Turk J Phys Med Rehab 2024;70(3):390-396
DOI: 10.5606/tftrd.2024.13479
Available online at www.turkishjournalpmr.com

Original Article

Does transforaminal epidural steroid injection added to dorsal root ganglion pulsed radiofrequency treatment increase efficacy?

Gokhan Yildiz[1], Hamit Goksu[2], Erkan Yavuz Akcaboy[3], Seref Celik[3], Mustafa Yemliha Ayhan[3], Samet Sancar Kaya[4]

[1]Department of Algology, Ankara Etlik City Hospital, Ankara, Türkiye
[2]Department of Algology, Dr. Abdurrahman Yurtaslan Oncology Training and Research Hospital, Ankara, Türkiye
[3]Department of Algology, Ankara Bilkent City Hospital, Ankara, Türkiye
[4]Department of Algology, Adıyaman University Training and Research Hospital, Adıyaman, Türkiye

ABSTRACT

Objectives: This study aimed to compare the treatment outcomes between dorsal root ganglion (DRG) pulsed radiofrequency (PRF) and DRG PRF plus transforaminal epidural steroid injection (TFESI) in patients with chronic lumbosacral radicular pain.

Patients and methods: Eighty-one patients (39 males, 42 females; mean age: 57.5±11.9 years; range 18 to 65 years) who underwent DRG PRF (Group 1) and 59 patients (34 males, 25 females; mean age: 58.7±12.3 years; range 18 to 65 years) who underwent DRG PRF plus TFESI (Group 2) between February 2021 and June 2022 were enrolled in the retrospective study. A Visual Analog Scale (VAS) was used to assess pain severity. Patients in both groups were evaluated before treatment and at four weeks and six months after treatment.

Results: The four-week and six-month VAS scores were significantly lower than the baseline VAS scores in both groups. There was no significant difference between the groups in terms of the VAS scores at baseline, four weeks, and six months. There was no significant difference between the groups in terms of the rate of pain reduction of 50% or more at either measurement point. The presence or absence of a previous lumbar surgery had no effect on achieving a significant decrease in pain.

Conclusion: Although DRG PRF and TFESI are easy to apply together, adding corticosteroids to DRG PRF treatment for patients with chronic radicular pain did not improve long-term outcomes.

Keywords: Fluoroscopy, intervertebral disc, neuropathic pain, postlaminectomy syndrome, pulsed radiofrequency treatment, steroids.

The prevalence of lumbar disc pathology and associated radicular symptoms can reach up to 43% in the general population.[1] In patients with lumbosacral radicular pain (LRP), the primary goal is to relieve pain and achieve functional recovery; however, it is equally important to make the process cost-effective. Manchikanti et al.[2] emphasized that 87.6 billion dollars were spent on lower back and neck pain in the USA in 2013. Owing to increasing health costs, minimally invasive methods that shorten the length of hospital stay, increase the number of functionally active days, and reduce the loss of workforce are steadily gaining importance.

Interventional methods can be applied to patients with LRP if severe pain persists for more than three months and the pain does not decrease with conservative methods, such as analgesics and physical therapy applications.[3] Dorsal root ganglion (DRG) pulsed radiofrequency (PRF) and transforaminal epidural steroid injection (TFESI) are among the most frequently applied interventions. Transforaminal epidural steroid injection has been added to DRG PRF treatment by many clinicians since these two interventions can be performed in the same session through the same needle entry. However, it is debatable whether steroids added to

Corresponding author: Gokhan Yildiz, MD. Ankara Etlik Şehir Hastanesi, Algoloji Kliniği, 06170 Yenimahalle, Ankara, Türkiye
E-mail: gkoyldz@gmail.com

Received: July 12, 2023 **Accepted:** January 17, 2024 **Published online:** July 26, 2024

Cite this article as: Yildiz G, Goksu H, Akcaboy EY, Celik S, Ayhan MY, Kaya SS. Does transforaminal epidural steroid injection added to dorsal root ganglion pulsed radiofrequency treatment increase efficacy?. Turk J Phys Med Rehab 2024;70(3):390-396. doi: 10.5606/tftrd.2024.13479.

