Eurasian Journal of
Anesthesiology & Intensive Care
Original Article
doi
10.51271/EAJAIC-0045

Ultrasound-guided treatment of cervical facet joint pain: a retrospective comparison of repeated medial branch blocks and pulsed radiofrequency

Çile Aktan*[1], Cemil Aktan[2], Gözde Çelik[3]

[1]Department of Algology, Antalya Training and Research Hospital, Antalya, Turkiye
[2]Department of Orthopedics and Traumatology, Antalya Training and Research Hospital, Antalya, Turkiye
[3]Department of Algology, Malatya Training and Research Hospital, Malatya, Turkiye

Cite this article: Aktan Ç, Aktan C, Çelik G. Ultrasound-guided treatment of cervical facet joint pain: a retrospective comparison of repeated medial branch blocks and pulsed radiofrequency. *Eur J Anesthesiol Intens Care*. 2026;3(1):1-7.

***Corresponding Author:** Çile Aktan, drcilezengin@hotmail.com

Received: 23/12/2025 ◆ **Accepted:** 21/01/2026 ◆ **Published:** 09/02/2026

ABSTRACT

Aims: Ultrasound-guided cervical medial branch interventions are increasingly used for chronic facet-mediated neck pain, yet comparative data between serial cervical medial branch blocks (CMBB) and pulsed radiofrequency (pRF) under ultrasound guidance are limited. This study compared the short- and medium-term clinical outcomes of repeated ultrasound-guided CMBB with those of single-session ultrasound-guided pRF in patients with chronic cervical facet joint pain.

Methods: In this retrospective cohort, 104 patients with clinically and radiologically confirmed cervical facetogenic pain who exhibited ≥50% temporary pain relief after diagnostic medial branch blocks were analyzed. Patients underwent either four weekly ultrasound-guided CMBBs with 0.25% bupivacaine (n=45) or a single ultrasound-guided pRF procedure targeting the cervical medial branches (n=59). Pain intensity (Numeric Rating Scale, NRS), neck-related disability (Neck Disability Index, NDI), and average daily analgesic tablet intake were assessed at baseline and at 1, 3, and 6 months. Responder status was defined as ≥50% reduction in NRS and/or ≥40% improvement in NDI.

Results: Both CMBB and pRF produced significant within-group improvements in NRS, NDI, and analgesic consumption over 6 months (all p<0.001). CMBB yielded faster symptomatic relief, with lower NRS scores at 1 and 3 months (4.16±1.55 vs. 4.69±1.59, p=0.045; and 4.44±1.39 vs. 4.36±2.31, p=0.043) and higher early NRS responder rates at 1 month (77.8% vs. 50.8%, p=0.009). At 6 months, pain, disability, and analgesic use were comparable between groups, and NDI responder rates converged (62.2% vs. 66.1%, p=0.839). Hedges' g values indicated small-to-moderate between-group effect sizes favoring CMBB in the early phase (up to −0.65). No significant complications occurred; minor adverse events were infrequent and self-limiting in both groups.

Conclusion: Both repeated ultrasound-guided CMBB and single-session ultrasound-guided pRF are effective, safe, and feasible options for chronic cervical facet joint pain. CMBB provides more rapid, clinically meaningful improvement, whereas pRF offers comparable medium-term outcomes and may be preferable in patients unable to attend repeated procedures. These findings support individualized treatment selection based on clinical profile, comorbidities, and logistical constraints, and highlight the need for prospective randomized trials to confirm and extend these results.

Keywords: Facet joint pain, ultrasonography, interventional, medial branch block, pulsed radiofrequency treatment, neck pain

INTRODUCTION

Chronic pain originating from the cervical facet joints represents a major contributor to persistent neck discomfort, accounting for a significant proportion of chronic neck pain cases and exerting a considerable socioeconomic burden worldwide.[1] The facet joints receive sensory input from the medial branches of the dorsal rami, which contribute

This work is licensed under a Creative Commons Attribution 4.0 International License.

critically to segmental spinal stability; therefore, they have become important targets in interventional pain treatment strategies.

Among available modalities, conventional radiofrequency (RF) neurotomy is recognized for producing prolonged pain relief by denervating nociceptive medial branches. However, this method can be technically demanding, often necessitating multilevel treatment and carrying a risk of post-procedural neuritis or dysesthesia.[2,3]

In contrast, pulsed radiofrequency (pRF) has been introduced as a minimally invasive alternative that delivers intermittent bursts of high-voltage current at subdestructive temperatures. Rather than ablating neural tissue, pRF modulates nociceptive transmission through controlled electric fields, resulting in reversible changes in neuronal signaling and dorsal horn activity. Previous investigations have confirmed its favorable safety profile and therapeutic efficacy in treating lumbar, thoracic, and cervical facet-related pain syndromes.[4-8] Although the duration of symptom control is often shorter than that achieved with conventional RF, its lower complication rate and improved procedural tolerance make it a valuable clinical option.

