	25.13 ± 1.66 (24-30)	24.71 ± 1.34 (22-28)	0.186	**<0.001***
Post-procedure 6th Month	ODI	26.90 ± 2.13 (24-30)	26.68 ± 2.20 (24-30)	0.591	**<0.001***

IA-PRF: *Intra-articular pulsed radiofrequency,* ***MB-PRF:*** *Medial branch pulsed radiofrequency,* ***NRS:*** *Numerical Rating Scale,* ***ODI:*** *Oswestry Disability Index,* ***SD:*** *Standard deviation, † Intergroup comparison by Mann–Whitney U test, ‡ Intragroup change over time by Friedman test, *<0.05 was considered significant.*

Although clinically significant pain and functional improvement was achieved in both treatment groups, the differences between the groups did not reach statistical significance. In addition, no complications developed during the intervention or during the short-term follow-up period in both procedure groups. Detailed findings regarding the comparative analysis of NRS and ODI scores between the groups are presented in Table II.

DISCUSSION

This prospective randomized study compared the short-term results of the efficacy of IA-PRF and MB-PRF in patients with confirmed LFJ pain by diagnostic intra-articular injection. Treatment response was evaluated on the NRS and ODI. Results showed that both methods provided statistically significant clinical improvement in LFJ-induced low back pain; however, there was no significant difference in clinical efficacy between the methods. These results indicate that both IA-PRF and MB-PRF may be effective in the short-term treatment of LFJ-related pain.

LFJ-induced pain is one of the important causes of chronic low back pain and is usually diagnosed with diagnostic injections (7). As recommended in the literature, patients with at least 50% reduction in pain after diagnostic block were included in the present study (8,25,30). Interventional methods are preferred in patients who do not respond to conservative approaches in the treatment of LFJ-induced low back pain (6). Although CRF applied to the medial branch is frequently used, it may cause undesirable effects such as permanent damage to nerve structures, burning sensation and neuritic pain by creating thermal lesions (1,5,6). In this context, PRF applications, which operate at low temperature and provide a neuromodulatory effect with minimal tissue destruction, are considered as a safer alternative (11,18,27). However, there is still no universally accepted gold standard for radiofrequency applications in the treatment of LFJ pain (14).

PRF is an interventional treatment method that works with intermittent electrical energy pulses at low temperature (≤42 °C) and aims to provide analgesic effect without thermal damage to the target tissue, unlike CRF applications (4). Although the mechanism of action of PRF has not been fully explained, available evidence suggests that this method shows neuromodulatory effects at multiple biological levels. Electron microscopic studies have shown that PRF application causes structural changes especially in small diameter C and Aδ fibers involved in nociceptive transmission (11). Moreover, PRF reportedly activates the endogenous opioid system and increases opioid precursor mRNAs and corresponding peptides such as proenkephalin, proopiomelanocortin and prodynorphin (19). In addition, it has been shown in animal models that PRF administration suppresses the expression of proinflammatory cytokines such as tumor necrosis factor-α and interleukin-6, while modulating the expression of genes involved in pain transmission such as GABAB-R1 receptor, Na/K ATPase, 5-HT3 receptor and c-Fos (28). These multilevel biological effects suggest that PRF may be effective not only as a method to suppress nerve conduction, but also through regulation of inflammation and modulation of neuroimmune response.

The target in MB-PRF application is the medial branches of the dorsal spinal nerves that provide sensation of the facet joints (6). These nerves play a role in the transmission of nociceptive inputs, especially in the facet joint capsule and paraspinal soft tissues; pathological examinations have shown that both sensory and autonomic nerve fibers are densely present in these structures (31). With PRF application, pain transmission is inhibited by decreasing neuroexcitability in these nerves (11). However, the anatomical variation of the medial branch nerves makes accurate localization difficult, especially in fluoroscopic interventions, and may cause variable efficacy due to the regenerative capacity of the nerves (10,21,23,29). In addition, the application requires technical skill due to its proximity to the nerve structure and the level of invasiveness is relatively high (20).

