ORIGINAL ARTICLE

PULSED RADIOFREQUENCY WITH TRANSFORAMINAL EPIDURAL STEROID INJECTION FOR LUMBAR DORSAL ROOT GANGLION: A RETROSPECTIVE STUDY COMPARING GERIATRIC AND YOUNGER PATIENTS WITH RADICULAR PAIN

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Abstract

Introduction: Radicular lower extremity pain is a major cause of disability among geriatric individuals. Pulsed radiofrequency treatment to the dorsal root ganglion and transforaminal epidural steroid injection are minimally invasive therapies. This study evaluated the effectiveness of combination treatments for lower-extremity radicular pain in both geriatric and younger patients and evaluated the effect of paraspinal muscle degeneration on treatment success.

Materials and Method: A retrospective analysis of 123 patients with lower extremity radicular pain treated with pulsed radiofrequency treatment to the dorsal root ganglion and transforaminal epidural steroid injection was performed. Patients were assigned to younger (18–64 years) and geriatric (≥ 65 years) groups based on age. Pain intensity was assessed using Numeric Rating Scale before the procedure and at the 12-week follow-up. Fatty infiltration was assessed by lumbar magnetic resonance imaging using the Goutallier classification. Treatment success was defined as a ≥50% reduction in the baseline Numeric Rating Scale score.

Results: No postoperative complications were observed. The treatment success rates were 50.7% and 46.4% in the younger and geriatric groups, respectively (p=0.633). Geriatric patients exhibited significantly more fatty degeneration and a longer duration of pain than younger patients. However, these differences did not exhibit an effect on treatment success between the groups.

Conclusion: Pulsed radiofrequency treatment combined with transforaminal epidural steroid injection appears to be an effective and safe treatment option for radicular pain regardless of age. Although paraspinal muscle fatty degeneration is more pronounced in older adults, it does not negatively affect the early clinical outcomes.

Keywords: Injections, Epidural; Geriatric Assessment; Magnetic Resonance Imaging; Pain Measurement; Pulsed Radiofrequency Treatment; Radiculopathy.

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INTRODUCTION

Radicular leg pain affects 13-40% of adults and is associated with degenerative spinal abnormalities such as lumbar disc herniation and spinal canal or foraminal stenosis which are highly prevalent in the general population (1,2). These conditions are associated with significant functional impairment, diminished quality of life, and high healthcare costs (3). Radicular pain is caused by mechanical compression and inflammation of the dorsal root ganglion (DRG) or spinal nerve, resulting in nociceptive signaling(1).

Initial management typically includes non-interventional approaches, such as medications (e.g., nonsteroidal anti-inflammatory drugs, gabapentinoids, and serotonin-norepinephrine reuptake inhibitors), combined with physical therapy to improve function and relieve pain. Lifestyle modifications and ergonomic education are also recommended to limit symptom progression (2). Minimally invasive interventional procedures are recognized as alternatives to surgery for patients with severe symptoms (2).

Pulsed radiofrequency (PRF) of the DRG is a promising modality for treating radicular pain. PRF delivers short bursts of radiofrequency energy at subneuroablative temperatures, altering pain transmission pathways without causing permanent nerve damage (4). This selective neuromodulation may suppress nociceptive input through functional changes in the DRG(5). PRF is more selective and has fewer side effects than conventional radiofrequency ablation (RFA), and it can be performed even in patients with neuropathic or highly neural-sensitive conditions(6).

The efficacy of PRF has been demonstrated clinically (7,8);however, outcomes may vary across patient populations. Recent studies have examined the musculoskeletal system, particularly, the role of lumbar paravertebral muscle structure in spinal column stability and the pathophysiology of chronic pain(9). The Goutallier classification is an MRI-based system that categorizes the fat content of the paravertebral muscles on a scale from 0 to 4. It serves a reliable prognostic tool for evaluating spinal pathology and sarcopenia (10). This classification has previously been used to evaluate the lumbar erector spinae plane block in patients with axial back pain (11). However, its role in predicting the success of PRF treatment for radicular pain remains unclear.