Historically, cervical medial branch procedures have been performed under fluoroscopic guidance, which ensures accurate needle localization but exposes both patient and operator to ionizing radiation. Fluoroscopy also has limitations in soft-tissue visualization and typically requires more time and equipment. The advent of ultrasound (US) guidance has addressed many of these drawbacks. US allows real-time imaging of both vascular and neural structures, eliminates radiation exposure, and facilitates bedside applications. Several comparative studies have shown that US-guided cervical medial branch blocks (CMBB) yield analgesic outcomes comparable to those achieved with fluoroscopy, confirming US as a safe and reliable alternative.[9-13]

Despite the growing use of US guidance in cervical medial branch interventions, direct comparative data evaluating US-guided CMBB and US-guided pRF remain absent from the literature.

Although both modalities have been widely investigated as individual treatment options for facet-mediated neck pain, existing studies have predominantly assessed them separately or under fluoroscopic guidance, leaving a significant gap regarding their relative clinical value when performed with US. To address this unmet need, the present study aimed to compare the short- and medium-term therapeutic outcomes of repeated US-guided CMBB and single-session US-guided pRF in patients with cervical facetogenic pain.

We hypothesized that repeated US-guided CMBB would yield more rapid symptom reduction due to their immediate anesthetic effect, whereas US-guided pRF would provide comparable mid-term improvement through neuromodulatory mechanisms. By delineating the temporal patterns of analgesic and functional recovery associated with these two techniques, this study seeks to generate clinically relevant evidence to inform individualized treatment planning in interventional pain practice.

The primary outcome of the study was pain intensity, assessed using the Numeric Rating Scale (NRS). Secondary outcomes included neck-related disability measured by the Neck Disability Index (NDI), changes in daily analgesic consumption, and responder rates based on predefined clinically meaningful thresholds.

METHODS

Ethics

The study protocol was approved by the Clinical Researches Ethics Committee of Antalya Training and Research Hospital (Date: 10.10.2024, Decision No: 15/13), and all procedures adhered to the principles of the Declaration of Helsinki. A formal sample size calculation was not performed, and all eligible patients within the study period were included.

Study Design and Setting

This retrospective, observational study was conducted at the Department of Pain Medicine, Antalya Training and Research Hospital. All interventions performed between June 2023 and June 2025 were retrospectively reviewed from medical records and had been carried out by a single experienced pain specialist with more than seven years of procedural experience, ensuring procedural consistency and minimizing operator-related variability.

Patient Enrollment

A total of 126 patients were screened for eligibility. Twenty-two individuals were excluded due to incomplete treatment sessions or loss to follow-up. The remaining 104 patients constituted the final study cohort, of whom 59 underwent US-guided pRF, and 45 received repeated US-guided CMBB procedures (Figure 1).

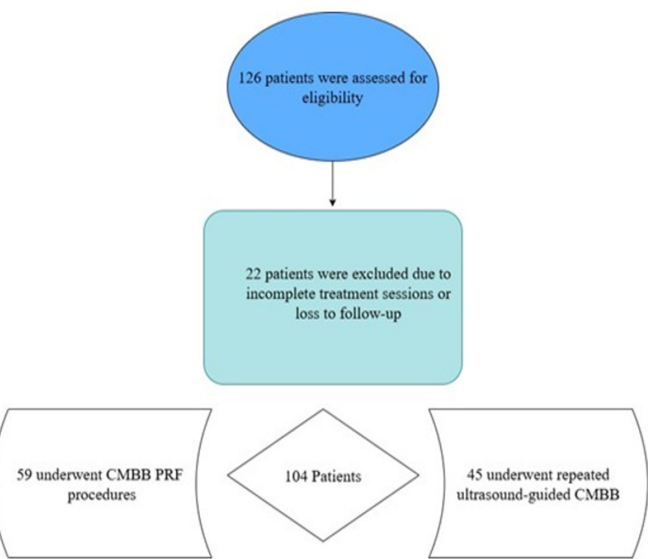

Figure 1. Flow diagram of patient selection and group allocation
Flowchart illustrating the screening, exclusion, and allocation process for patients undergoing either repeated ultrasound-guided CMBB or pRF treatment

Eligibility criteria included adults aged 18 to 80 years with at least 3 months of localized neck pain at the C3 to C6 levels, a baseline NRS of 4 or higher, and a positive response to diagnostic medial branch blocks, defined as at least 50% temporary pain relief at two or more levels. Exclusion criteria were pregnancy, psychiatric disorders, neurologic deficits,

infection, prior cervical spine surgery, and any interventional treatment within the preceding six months. Patients who did not attend follow-up visits or did not complete the planned intervention were also excluded (Figure 2).