DRG PRF treatment improve outcomes, and there is limited data in the literature.[1] This study aimed to contribute to the literature by comparing the effectiveness of DRG PRF and DRG PRF plus TFESI in patients with LRP.

PATIENTS AND METHODS

One hundred sixty-two patients who underwent DRG PRF and combined DRG PRF and TFESI for LRP at the Ankara Bilkent City Hospital, Department of Algology between February 2021 and June 2022 were selected for the retrospective study. Patients who did not meet the inclusion criteria and those whose records could not be obtained were excluded; thus, 140 patients were included in the study. A patient flow chart is shown in Figure 1. The inclusion criteria for the study were as follows: *(i)* patients with LRP for more than 12 weeks, with or without lumbar disc surgery (without implants); *(ii)* compatibility of radicular pain symptoms with magnetic resonance imaging (MRI) findings; *(iii)* only bulging or disc protrusion on MRI; *(iv)* intervention at one or two lumbar levels in only one session according to the affected level; and *(v)* inadequate response to previous epidural steroid injection, physical therapy, and medical treatment options, including gabapentinoids and weak opioids. The exclusion criteria were as follows: *(i)* extruded or sequestered disc on MRI; *(ii)* severely narrow vertebral canal and intervertebral foramen; *(iii)* Grade ≥2 spondylolisthesis; *(iv)* severe motor deficit; *(v)* diabetes mellitus; and *(vi)* additional intervention for other reasons, such as facet joint injections. The patients were evaluated in two groups: the group treated with DRG PRF (Group 1) included 81 patients (39 males, 42 females; mean age: 57.5±11.9 years; range 18 to 65 years), and the group treated with DRG PRF plus TFESI (Group 2) included 59 patients (34 males, 25 females; mean age: 58.7±12.3 years; range 18 to 65 years).

After hemodynamic monitoring and intervention site cleaning, position and needle targeting were adjusted by C-arm fluoroscopy as described by Simopoulos et al.[4] After the patient was connected to the radiofrequency generator, the position of the end of the needle was visualized anteriorly and laterally by C-arm fluoroscopy. Paresthesia response was obtained in the related dermatome by giving a sensory stimulus between 0.4 and 0.7 V at a frequency of 50 Hz. The absence of contraction in the relevant myotome was checked by providing a stimulus between 0.8 and 1.5 V at a frequency of 2 Hz. Impedance was maintained below 400 ohms. The patients in Group 1 were treated with PRF at 42°C for 120 sec per level. The patients in Group 2 were treated with PRF at 42°C for 120 sec per level. Afterward, the appropriate epidural spread was confirmed by administering 2 mL of contrast agent. At each level, 8 mg of dexamethasone was administered. All patients were followed up in the recovery unit for 60 min after the intervention and were discharged without complications. A fluoroscopic view of needle placement for left-sided lumbar DRG PRF application and TFESI is shown in Figures 2, 3, and 4.