No study to date has compared the efficacy of PRF for lower extremity radicular pain between geriatric and younger populations or investigated the impact of paraspinal muscle structure. This study aimed to compare the efficacy of PRF treatment between geriatric and younger patients and to evaluate treatment success according to the Goutallier classification and post-procedure opioid use.

MATERIALS AND METHOD

Study Design and Approval

This retrospective observational study was approved by the local ethics committee (Approval No: 2024-1140) and registered with ClinicalTrials.gov (NCT06903949). The study analyzed the records of patients who underwent PRF and transforaminal epidural steroid injection (TFESI) targeting to the lumbar dorsal root ganglia under fluoroscopic guidance for the treatment of chronic lower extremity radicular pain between October 1, 2023, and October 1, 2024.

Participants and Data Collection

Electronic medical records were reviewed to identify patients who received PRF and TFESI under fluoroscopic guidance to the lumbar DRG. Patients were categorized into geriatric (≥65 years) and younger (18–64 years) groups (Figure 1). Extracted data included demographic characteristics, pain scores, and lumbar MRI findings. Inclusion criteria were: age ≥18 years, chronic lower extremity radicular pain, failure of conservative treatment

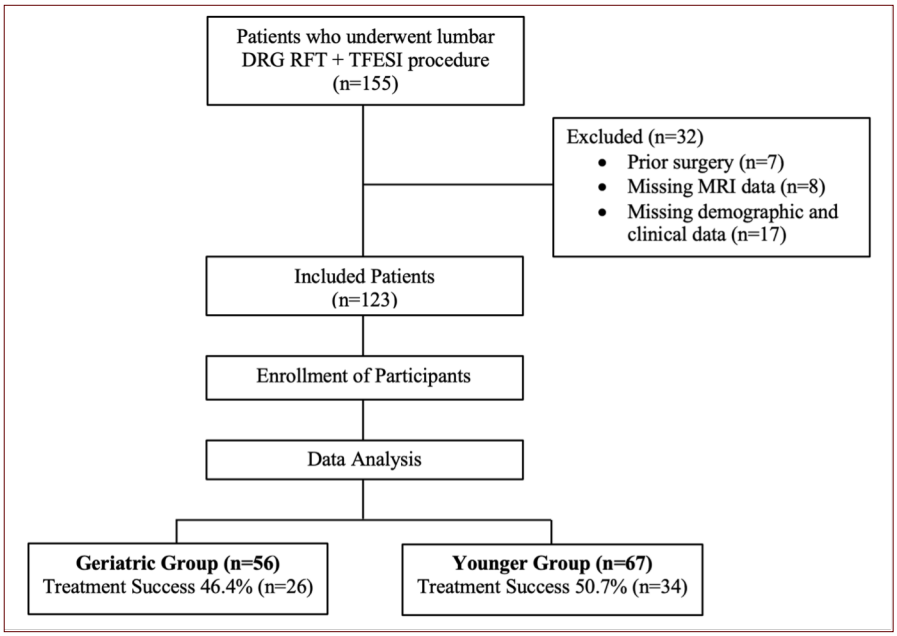

Figure 1. Design of the study

(medical or physical therapy) for at least 3 months, and availability of complete clinical and radiological records, including a lumbar spine MRI performed within 1 year before the procedure. Patients were excluded if their clinical or radiological records were incomplete or missing, or if they had a history of lumbar spine surgery or interventional procedures.

Pulsed Radiofrequency and Transforaminal Epidural Steroid Injection Application

All interventions were performed under fluoroscopic guidance by four interventional pain physicians, each with at least 3 years of experience. Patients were placed in the prone position, and sterile technique was maintained. Fluoroscopy (General Electric OEC One CFD C-Arm; Beijing, China) was used to target the lumbar DRG. A 20-gauge, 10-cm radiofrequency cannula with a 10-mm active tip (TOP Neuropole Needle; TOP Corporation, Japan) was inserted via a transforaminal approach using an ipsilateral oblique trajectory to enhance needle accuracy (Figure 2). Needle placement was confirmed using motor and sensory stimulation. PRF was applied at 5 Hz, 50 V, 20 milliseconds for 240 s at 42°C using an RF generator (TOP Lesion Generator; TOP Corporation, Japan). Following PRF, an injectate consisting of 5 mg bupivacaine (0.5% concentration), 4 mg dexamethasone, and isotonic saline (total volume: 3 mL) was administered. All patients were monitored for complications post-procedure; no adverse events were reported.