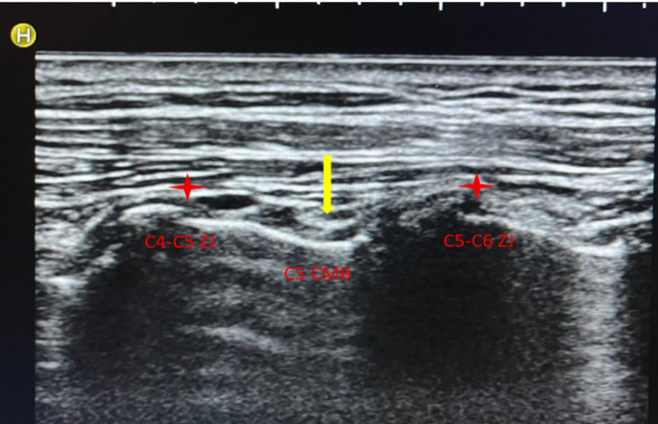

Figure 2. Sonographic localization of the C5 cervical medial branch in the sagittal plane
Sagittal ultrasonographic image showing the anatomical location of the cervical medial branch (yellow arrow) at the C5 level between two adjacent facet joints (asterisks)

Treatment allocation was based on real-world clinical considerations rather than randomization. Patients who were unable to attend repeated weekly sessions, had relative contraindications to repeated injections (e.g., continuous anticoagulant therapy), or had significant mobility or access limitations were preferentially treated with single-session pRF. Patients without these constraints were offered repeated CMBB.

Clinical Workflow

Diagnosis and follow-up were jointly carried out by an orthopedic spine surgeon and a pain physician to ensure diagnostic consistency. All interventions were performed in an outpatient setting. Standard pre-procedural evaluation was completed for each patient, including peripheral intravenous access. No sedation was administered.

Ultrasound Technique

A standardized sagittal out-of-plane US approach was used for both CMBB and pRF procedures. Patients were positioned prone, and a linear transducer operating at 10 to 15 MHz was aligned longitudinally over the paraspinal region to visualize the articular pillar. Under real-time imaging, the needle was advanced toward the medial branch without repositioning the probe, which was particularly advantageous in patients with restricted cervical mobility (Figure 3).

Diagnostic blocks were performed at a minimum of two cervical levels using 1 ml of 2% lidocaine per level. A reduction of at least 50 percent in pain within one hour confirmed facetogenic pain.

Treatment Protocols

CMBB group: Therapeutic injections were administered once weekly for four consecutive sessions using a 22 gauge, 10 cm insulated needle. Correct needle placement was confirmed using sensory stimulation at 50 Hz below 0.5 V and motor stimulation at 2 Hz. After confirmation, 1 ml of 0.25 percent bupivacaine was delivered at each targeted medial branch level. Corticosteroids were not used.

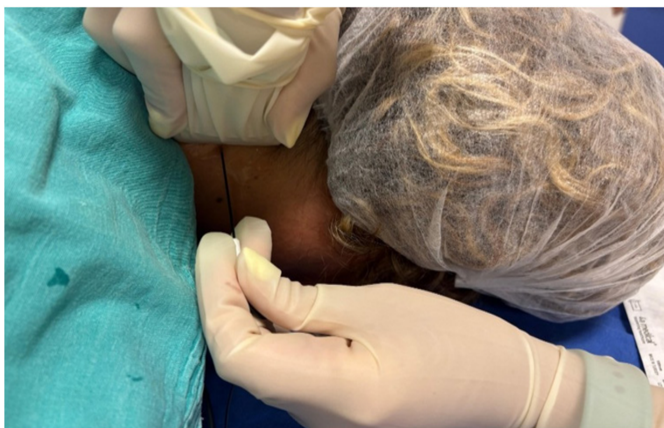

Figure 3. Patient positioning and ultrasound probe placement during cervical medial branch block or pulsed radiofrequency procedure
Patient in prone position with slight cervical flexion. Ultrasound probe positioned longitudinally over the posterolateral neck to identify the articular pillars. Needle insertion performed via an out-of-plane, anterior-to-posterior approach

pRF group: Patients who could not attend repeated sessions or had contraindications to serial injections, such as continuous anticoagulant therapy, severe mobility limitations, or limited access to follow-up visits, underwent single-session pRF one week after diagnostic blocks. Using the same US-guided approach, a 22-gauge, 10 cm RF cannula with a 5 mm active tip was positioned at the medial branch. Positioning was verified by sensory and motor stimulation, and pRF was applied at 65 V and 42 °C for two 120-second cycles. All pRF procedures were performed using identical settings.