IA-PRF is based on direct intra-articular application of the PRF technique and specifically targets the suppression of synovial inflammation and capsular tension (9). It has been shown that the facet joint capsule has intense nociceptive innervation and this area becomes hypersensitized in degenerative processes due to proinflammatory cytokines, synovial hyperplasia and

increased pain mediators in the joint fluid (2). IA-PRF application modulates axoplasmic conduction and cell membrane permeability in local nerve endings by generating an electrical field in this region; thus, the transmission of peripheral nociceptive signals is suppressed and central sensitization of pain can be prevented (9,15). As reported by Schianchi, IA-PRF provides long-term reduction in pain with high success rates when applied in small and large joints (22). Chang et al. showed that IA-PRF application in patients with refractory LFJ pain provided a significant reduction in pain for up to 6 months and no serious complications were reported (4). Do et al. reported that IA-PRF offered similar short-term effects compared to intra-articular steroid injection, but the efficacy lasted longer (9). In addition, IA-PRF may be technically easier to administer than MB-PRF due to the larger target area and may provide a wider analgesic effect with less needle placement (3).

The prospective nature of our study provides an important methodological advantage in terms of data integrity and quality of follow-up. Furthermore, the fact that the patients were selected by diagnostic injection and the evaluation parameters were systematically monitored increases the clinical validity of the findings. The limited number of studies directly comparing these two techniques in the literature makes the findings of our study significant.

Limitations

Although our study was prospectively designed and supported by systematic follow-up data, it has some limitations. First of all, the study was conducted in a single center and the findings reflect only a specific patient population. Although the sample size is considered adequate for interventional pain treatments, multicenter studies are needed to confirm the results in larger clinical settings. Furthermore, only short-term follow-up data (1 and 6 months) were evaluated and long-term treatment efficacy was not analyzed. Another limitation is that contrast agent injection to verify intraarticular spread after RF needle placement was not performed. Instead, correct needle positioning at each level was ensured using anteroposterior, lateral, and oblique fluoroscopic views. These limitations partially limit the external validity of the study and the generalizability of the results.

Future Directions

In order to compare the efficacy of IA-PRF and MB-PRF more clearly and to guide clinical decision-making, multicenter, large-scale and long-term follow-up studies are needed. In addition, separate evaluation of both applications in subgroups with different age groups, degeneration levels and comorbidities may enable the development of patient-based treatment approaches. Further studies investigating the relationship between radiologic imaging findings and treatment response and evaluation of the biological effects of PRF with objective biomarkers or neurophysiologic tests will contribute to a better understanding of treatment mechanisms. Furthermore, the synergistic effects of IA-PRF and combination therapies (e.g. steroid injection or physical therapy) should also be investigated.

CONCLUSION

In this prospective study, the short-term efficacy of IA-PRF and MB-PRF for diagnostically confirmed LFJ pain was compared, and both methods were shown to provide pain control and functional improvement at the 1- and 6-month follow-ups. Although no statistically significant difference was found between the methods, both techniques stand out as effective and safe interventional options. Considering the lack of prospective data directly comparing these two methods in the literature, our study provides original information that will contribute to clinical practice with its findings. The findings support the necessity of individualizing the treatment approach according to patient characteristics. Future studies with larger samples and longer-term follow-up are still needed regarding this topic.

Declarations

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: The authors declare no competing interests.

AUTHORSHIP CONTRIBUTION

Study conception and design: BE, SD, ISE

Data collection: BE, ISE

Analysis and interpretation of results: BE, SD, ISE

Draft manuscript preparation: BE, SD

Critical revision of the article: BE, SD, ISE

All authors (BE, SD, ISE) reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Arias Garau J: Radiofrequency denervation of the cervical and lumbar spine. Phys Med Rehabil Clin N Am 29:139-154, 2018. https://doi.org/10.1016/j.pmr.2017.08.011
2. Ashton IK, Ashton BA, Gibson SJ, Polak JM, Jaffray DC, Eisenstein SM: Morphological basis for back pain: The demonstration of nerve fibers and neuropeptides in the lumbar facet joint capsule but not in ligamentum flavum. J Orthop Res 10:72-78, 1992. https://doi.org/10.1002/jor.1100100109
3. Bogduk N, Long DM: The anatomy of the so-called “articular nerves” and their relationship to facet denervation in the treatment of low-back pain. J Neurosurg 51:172-177, 1979. https://doi.org/10.3171/jns.1979.51.2.0172
4. Chang MC, Cho YW, Ahn DH, Do KH: Intraarticular pulsed radiofrequency to treat refractory lumbar facet joint pain in patients with low back pain. World Neurosurg 112:e140-e144, 2018. https://doi.org/10.1016/j.wneu.2017.12.181
5. Civelek E, Cansever T, Kabatas S, Kırcelli A, Yılmaz C, Musluman M, Ofluoglu D, Caner H: Comparison of effectiveness of facet joint injection and radiofrequency denervation in chronic low back pain. Turk Neurosurg 22:200-206, 2012. https://doi.org/10.5137/1019-5149.JTN.5207-11.1