Data collected included demographic and clinical variables such as age, sex, body mass index (BMI, kg/m^2), comorbidities, duration of radicular pain (months), and post-procedural opioid use. Pain intensity was measured using a Numerical Rating Scale (NRS) ranging from 0 (no pain) to 10 (worst pain possible).

NRS scores were recorded before the procedure and 12 weeks post-procedure. Treatment success was defined as a ≥50% reduction in NRS score at 3 months post-procedure. Radiological assessment focused on paraspinal muscle fat infiltration on lumbar MRI at the third vertebral level.

The degree of infiltration was assessed using the Goutallier classification: grade 0 (no fat), grade 1

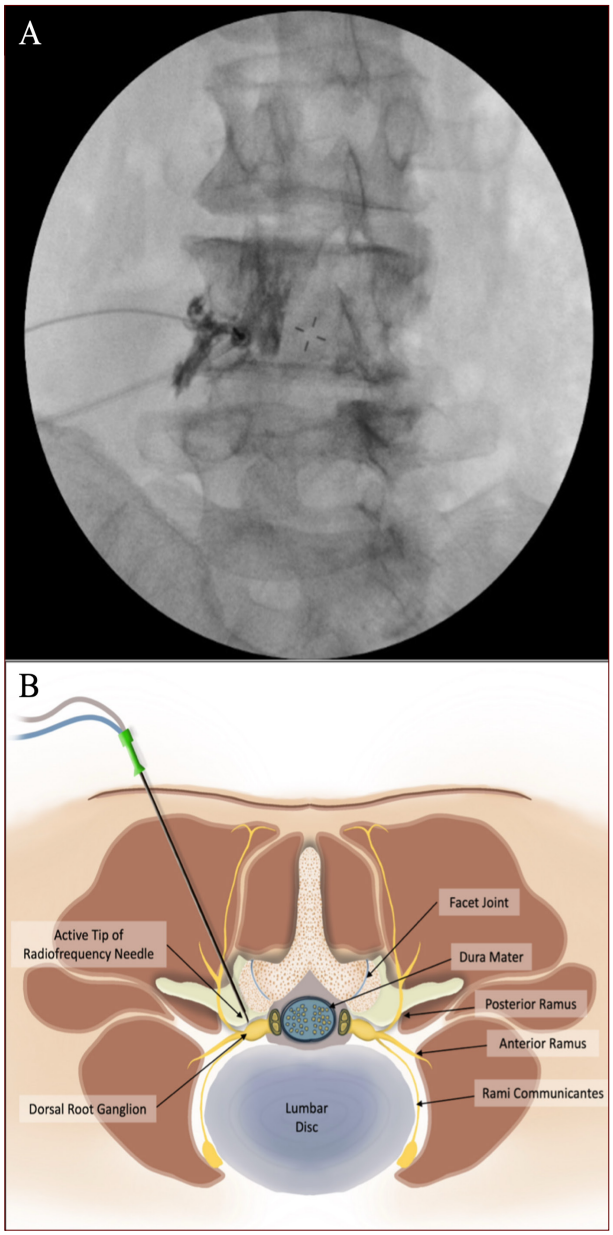

Figure 2. A: Oblique fluoroscopic image showing ipsilateral lumbar DRG needle positioning and contrast spread pattern indicating correct anterior epidural placement
B: Axial view showing the technique of lumbar transforaminal injection with radiofrequency needle targeting lumbar DRG (illustrated by Ufuk Turan)