Post-Procedure Care

Minor complications occurring within 24 hours were documented through standardized nursing forms. All patients received structured education on daily isometric cervical exercises by a dedicated pain nurse. Exercise adherence was encouraged but not objectively monitored.

Statistical Analysis

Data were analyzed using SPSS version 25 (IBM, Armonk, NY, USA). Quantitative variables were expressed as mean±standard deviation, and categorical variables as frequencies and percentages. Normality of distribution was assessed using the Shapiro–Wilk test. As most continuous variables were non-normally distributed, nonparametric tests were primarily used.

Baseline comparisons between groups used Independent samples t-tests or Mann–Whitney U-tests, as appropriate. Categorical variables were evaluated using Chi-square or Fisher's exact tests. Longitudinal changes in NRS, NDI, and analgesic consumption were assessed using Friedman tests with Bonferroni-adjusted Dunn post hoc analyses. Between-group comparisons at each follow-up were performed using Mann–Whitney U tests. Responder rates were compared using Chi-square or Fisher's exact tests.

Correlations between pain and disability were evaluated using Spearman's rank correlation. Between-group effect sizes were quantified using Hedges' g with 95 percent confidence intervals. Statistical significance was defined as a two-tailed p-value less than 0.05. No imputation for missing data was required because all included patients completed the follow-up assessments.

RESULTS

A total of 104 patients were included in the analysis, comprising 59 individuals in the pRF group and 45 in the CMBB group. Baseline demographic and clinical variables were comparable between groups, with no significant differences in age, sex distribution, or baseline NRS and NDI scores (Table 1).

Pain scores (NRS) improved significantly over time in both treatment arms (p<0.001). In the CMBB group, NRS decreased from 7.89±0.71 at baseline to 4.16±1.55, 4.44±1.39, and 4.78±1.72 at one, three, and six months. Similar reductions were observed in the pRF group, with scores declining from 7.66±0.86 to 4.69±1.59, 4.36±2.31, and 4.64±2.13. Between-group comparisons revealed lower NRS values in the CMBB group at one and three months (p=0.045 and p=0.043), although no significant difference remained at six months. Early NRS responder rates were higher with CMBB at one month (77.8 percent versus 50.8 percent, p=0.009), while responder proportions converged at three and six months (Table 1).

Neck-related disability, measured by the NDI, also improved significantly within both groups (p<0.001). CMBB reduced NDI from 23.73±5.01 to 12.44±5.09 at one month, 12.09±6.09 at three months, and 13.36±5.84 at six months. The pRF group showed comparable improvement from 24.78±4.53 to 15.78±5.16, 12.42±5.45, and 12.83±5.60 across the same time points. Between-group analysis demonstrated better NDI scores with CMBB at one month (p=0.001), but no differences at later follow-up. Responder rates based on a 40 percent NDI reduction were similar between groups throughout follow-up (Table 1).

Pain and disability were positively correlated at baseline and throughout follow-up in both groups. In the CMBB group, Spearman's rho ranged from 0.50 to 0.70 (all p<0.001). Correlations were stronger in the pRF group, with coefficients ranging from 0.61 to 0.77 (all p<0.001) (Table 1).

Analgesic consumption declined significantly in both groups over six months (p<0.001). CMBB reduced daily tablet use from 19.24±4.02 to 10.44±5.51, 9.87±5.94, and 10.53±5.66. The pRF group demonstrated a similar trend, decreasing from 19.80±3.31 to 11.59±5.60, 9.32±6.43, and 9.78±6.21. No significant between-group differences were detected at any follow-up interval. CMBB showed a higher proportion of early analgesic-use responders at one month (p=0.034), but responder rates were comparable thereafter (Figure 4, Table 2).

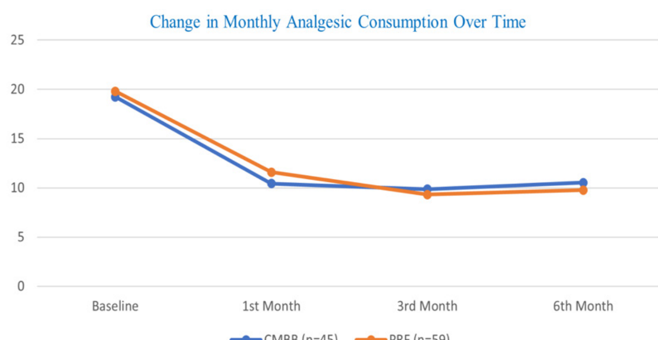

Figure 4. Change in mean daily number of analgesic tablets over time in both treatment groups
Both CMBB and pRF groups showed significant reductions in analgesic consumption from baseline to 6 months (p<0.001, Friedman test). The CMBB group demonstrated an earlier reduction at 1 month (p=0.034, Chi-square test).