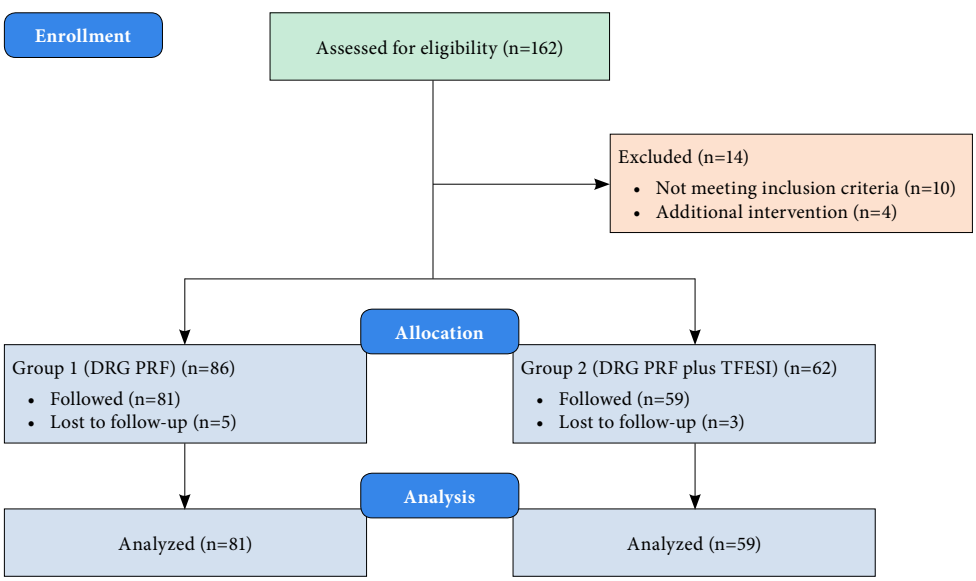

Figure 1. Patient flow chart.
DRG: Dorsal root ganglion; PRF: Pulsed radiofrequency; TFESI: Transforaminal epidural steroid injection.

A Visual Analog Scale (VAS) was used to assess pain. Pain was rated from 0 (no pain) to 10 (unbearable pain). Patients in both groups were evaluated before treatment and at four weeks and six months after treatment. By evaluating each group within itself, we determined whether there was a significant difference between the VAS scores before and after treatment. In the evaluation of the patients at four weeks and six months after treatment, a pain reduction of 50% or more was considered clinically significant. We evaluated whether there was a significant difference between the groups in the rates of patients who achieved 50% or more pain reduction at four weeks and six months. In addition, it was determined whether a 50% or greater reduction in VAS score was associated with parameters such as sex, history of lumbar surgery, and duration of pain.

Statistical analysis

Data were analyzed using IBM SPSS version 25.0 software (IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov and Shapiro-Wilk tests were used for normality analysis. Categorical data were expressed as numbers and percentages (%). Numerical variables with a normal distribution were shown as mean ± standard deviations (SD), and nonnormally distributed numerical variables were shown as medians and interquartile ranges. The chi-square test was used to compare categorical variables between the two groups. The independent samples t-test and Mann-Whitney U test were used to compare numerical variables according to their normal distribution. Binary logistic regression analysis was performed to detect the variables associated with 50% or more reduction in pain at four weeks and six months. A p-value <0.05 was considered statistically significant.

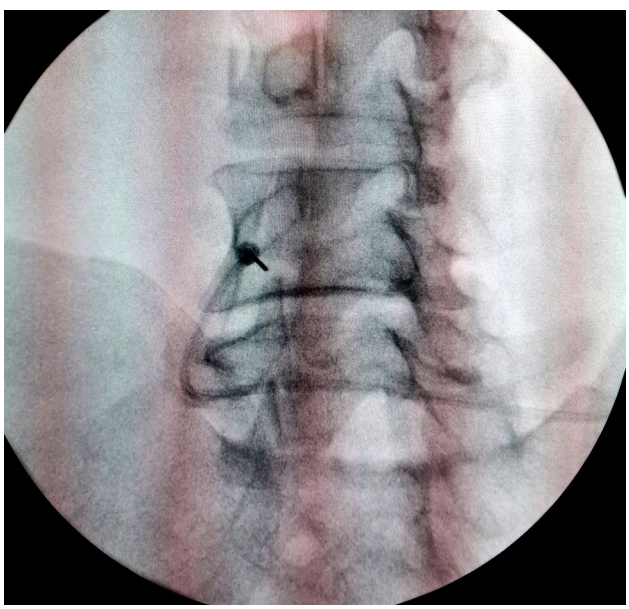

Figure 2. Left oblique view and appropriate needle placement.

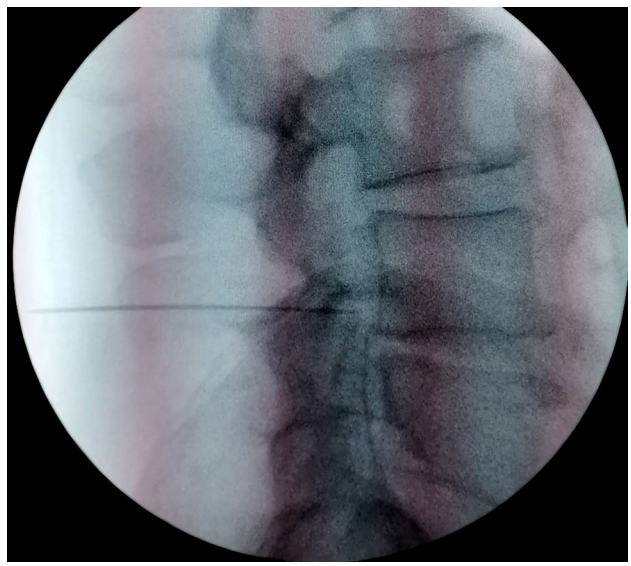

Figure 3. Lateral view of the needle in the intervertebral foramen.