(DRG: Dorsal Root Ganglion)

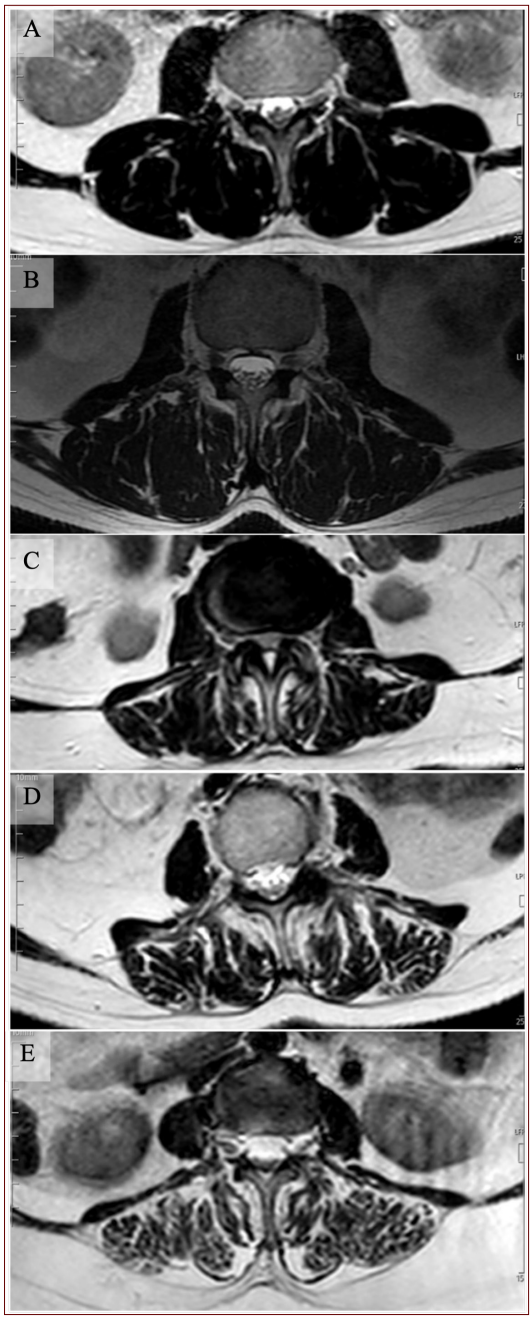

Figure 3. T2-weighted axial sections at the third lumbar vertebra level. The Goutallier classification: (A) Grade 0, no visible fat streaks; (B) Grade 1, minimal fat streaks; (C) Grade 2, more muscle than fat; (D) Grade 3, equal fat and muscle; (E) Grade 4, more fat than muscle.

(minimal fatty streaks), grade 2 (more muscle than fat), grade 3 (equal muscle and fat),and grade 4 (more fat than muscle). Patients were categorized as having mild (grades 0–1), moderate (grade 2), or severe (grades 3–4) infiltration (Figure 3).

Statistical Analysis

Data analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics included mean ± standard deviation (SD), median with interquartile range (Q1–Q3), frequencies, and percentages. Comparisons between geriatric and younger groups were made using the Mann–Whitney U test for continuous variables and Pearson's chi-square test or Fisher's exact test for categorical variables. Spearman's correlation test was used for correlation analyses. Univariate binary logistic regression was performed to identify factors associated with treatment success. A p-value <0.05 was considered statistically significant.

RESULTS

This retrospective study included 123 patients. The mean age was 59.38 ± 14.67 years, with 67 patients in the younger group and 56 in the geriatric group. The geriatric group was significantly older than the younger group (p<0.001), as age served as the criterion for classification (Table 1). There was no significant difference in BMI between the groups (p=0.534).