No major procedure-related adverse events occurred. Minor events were reported in 14.4 percent of patients, consisting of vascular puncture in 5.8 percent and transient post-procedural discomfort in 8.7 percent. Complication rates did not differ significantly between groups, and all events resolved within 24 to 48 hours (Table 2).

DISCUSSION

To the best of our knowledge, direct head-to-head comparisons between repeated US-guided CMBB and US-guided pRF for the management of chronic facetogenic neck pain remain limited in the existing literature, particularly with respect to medium-term clinical outcomes and real-

Table 1. Pain and disability outcomes following CMBB and pRF treatments

Outcome measure	CMBB (n=45)	pRF (n=59)	p-value	Hedges g (95% CI)
NRS score (baseline)	7.89±0.71	7.66±0.86	0.237	NA
NRS score (1 month)	4.16±1.55	4.69±1.59	0.045	-0.33 (-0.68 to-0.02)
NRS score (3 months)	4.44±1.39	4.36±2.31	0.043	-0.21 (-0.52 to 0.11)
NRS score (6 months)	4.78±1.72	4.64±2.13	0.070	-0.15 (-0.45 to 0.16)
≥50% NRS reduction (1 month)	77.8% (35/45)	50.8% (30/59)	0.009	NA
≥50% NRS reduction (3 months)	75.6% (34/45)	72.9% (43/59)	0.934	NA
≥50% NRS reduction (6 months)	60.0% (27/45)	64.4% (38/59)	0.798	NA
NDI score (baseline)	23.73±5.01	24.78±4.53	0.224	NA
NDI score (1 month)	12.44±5.09	15.78±5.16	0.001	-0.65 (-1.05 to -0.25)
NDI score (3 months)	12.09±6.09	12.42±5.45	0.560	-0.12 (-0.42 to 0.17)
NDI score (6 months)	13.36±5.84	12.83±5.60	0.567	-0.09 (-0.38 to 0.20)
≥40% NDI reduction (1 month)	66.7% (30/45)	55.9% (33/59)	0.364	NA
≥40% NDI reduction (3 months)	68.9% (31/45)	69.5% (41/59)	1.000	NA
≥40% NDI reduction (6 months)	62.2% (28/45)	66.1% (39/59)	0.839	NA

Values are presented as mean±SD or % (n/N). NRS: Numeric Rating Scale, NDI: Neck Disability Index, CMBB: Cervical medial branch block, pRF: Pulsed radiofrequency

Table 2. Analgesic consumption and adverse events following CMBB and pRF treatments

Outcome measure	CMBB (n=45)	pRF (n=59)	p-value
Mean daily analgesic tablet use (baseline)	19.24±4.02	19.80±3.31	0.574
Mean daily analgesic tablet use (1 month)	10.44±5.51	11.59±5.60	0.304
Mean daily analgesic tablet use (3 months)	9.87±5.94	9.32±6.43	0.249
Mean daily analgesic tablet use (6 months)	10.53±5.66	9.78±6.21	0.274
≥50% reduction in analgesic use (1 month)	73.3% (33/45)	50.8% (30/59)	0.034
≥50% reduction in analgesic use (3 months)	77.8% (35/45)	71.2% (42/59)	0.472
≥50% reduction in analgesic use (6 months)	66.7% (30/45)	66.1% (39/59)	0.955
Any minor adverse event	15.6% (7/45)	13.6% (8/59)	0.785
Vascular puncture	6.7% (3/45)	5.1% (3/59)	0.739
Transient post-procedural discomfort	8.9% (4/45)	8.5% (5/59)	0.953

Data are presented as mean±SD or % (n/N). CMBB: Cervical medial branch block; pRF: Pulsed radiofrequency.

world outpatient practice settings. The findings of this study demonstrate that both interventions substantially alleviate pain, improve functional capacity, and reduce analgesic requirements over a six-month follow-up period.

Although both techniques were clinically effective, the CMBB group experienced faster symptomatic improvement, particularly during the first month. This early benefit likely reflects the immediate interruption of nociceptive input by local anesthetic administration. In contrast, pRF exerts its effect through delayed neuromodulatory mechanisms that gradually stabilize dorsal horn excitability. Such temporal divergence between rapid but transient block effects and slower, sustained pRF outcomes is consistent with previous neurophysiological observations in spinal pain management.[15-19] This distinction underscores the fundamentally different mechanisms of action underlying these two interventions and provides a physiological explanation for the observed temporal differences in clinical response.

Effect size analyses indicated that between-group differences were small to moderate, suggesting that while CMBB accelerated early recovery, the overall magnitude of difference was modest and mainly relevant in the short term. The convergence of outcomes at medium-term follow-up supports the possibility that these US-guided interventions may play complementary or interchangeable roles in individualized treatment planning. From an evidence-based perspective, this finding suggests that treatment selection may reasonably be guided by patient-specific priorities such as the need for rapid symptom relief versus procedural convenience.