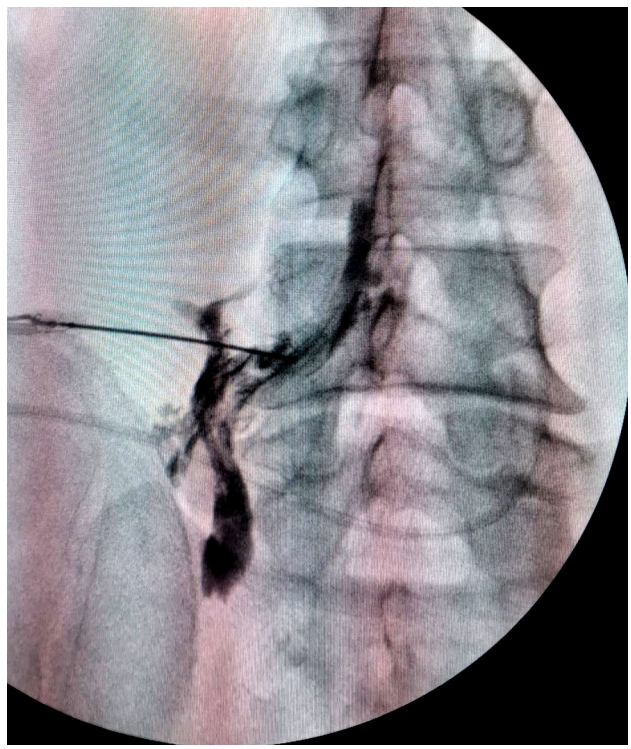

Figure 4. Appropriate transforaminal epidural contrast agent spread.

TABLE 1
Demographic and clinical characteristics of the groups

	Group 1 (DRG PRF) (n=81)					Group 2 (DRG PRF plus TFESI) (n=59)					
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	*p*
Age (year)			57.5±11.9					58.7±12.3			0.575[a]
Sex											0.268[b]
Female	39	48.1				34	57.6				
Male	42	51.9				25	42.4				
Body mass index (kg/m^2)			27.64±3.01					28.03±2.69			0.423[a]
Side of pain											0.454[b]
Right	45	55.6				29	49.2				
Left	36	44.4				30	50.8				
Treatment level											0.546[b]
Single level	44	54.3				29	49.2				
Two-level	37	45.7				30	50.8				
Duration of pain (year)			3.72±2.60					2.88±1.21			0.131[c]
Operation history											0.416[b]
No history of surgery	55	72.4				44	78.6				
Surgery before treatment	21	27.6				12	21.4				
VAS 0th				8.0	8.0-8.8				8.0	7.0-8.0	0.181[c]
P[d] (VAS 0th - VAS 4th week)			<0.001					<0.001			
VAS-4th week				6.0	5.0-7.0				4.0	3.0-6.0	0.543[c]
P[d] (VAS 4th week - VAS 6th month)			0.020					<0.01			
VAS-6th month				7.0	6.0-8.0				5.0	4.0-6.0	0.373[c]
P[d] (VAS 0th - VAS 6th month)			<0.001					<0.001			

DRG PRF: Dorsal root ganglion pulsed radiofrequency; TFESI: Transforaminal epidural steroid injection; SD: Standard deviation; VAS: Visual analog scale; a Independent t test; b Chi-Square test; c Mann-Whitney U test; d Wilcoxon signed-rank test.