6. Cohen SP, Bhaskar A, Bhatia A, Buvanendran A, Deer T, Garg S, Hooten WM, Hurley RW, Kennedy DJ, McLean BC, Moon JY, Narouze S, Pangarkar S, Provenzano DA, Rauck R, Sitzman BT, Smuck M, van Zundert J, Vorenkamp K, Wallace MS, Zhao Z: Consensus practice guidelines on interventions for lumbar facet joint pain from a multispecialty, international working group. Reg Anesth Pain Med 45:424-467, 2020. https://doi.org/10.1136/rapm-2019-101243
7. Cohen SP, Raja SN: Pathogenesis, diagnosis, and treatment of lumbar zygapophysial (facet) joint pain. Anesthesiology 106:591-614, 2007. https://doi.org/10.1097/00000542-200703000-00024
8. Cohen SP, Williams KA, Kurihara C, Strassels SA, Foster L, Burney R, Griffith SR, Larkin TM, Crooks M, Nguyen C, Su S, Jones SS: Multicenter, randomized, comparative cost-effectiveness study comparing 0, 1, and 2 diagnostic medial branch (facet joint nerve) block treatment paradigms before lumbar facet radiofrequency denervation. Anesthesiology 113:395-405, 2010. https://doi.org/10.1097/ALN.0b013e3181e33ae5
9. Do KH, Ahn SH, Cho YW, Chang MC: Comparison of intra-articular lumbar facet joint pulsed radiofrequency and intra-articular lumbar facet joint corticosteroid injection for management of lumbar facet joint pain: A randomized controlled trial. Medicine (Baltimore) 96:e6524, 2017. https://doi.org/10.1097/MD.0000000000006524
10. Dreyfuss P, Baker R, Leclaire R, Fortin L, Lambert R, Bergeron Y, Rossignol M: Radiofrequency facet joint denervation in the treatment of low back pain: A placebo-controlled clinical trial to assess efficacy. Spine (Phila Pa 1976) 27: 556-557, 2002. https://doi.org/10.1097/00007632-200203010-00026
11. Erdine S, Bilir A, Cosman ER, Cosman ER Jr: Ultrastructural changes in axons following exposure to pulsed radiofrequency fields. Pain Pract 9:407-417, 2009. https://doi.org/10.1111/j.1533-2500.2009.00317.x
12. Jacobson RE, Palea O, Granville M: Bipolar radiofrequency facet ablation of the lumbar facet capsule: An adjunct to conventional radiofrequency ablation for pain management. Cureus 9:e1635, 2017. https://doi.org/10.7759/cureus.1635
13. Kalichman L, Kim DH, Li L, Guermazi A, Hunter DJ: Computed tomography-evaluated features of spinal degeneration: Prevalence, intercorrelation, and association with self-reported low back pain. Spine J 10:200-208, 2010. https://doi.org/10.1016/j.spinee.2009.10.018
14. Li SJ, Zhang SL, Feng D: A comparison of pulsed radiofrequency and radiofrequency denervation for lumbar facet joint pain. J Orthop Surg Res 18:331, 2023. https://doi.org/10.1186/s13018-023-03814-5
15. Lim JW, Cho YW, Lee DG, Chang MC: Comparison of intraarticular pulsed radiofrequency and intraarticular corticosteroid injection for management of cervical facet joint pain. Pain Phys 20:E961-E967, 2017. https://doi.org/10.36076/ppj.20.5.E961
16. Manchikanti L, Pampati V, Fellows B, Baha AG: The inability of the clinical picture to characterize pain from facet joints. Pain Phys 3:158-166, 2000. https://doi.org/10.36076/ppj.2000/3/158
17. Manchikanti L, Pampati V, Fellows B, Bakhit CE: Prevalence of lumbar facet joint pain in chronic low back pain. Pain Phys 2:59-64, 1999. https://doi.org/10.36076/ppj.1999/2/59