In addition to statistical significance, improvements should be interpreted relative to established minimal clinically important difference thresholds. An NRS reduction of approximately 2 points and an NDI improvement of 7 to 10 points are generally considered meaningful in cervical spine pain. Both CMBB and pRF exceeded these benchmarks across all follow-up intervals, confirming the clinical relevance of the observed improvements. The early advantage of CMBB likewise surpassed MCID criteria, reinforcing the mechanistic distinction between immediate anesthetic effects and delayed neuromodulation. This observation strengthens the argument that the early superiority of CMBB is not merely statistically detectable but also clinically meaningful.

The stronger correlation between pain intensity and disability observed in the pRF group suggests that neuromodulatory interventions may exert broader central effects on pain processing and functional restoration than peripheral block techniques alone. This observation aligns with the hypothesis that pRF influences both peripheral nociceptors and central sensitization, thereby contributing to more integrated improvements in pain–function. Such an effect may be particularly relevant in patients with features of central sensitization or long-standing chronic pain.

The earlier functional gains in the CMBB group during the first three months are consistent with evidence indicating that local anesthetic-based medial branch blocks can improve cervical mobility and normalize muscle activation patterns.[20] The greater early reduction in analgesic consumption observed in this group further supports its clinical utility, particularly in older patients or those with polypharmacy concerns, in whom minimizing systemic medication exposure is desirable. In this context, CMBB may serve as an effective strategy for short-term functional restoration and medication de-escalation.

Although direct head-to-head US-guided comparisons are lacking, Manchikanti et al.[21] previously evaluated these modalities under fluoroscopic guidance. However, their study employed conventional RF at 80 °C with a tissue-destructive intent, which differs fundamentally from the neuromodulatory mechanism of pRF. Additionally, whereas their protocol distributed repeated blocks over a one-year period, the present study implemented a condensed four-week CMBB schedule. This pragmatic design more closely reflects real-world outpatient practice and may enhance treatment adherence while reducing attrition and procedural burden.

Importantly, no corticosteroids or adjunct anesthetics were used in the pRF arm of the present study, allowing a more accurate assessment of the intrinsic neuromodulatory effects of pRF. This methodological choice strengthens causal interpretation and aligns with emerging evidence demonstrating that pRF alone can provide sustained analgesia without pharmacologic confounding.[22,23] This feature represents a methodological strength of the current study compared with prior mixed-intervention protocols.

From a pragmatic standpoint, treatment allocation reflected common clinical constraints, including anticoagulant therapy, mobility limitations, and difficulty attending repeated appointments. In such scenarios, single-session pRF represented a feasible alternative, whereas CMBB remained appropriate for patients without contraindications

to repeated procedures. These findings support a patient-centered, individualized approach rather than a one-size-fits-all treatment algorithm.

Beyond clinical efficacy, US guidance offers several procedural advantages. The elimination of ionizing radiation enhances long-term safety for both patients and clinicians, while real-time visualization of vascular and neural structures may reduce procedural risk. The out-of-plane sagittal technique used in this study proved time-efficient and allowed multilevel access without frequent probe repositioning, particularly benefiting patients with short necks or limited cervical mobility.

These technical efficiencies carry important economic implications. Reducing the number of visits, avoiding fluoroscopy, and shortening procedural duration may substantially lower healthcare costs, making US-guided interventions especially suitable for outpatient pain practices.[24,25] Furthermore, recent studies have confirmed the accuracy and clinical utility of US-guided pRF, demonstrating outcomes comparable to fluoroscopic approaches.[26-28] The present study extends this growing body of evidence by providing the first medium-term, US-guided comparison of CMBB and pRF within the same clinical framework.

Limitations

This study has several limitations. First, its retrospective and non-randomized design introduces inherent selection bias, as treatment allocation reflected clinical and logistical considerations rather than random assignment. Second, although baseline characteristics were comparable between groups, unmeasured confounders, including chronicity of pain, psychosocial status, and adherence to exercise recommendations, may have influenced treatment response. Third, the six-month follow-up period limits the ability to evaluate long-term durability. Finally, outcomes beyond pain, disability, and analgesic use, such as quality-of-life indices or objective functional assessments, were not examined. These limitations should be considered when interpreting the findings, and prospective randomized studies with longer follow-up are needed to validate and extend these results.

All data were reviewed by an independent spine surgeon blinded to treatment allocation, which reduced the potential for observer bias. While patients were advised to perform isometric cervical exercises, adherence was not objectively verified. Future prospective, multicenter, randomized studies incorporating exercise monitoring or wearable sensors may help elucidate the interaction between neuromodulation, muscular reactivation, and functional recovery.