TABLE 2
Comparison of 50% or more pain reduction at four weeks and six months between treatment groups

		DRG PRF grup (n=81)		DRG PRF plus TFESI group (n=59)	
		Count	Within treatment	Count	Within treatment
		n	%	n	%
VAS 0th - 4th week	No meaningful difference	52	43	43	72.9
	Meaningful difference	29	35.8	16	27.1
VAS 0th - 6th month	No meaningful difference	58	71.6	46	78.0
	Meaningful difference	23	28.4	13	22.0

DRG-PRF: Dorsal root ganglion pulse radiofrequency; TFESI: Transforaminal epidural steroid injection, VAS: Visual analog scale.

RESULTS

The mean duration of pain was 3.72±2.60 years in Group 1 and 2.88±1.21 years in Group 2. While the number of patients who had undergone lumbar surgery before treatment was 21 (27.6%) in Group 1, it was 12 (21.4%) in Group 2, and there was no significant difference between the groups. No significant differences were found between the demographic and clinical characteristics of the groups at baseline ($p>0.05$). The demographic and clinical characteristics are shown in Table 1.

In Groups 1 and 2, the median VAS scores did not significantly differ between the groups at baseline, four weeks, and six months ($p>0.05$). The four-week and six-month VAS scores were significantly lower than the baseline in Groups 1 and 2 ($p<0.001$ for both). The four-week VAS score was significantly lower than the six-month VAS score in Groups 1 and 2 ($p=0.020$ and $p<0.01$, respectively).

The proportion of patients who achieved a pain reduction of 50% or more at four weeks was 35.8% in Group 1 and 27.1% in Group 2. The proportion of patients who achieved a pain reduction of 50% or more at six months was 28.4% in Group 1 and 22.0% in Group 2. There was no significant difference between the two groups in terms of the rate of significant reduction in pain at four weeks (chi-square test, $p=0.277$) or six months (chi-square test, $p=0.395$). Comparisons of patients achieving 50% or more pain reduction at four weeks and six months between the groups are shown in Table 2.

Regression analysis, including variables such as history of previous lumbar surgery, sex, pain duration, level, and side of the intervention, revealed no significant association between these variables and a pain reduction of 50% or more ($p>0.05$).

DISCUSSION

In our study, DRG PRF and DRG PRF plus TFESI provided significant decreases in pain scores compared to baseline at follow-up appointments. However, there was no significant difference in the pain scores between the groups, and the addition of TFESI to DRG PRF treatment did not contribute to pain relief in patients with LRP.

Foraminal narrowing originating from the intervertebral disc and exposure to the chemical structure of the nucleus pulposus can cause inflammation of the neurovascular structures, including the DRG.[3] Inflammatory cytokines and neuropeptides are continuously released from glial cells due to mechanical and chemical damage. This causes a continuous afferent input in the DRG, triggering spontaneous hyperactivity. In a radicular pain model created in rats, it was shown that PRF treatment applied to the DRG reduces the automaticity responsible for neuropathic pain by decreasing glial cell activity and levels of the calcitonin gene-related peptide.[5] Pulsed radiofrequency can generate high-intensity electric fields, and the transmembrane cell potential may be affected within these electric fields. Thus, subcellular and biomolecular changes can occur without high temperatures.[6] Proinflammatory mediators, such as tumor necrosis factor alpha and interleukin-6, have been shown to be decreased.[7] It has also been demonstrated that while serotonin and gamma-aminobutyric acid increase in the DRG and spinal cord after DRG PRF treatment, excitatory amino acids, such as glutamate, are decreased.[8]

In a study evaluating the efficacy of PRF in rats with and without sciatic nerve damage, allodynia, hyperalgesia, and neuropathic pain were reduced within four weeks of applying PRF to the damaged sciatic nerve.[9] This four-week period was essential

for evaluating the effectiveness of PRF therapy. We also performed the first evaluation of the patients in our study four weeks after treatment. Although pain scores were lower in the DRG PRF plus TFESI group than in the DRG PRF group at four-week and six-month follow-up examinations, these differences were not statistically significant. Ding et al.[1] divided their patients into three groups and applied TFESI, TFESI plus DRG PRF, and only DRG PRF in their study. Similar to the results of our study, they did not find a significant difference between VAS scores at three-month and six-month follow-up examinations between the TFESI plus DRG PRF and DRG PRF groups.