18. Maretto F, Vennik M, Albers KI, van Duijn B: TNFα secretion of monocytes exposed to pulsed radiofrequency treatment: A possible working mechanism of PRF chronic pain management. Pain Pract 14:399-404, 2014. https://doi.org/10.1111/papr.12101
19. Moffett J, Fray LM, Kubat NJ: Activation of endogenous opioid gene expression in human keratinocytes and fibroblasts by pulsed radiofrequency energy fields. J Pain Res 5:347-357, 2012. https://doi.org/10.2147/JPR.S35076
20. Moussa WM, Khedr W: Percutaneous radiofrequency facet capsule denervation as an alternative target in lumbar facet syndrome. Clin Neurol Neurosurg 150:96-104, 2016. https://doi.org/10.1016/j.clineuro.2016.09.004
21. Qi LN, Sun Y, Shi YT, Yang JH, Yang YR, Qin XZ: Comparison of the efficacy of different radiofrequency techniques for the treatment of lumbar facet joint pain: Combined with anatomy. Curr Pain Headache Rep 28:699-708, 2024. https://doi.org/10.1007/s11916-024-01241-7
22. Schianchi PM: A new technique to treat facet joint pain with pulsed radiofrequency. Anesth Pain Med 5:e21061, 2015. https://doi.org/10.5812/aapm.21061
23. Schofferman J, Kine G: Effectiveness of repeated radiofrequency neurotomy for lumbar facet pain. Spine (Phila Pa 1976) 29:2471-2473, 2004. https://doi.org/10.1097/01.brs.0000143170.47345.44
24. Schwarzer AC, Aprill CN, Derby R, Fortin J, Kine G, Bogduk N: Clinical features of patients with pain stemming from the lumbar zygapophysial joints. Is the lumbar facet syndrome a clinical entity? Spine (Phila Pa 1976) 19:1132-1137, 1994. https://doi.org/10.1097/00007632-199405001-00006
25. Sehgal N, Dunbar EE, Shah RV, Colson J: Systematic review of diagnostic utility of facet (zygapophysial) joint injections in chronic spinal pain: An update. Pain Physician 10:213-228, 2007. https://doi.org/10.36076/ppj.2007/10/213
26. Shealy CN: Percutaneous radiofrequency denervation of spinal facets: Treatment for chronic back pain and sciatica. J Neurosurg 43:448-451, 1975. https://doi.org/10.3171/jns.1975.43.4.0448
27. Sluijter ME, Imani F: Evolution and mode of action of pulsed radiofrequency. Anesth Pain Med 2:139-141, 2013. https://doi.org/10.5812/aapm.10213
28. Vallejo R, Tilley DM, Williams J, Labak S, Aliaga L, Benyamin RM: Pulsed radiofrequency modulates pain regulatory gene expression along the nociceptive pathway. Pain Phys 16:E601-E613, 2013. https://doi.org/10.36076/ppj.2013/16/E601
29. van Kleef M, Barendse GA, Kessels A, Voets HM, Weber WE, de Lange S: Randomized trial of radiofrequency lumbar facet denervation for chronic low back pain. Spine (Phila Pa 1976) 24:1937-1942, 1999. https://doi.org/10.1097/00007632-199909150-00013
30. van Wijk RM, Geurts JW, Wynne HJ, Hammink E, Buskens E, Lousberg R, Knape JT, van Kleef M: Radiofrequency denervation of lumbar facet joints in the treatment of chronic low back pain: A randomized, double-blind, sham lesion-controlled trial. Clin J Pain 21:335-344, 2005. https://doi.org/10.1097/01.ajp.0000120792.69705.c9
31. Zhou L, Schneck CD, Shao Z: The anatomy of dorsal ramus nerves and its implication in lower back pain. Neurosci Med 3:192-201, 2012. https://doi.org/10.4236/nm.2012.32025