In addition, existing studies on US-guided medial branch pRF have several limitations that should be acknowledged. Most reports involve small sample sizes, heterogeneous patient populations, or short follow-up periods, and many lack direct comparisons with alternative interventional techniques. Variability in pRF parameters and target localization further limits cross-study comparability. These gaps in the literature highlight the need for standardized protocols and comparative designs, which the present study partially addresses by evaluating two US-guided modalities within the same clinical framework.

CONCLUSION

As a result, both repeated US-guided CMBB and single-session US-guided pRF demonstrated significant and clinically meaningful improvements in pain, disability, and analgesic consumption over a six-month follow-up period. CMBB provided faster early-phase symptom relief, likely reflecting the immediate interruption of nociceptive input by local anesthetics, whereas pRF achieved comparable medium-term outcomes through sustained neuromodulatory effects. The favorable safety profile and absence of major complications in both groups support the feasibility of US-guided approaches as practical and well-tolerated interventions for chronic cervical facetogenic pain. Given the non-randomized treatment allocation and potential for unmeasured confounding, these results should be interpreted cautiously. Prospective randomized trials with longer follow-up and broader functional outcome measures are needed to establish comparative effectiveness and inform optimal patient selection strategies more definitively.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study protocol was approved by the Clinical Researches Ethics Committee of Antalya Training and Research Hospital (Date: 10.10.2024, Decision No: 15/13).

Informed Consent

As this was a retrospective study, formal written informed consent was not required and was therefore not obtained.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

Concept: Ç.A., G.Ç.; Methodology: Ç.A., G.Ç.; Data Collection and Investigation: G.Ç.; Formal Analysis: C.A., Ç.A.; Writing–Original Draft: Ç.A.; Writing–Review and Editing: Ç.A., G.Ç., C.A.; Supervision: C.A.; Critical Review: All authors.

REFERENCES

1. Manchikanti L, Singh V, Rivera J, Pampati V. Prevalence of cervical facet joint pain in chronic neck pain. *Pain Physician*. 2002;5(3):243-249. Erratum in: *Pain Physician*. 2002;5(4):445.
2. Groen GJ, Baljet B, Drukker J. The innervation of the spinal dura mater: anatomy and clinical implications. *Acta Neurochir (Wien)*. 1988;92(1-4):39-46. doi:10.1007/BF01401971. PMID: 3407473
3. Tekin I, Mirzai H, Ok G, Erbuyun K, Vatansever D. A comparison of conventional and pulsed radiofrequency denervation in the treatment of chronic facet joint pain. *Clin J Pain*. 2007;23(6):524-529. doi:10.1097/AJP.0b013e318074c99d