Another important issue related to PRF treatment is patient selection and the effects of patients' characteristics on treatment success. Van Boxem et al.[10] found that the percentage of patients who achieved 50% or more pain reduction with DRG PRF treatment was 22.9% at six months. In that study, PRF therapy was applied for 2 min per level. Due to the low success rate in that study, Van Boxem et al.[11] also performed a prospective study in which they included only patients with disc herniation, excluding patients with spinal stenosis and postlaminectomy syndrome. In their prospective study, they applied PRF treatment for 4 min per level and achieved a success rate of 55.4%.[11] Both studies suggested that DRG PRF treatment was less successful in cases of spinal stenosis and postlaminectomy syndrome. However, PRF was applied for a longer period in the second study than in the first. Abejón et al.[12] provided adequate analgesia in cases of disc herniation and spinal stenosis with DRG PRF treatment, but they did not effectively decrease the VAS scores of patients with postlaminectomy syndrome. In contrast, Chao et al.[13] reported that previous lumbar surgery had no effect on the success of DRG PRF. These differences in success rates may be related to PRF application times and patients' characteristics. In our study, we applied PRF treatment for 2 min per level, and the proportion of patients who had pain reduction of 50% or more at four weeks in the DRG PRF group was 35.8%, while this rate was 28.4% at six months. Previous lumbar surgery had no effect on the pain scores after treatment in either group. The effects of application time of DRG PRF treatment are controversial. Antiallodynic effects were significantly increased by increasing the application time from 2 to 6 min in an animal model in which nerve damage was caused by resiniferatoxin.[14] This time-dependent effect of PRF therapy has not been formally evaluated in human studies. Although the application times vary in the literature, PRF is generally applied for 2 min per level. Treatment success may be increased by increasing the application time; however, prospective studies are needed on this subject.

Transforaminal epidural steroid injection is an essential treatment because it provides direct access to the anterior epidural space at the level of narrowing.[15] The anti-inflammatory effects of steroids are well established. In addition, they are thought to be effective by inhibiting neural transmission, stabilizing neural membranes, and increasing neural blood flow.[3] Despite these positive features of epidural steroid applications, only their short-term efficacy has been demonstrated, and their long-term efficacy remains controversial.[16] In addition, the most important factor for successful epidural steroid administration is the duration of symptoms before treatment.[17] The mean duration of symptoms was 3.04±3.28 months in patients with good results and 7.96±9.04 months in patients whose pain scores remained high. In our study, the mean duration of symptoms was 3.72±2.60 years in Group 1 and 2.88±1.21 years in Group 2, constituting a significant difference. On the other hand, in 2014, the USA Food and Drug Administration (FDA) issued a fact sheet on rare but serious adverse events such as epidural steroid-induced vision loss and stroke. In addition, the FDA issued a warning regarding the use of steroids in epidural applications.[3] After cases of spinal cord infarction with particulate steroids,[18] cord infarction developing with dexamethasone has been reported, although nonparticle steroids seem safer.[19] In our study, no complications were observed in either group of patients.

This study has several limitations. We could not use a scale to evaluate the effects of the applied treatment on functional capacity. Another limitation of our study was that the follow-up period was limited to six months, and there were no longer-term results.

In conclusion, although DRG PRF and TFESI can be applied through the same needle entry, we found that adding TFESI to DRG PRF treatment, particularly in patients with long-term chronic radicular pain, had no effect on treatment results. Considering the critical side effects of steroids, it is possible that the addition of steroids should be avoided in patients with chronic LRP if DRG PRF treatment is applied. However, further randomized controlled studies are needed on this subject.

Ethics Committee Approval: The study protocol was approved by the Ankara Bilkent City Hospital Ethics Committee (date: 11.01.2023, no: E1-23-3203). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, control/supervision,: G.Y., E.Y.A., Ş.Ç.; Design: G.Y., S.S.K.; Data collectionand/or processing: G.Y., H.G., M.Y.A.; Analysis and/or interpretation, critical review: H.G., E.Y.A.; Literature review: G.Y., S.S.K., M.Y.A.; Writing the article: G.Y., Ş.Ç.; References and fundings: M.Y.A.; Materials: G.Y., S.S.K.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

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