Table 1. Comparison of Demographic, Clinical, and Procedural Characteristics Between Younger and Geriatric Patient Groups

Variable		All Participants (n=123)	Younger Group (n = 67)	Geriatric Group (n = 56)	p-value
Continuous Variables (Mean ± SD)					
Age (years)		59.38 ± 14.67	48.72 ± 10.87	72.14 ± 5.44	<0.001*
BMI (kg/m²)		24.07 ± 2.36	24.18 ± 2.30	23.95 ± 2.44	0.534*
Continuous Variables (Median [Q1-Q3])					
Pain Duration (months)		15 [10-20]	12 [9-18]	18 [12-24]	0.001*
Number of DRG Levels		2 [1-2]	2 [1-2]	2 [1-2]	0.397*
Baseline NRS		6 [5-7]	6 [5-7]	6 [5-7]	0.831*
Control NRS		3 [2-5]	3 [2-5]	3 [2-5]	0.996*
Goutallier Grade		2 [1-2]	2 [1-2]	2 [2-3]	<0.001*
-Mild (0-1)		34 (27.6%)	29 (43.2%)	5(8.9%)	
-Moderate (2)		64 (52%)	36 (53.7%)	28 (50%)	
-Severe (3-4)		25 (20.3%)	2 (3%)	23 (41.1%)	
Categorical Variables n (%)					
Gender	Male	44 (35.7%)	29 (43.3%)	15 (26.8%)	0.087§
	Female	79 (64.2%)	38 (56.7%)	41 (73.2%)	
Comorbidity (present)		83 (67.4%)	35 (52.2%)	48 (85.7%)	**<0.001§**
Opioid Consumption		22 (17.8 %)	9 (13.4%)	13 (23.2%)	0.241§
Unilateral DRG Intervention		117 (95.1%)	64 (95.5%)	53 (94.6%)	1.000§
Successful Treatment		60 (48.7%)	34 (50.7%)	26 (46.4%)	0.633§

Values are presented as mean ± standard deviation (SD), median [first and third quartile] or number (percentage). BMI = Body Mass Index, DRG: Dorsal Root Ganglion, NRS: Numeric Rating Scale. Bold p-values indicate statistical significance (p<0.05). *Mann–Whitney U test, §Chi-square test.

Table 2. Spearman Correlation Coefficients Between Variables and Binary Logistic Regression Analysis of Factors Associated with Treatment Success

Correlation Variables		Goutallier Grade	Control NRS	Basal NRS	Age	BMI	Pain Duration	DRG Level Number
Goutallier Grade	r	1	0.158	**0.257**	**0.623**	0.004	**0.343**	0.041
	p	-	0.080	**0.004**	**0.000**	0.964	**0.000**	0.649
Control NRS	r		1	**0.365**	0.066	**0.188**	0.012	-0.061
	p		-	**0.000**	0.466	**0.037**	0.891	0.500
Basal NRS	r			1	0.05	0.082	0.116	**0.195**
	p			-	0.579	0.365	0.201	**0.03**
Age	r				1	-0.107	**0.352**	0.072
	p				-	0.238	**0.000**	0.428
BMI	r					1	-0.05	-0.04
	p					-	0.586	0.659
Pain Duration	r						1	0.136
	p						-	0.132
DRG Level Number	r							1
	p							-

Binary Logistic Variables	B	OR	95% CI		p	Reference Category
			Lower	Upper		
Age	0.015	1.015	0.99	1.04	0.238	-
Age Group	0.173	1.189	0.584	2.42	0.633	Younger Group
BMI (kg/m^2)	0.128	1.137	0.974	1.327	0.104	-
Comorbidity (Yes/No)	0.072	1.075	0.505	2.286	0.851	Comorbidity Presence
Gender (Male/Female)	0.360	1.433	0.684	3.005	0.341	Male
Pain Duration (Months)	0.009	1.009	0.976	1.042	0.605	-
DRG Level Number	-0.473	0.623	0.302	1.286	0.201	-
Basal NRS	0.253	1.288	0.924	1.798	0.136	-
Control NRS	2.958	19.262	5.846	63.472	**<0.001**	-
Goutallier Grade	0.319	1.376	0.818	2.314	0.229	-

B: Regression Coefficient, CI: Confidence Interval, OR: Odd's Ratio, r: Spearman's Correlation Coefficient, BMI: Body Mass Index; DRG: Dorsal Root Ganglion; NRS: Numeric Rating Scale. Bold p-values indicate statistical significance (p<0.05).