4. Kroll HR, Kim D, Danic MJ, Sankey SS, Gariwala M, Brown M. A randomized, double-blind, prospective study comparing the efficacy of continuous versus pulsed radiofrequency in the treatment of lumbar facet syndrome. *J Clin Anesth*. 2008;20(7):534-537. doi:10.1016/j.jclinane.2008.05.013
5. Chang MC. Effect of pulsed radiofrequency treatment on the thoracic medial branch for managing chronic thoracic facet joint pain refractory to medial branch block with local anesthetics. *World Neurosurg.* 2018; 111:e644-8. doi:10.1016/j.wneu.2017.12.141
6. Mikeladze G, Espinal R, Finnegan R, Routon J, Martin D. Pulsed radiofrequency application in treatment of chronic zygapophyseal joint pain. *Spine J.* 2003;3(5):360-362. doi:10.1016/s1529-9430(03)00065-2
7. Liliang PC, Lu K, Hsieh CH, Kao CY, Wang KW, Chen HJ. Pulsed radiofrequency of cervical medial branches for treatment of whiplash-related cervical zygapophysial joint pain. *Surg Neurol.* 2008;70(Suppl 1): S1:50-55. doi:10.1016/j.surneu.2008.07.006
8. Chang MC, Yang S. Effectiveness of pulsed radiofrequency on the medial cervical branches for cervical facet joint pain. *World J Clin Cases.* 2022;10(22):7720-7727. doi:10.12998/wjcc.v10.i22.7720
9. Chen CK, Wong CC, Teo YY, Phui VE. Single entry posterior parasagittal approach radiofrequency neurotomy of cervical medial branch: a feasible alternative to conventional approaches in the treatment of cervical facet pain. *Int J Spine Surg.* 2021;15(6):1192-200. doi:10.14444/8151
10. Han SH, Park KD, Cho KR, Park Y. Ultrasound versus fluoroscopy-guided medial branch block for the treatment of lower lumbar facet joint pain: a retrospective comparative study. *Medicine (Baltimore).* 2017;96(16):e6655. doi:10.1097/MD.0000000000006655
11. Park KD, Lim DJ, Lee WY, Ahn J, Park Y. Ultrasound versus fluoroscopy guided cervical medial branch block for the treatment of chronic cervical facet joint pain: a retrospective comparative study. *Skeletal Radiol*. 2017;46(1):81-91. doi:10.1007/s00256-016-2516-2
12. Finlayson RJ, Etheridge JP, Tiyaprasertkul W, Nelems B, Tran DQ. A randomized comparison between ultrasound- and fluoroscopy-guided C7 medial branch block. *Reg Anesth Pain Med*. 2015;40(1):52-57. doi:10.1097/AAP.0000000000000186
13. Siegenthaler A, Mlekusch S, Trelle S, Schliessbach J, Curatolo M, Eichenberger U. Sonographically guided cervical facet nerve and joint injections: why sonography? *J Ultrasound Med.* 2013;32(11):1885-1892. doi:10.7863/ultra.32.11.1885
14. Bogduk N, Dreyfuss P, Govind J. A narrative review of lumbar medial branch neurotomy for the treatment of back pain. *Pain Med.* 2009; 10(6):1035-1045. doi:10.1111/j.1526-4637.2009.00692.x
15. Van Zundert J, Patijn J, Kessels A, Lamé I, van Suijlekom H, van Kleef M. Pulsed radiofrequency adjacent to the cervical dorsal root ganglion in chronic cervical radicular pain: a double blind sham controlled randomized clinical trial. *Pain.* 2007;127(1-2):173-182. doi:10.1016/j.pain.2006.09.002
16. Bogduk N. Pulsed radiofrequency. *Pain Med*. 2006;7(5):396-407. doi:10.1111/j.1526-4637.2006.00210.x
17. Byrd D, Mackey S. Pulsed radiofrequency for chronic pain. *Curr Pain Headache Rep.* 2008;12(1):37-41. doi:10.1007/s11916-008-0010-3
18. Choi GS, Ahn SH, Cho YW, Lee DG. Long-term effect of pulsed radiofrequency on chronic cervical radicular pain refractory to repeated transforaminal epidural steroid injections. *Pain Med*. 2012; 13(3):368-375. doi:10.1111/j.1526-4637.2012.01333.x
19. Malec-Milewska M, Buczek M, Sęk M. Pulsed radiofrequency for the treatment of cervical and lumbar facet joint pain. *Neurol Neurochir Pol.* 2021;55(1):70-77. doi:10.5603/PJNNS.a2020.0080
20. Manchikanti L, Hirsch JA, Falco FJ, et al. Management of lumbar facet joint pain: a systematic review of the evidence. *Pain Physician*. 2015; 18(6):E535-82.
21. Manchikanti L, Kosanovic R, Pampati V, Sanapati MR, Hirsch JA. Outcomes of cervical therapeutic medial branch blocks and radiofrequency neurotomy: clinical outcomes and cost utility are equivalent. *Pain Physician*. 2022;25(1):35-47.
22. Galiano K, Obwegeser AA, Walch C, et al. Ultrasound-guided facet nerve block in the cervical spine: a computed tomography-controlled feasibility study. *Reg Anesth Pain Med.* 2005;30(6):552-556. doi:10.1016/j.rapm.2005.07.005
23. Bodor M, Murthy N, Uribe Y. Ultrasound-guided cervical facet joint injections. *Spine J.* 2022;22(6):983-992. doi:10.1016/j.spinee.2022.01.011
24. Kietaibl S, Ferrandis R, Godier A, et al. Regional anaesthesia in patients on antithrombotic drugs: joint ESAIC/ESRA guidelines. *Eur J Anaesthesiol*. 2022;39(2):100-132. doi:10.1097/EJA.0000000000001600
25. Moster M, Bolliger D. Perioperative guidelines on antiplatelet and anticoagulant agents: 2022 update. *Curr Anesthesiol Rep.* 2022;12(3): 286-296. doi:10.1007/s40140-021-00511-3
26. Alsaeid MA, Algyar MF, Mahmoud AM, Farghaly OS, Salah AG, Raouf MM. Ultrasound-guided high-voltage pulsed radiofrequency versus standard-voltage pulsed radiofrequency in refractory chronic cervical radicular pain randomized clinical trial. *J Anesth*. 2025. doi:10.1007/s00540-025-03535-5
27. Lai J, Wu Y, Xiang Y, Wang Y. A novel transverse ultrasound-guided approach for puncturing the cervical dorsal root ganglion at the level of articular pillar for radiofrequency treatment. *J Pain Res.* 2024;17:3473-3485. doi:10.2147/JPR.S479986
28. Chalermkitpanit P, Pannangpetch P, Kositworakitkun Y, et al. Ultrasound-guided pulsed radiofrequency of cervical nerve root for cervical radicular pain: a prospective randomized controlled trial. *Spine J.* 2023;23(5):651-655. doi:10.1016/j.spinee.2023.01.004