The duration of radicular pain was significantly longer in the geriatric group (p=0.001). The number of DRG levels treated, as well as baseline and post-procedure NRS scores, were similar between groups (p>0.05). All procedures were well tolerated, with no complications during the procedure or follow-up.

Goutallier grading was significantly higher in the geriatric group (p<0.001). Mild fat infiltration

(grades 0–1) was observed in 43.2% of the younger group, compared to 8.9% in the geriatric group. Advanced fat infiltration (grades 3–4) was found in 3% of the younger group and 41.1% of the geriatric group.

Comorbidities were significantly more common in the geriatric group ($p<0.001$). There were no significant differences between groups in sex, post-procedural opioid use, or laterality of DRG PRF and TFESI interventions ($p>0.05$).

Treatment success, defined as a ≥50% reduction in the baseline NRS score, was achieved in 50.7% of the younger group and 46.4% of the geriatric group, with no statistically significant difference ($p=0.633$).

Spearman correlation analysis showed a significant positive correlation between Goutallier grade and age ($p<0.001$), pain duration ($p<0.001$), and baseline NRS score ($p=0.004$) (Table 2). A borderline positive correlation was also observed between Goutallier grade and follow-up NRS score ($p=0.08$). Third-month NRS scores were positively correlated with baseline NRS scores ($p<0.001$) and BMI ($p=0.037$) (Table 2).

Univariate binary logistic regression analysis showed that follow-up NRS score was significantly associated with treatment success ($p<0.001$). No other variables were significantly associated with treatment success ($p>0.05$).

DISCUSSION

This study evaluated the safety and effectiveness of PRF and TFESI treatments applied to the lumbar DRG in geriatric and younger patients. In this regard, it offers a novel contribution to the literature. The data analysis revealed similar treatment success rates between the two groups. However, age and paraspinal muscle fatty infiltration were significantly associated with pain duration and intensity. Nonetheless, the Goutallier score did not predict the success of PRF and TFESI treatment.

Degenerative conditions such as disc herniation and spinal stenosis severely affect quality of life. While conservative, non-surgical approaches are generally the first line of treatment, minimally invasive procedures are often necessary in long-standing or refractory cases(12). PRF and TFESI targeting the DRG are commonly employed in this setting. PRF induces neuromodulation via pulsed currents at tissue temperatures ≤42°C, providing a safer profile than conventional radiofrequency (neurolysis), which uses higher heat(13). It modulates nociceptive transmission by affecting conduction in the C and A-delta fibers(8,14). In a 1-year follow-up study, pain reduction of was observed in 45.9% of cases(15). Our study's success rate of 48.72% is consistent with existing literature.

Although our study used a combination of DRG PRF and TFESI, it is important to note the clinical results when each modality is applied individually must be taken into account. There have been rather many studies involving the application of PRF and TFESI as isolated interventions. For instance, PRF has been reported to induce long-term effects in chronic radicular pain, but TFESI appears to be more effective at the subacute phases (12). A randomized controlled trial comparing PRF and TFESI did not demonstrate a statistically significant difference in pain or disability scores, leading to the conclusion that PRF may be a viable alternative to corticosteroid injections for radicular pain, particularly in patients who are not appropriate candidates for corticosteroid injections (16). In contrast, favorable outcomes have been documented with the combined use of PRF and TFESI, including prolonged pain relief and functional improvement observed over a 12-month follow-up period (17). In a randomized controlled trial patients who failed to respond to repeated TFESI demonstrated substantial clinical improvement with high-voltage PRF (18). These results are consistent with the overall therapeutic literature that there could be some synergistic effect of combined treatment interven-

tion, particularly in patients chosen appropriately. This prospective effect shall be further investigated by randomized monotherapy versus combination treatment patterns in age or pathology-stratified patient groups to identify a more defined treatment pathway.

The influence of age on PRF and TFESI outcomes has been reported with varying results. One study comparing different PRF voltage levels found age was not a determining factor in treatment success(13). Another study combining PRF with TFESI showed better outcomes in patients aged 55 and older compared to those receiving only TFESI(19). However, other studies did not find a significant link between age and treatment response(20). Similarly, our analysis did not identify age as an independent predictor of treatment success, suggesting that the combination of PRF and TFESI may be effective regardless of age-related anatomical changes.

Fatty infiltration of the paraspinal muscles is a degenerative change that increases with age. Originally developed for assessing rotator cuff muscles, the Goutallier classification has been adapted to evaluate lumbar muscle degeneration(21). Mandelli et al. demonstrated a moderate-to-strong correlation between Goutallier grades and quantitative MRI-based fat measurements(10). Tamai et al. found that fatty infiltration correlates with age and decreased lumbar lordosis(9). Such age-related muscle degeneration can be observed even in otherwise healthy individuals(22). Importantly, fatty infiltration is not merely structural but is also linked to Modic changes, increased pain, and functional decline(23).

In our study, while the Goutallier grade correlated with age, pain duration, and baseline NRS scores, it was not predictive of treatment success. This suggests that paraspinal muscle degeneration may not adversely affect outcomes following PRF and TFESI. In the geriatric population, such degeneration is often part of sarcopenia and should be addressed with a multidisciplinary approach, not solely interventional pain treatments(24).

Evans et al. emphasized that in older adults, assessing muscle quality, not just mass, is crucial(24). Functional assessment, in addition to volume measurement, is necessary for a comprehensive understanding(24). In one study on chronic low back pain in older adults, sarcopenia prevalence reached 40%, supporting the high Goutallier scores observed in our geriatric group(25). The fact that these structural changes did not alter PRF and TFESI outcomes implies that neuromodulation may act independently of muscle quality.

Overall, our findings suggest that PRF and TFESI are safe and effective for managing radicular pain, even in older patients with structural paraspinal muscle changes. This supports their use as a promising alternative for older patients who are not surgical candidates or who have failed conservative treatments. Additionally, considering the potential functional limitations owing to diminished muscle quality, integrating post-PRF rehabilitation and exercise programs may further enhance treatment outcomes.

One of the strengths of this study is its evaluation of treatment effectiveness across age groups while incorporating morphological factors such as paraspinal muscle fat infiltration. The comparison between geriatric and younger patients provides valuable insight into the applicability of PRF and TFESI across diverse populations.

However, this study also has several limitations. Its retrospective design limits the ability to establish causality. The 12-week follow-up period may be insufficient to evaluate the long-term effectiveness of the treatment. Additionally, the Goutallier classification was evaluated using a single MRI slice; this could be improved with quantitative imaging techniques such as Dixon or IDEAL (Iterative Decomposition of Water and Fat with Echo Asymmetry and

Least-Squares Estimation). Another limitation is that treatment efficacy was assessed solely using the NRS. Future studies should incorporate functional scoring systems, such as the Oswerty Disability Index and the 36-Item Short Form Survey, to provide a more comprehensive evaluation of clinical impact.

Randomized controlled trials are needed to further investigate the effects of PRF parameters (e.g., voltage, frequency, and duration) tailored to age and muscle quality, as well as to evaluate the role of post-procedural rehabilitation strategies in optimizing outcomes.

CONCLUSION

The combination of PRF and TFESI appears to be a safe and effective treatment option for managing lower-extremity radicular pain, even in the context of age-related degenerative changes. Fatty infiltration of the paraspinal muscles in geriatric patients did not significantly impact short-term treatment response. Nevertheless, because of the potential effects of muscle degeneration on balance and functional capacity, PRF and TFESI should be integrated into a broader, multidisciplinary treatment approach. Future research focusing on personalized PRF protocols and interventions aimed at improving muscle quality may further enhance clinical outcomes.

Conflict of Interest

The authors declare that they have no conflict of interest related to this study.

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