Investigation of the Effects of Pulsed Radiofrequency Application of the Thoracal Dorsal Root Ganglion on Postherpetic Neuralgia and Post-thoracotomy Pain Syndromes

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Abstract

Aim: The causative agent of herpes zoster (HZ) is the reactivated varicella-zoster virus. HZ leads to severe and painful rashes that can be accompanied by long-term pain, i.e., postherpetic neuralgia (PHN). According to the International Association for the Study of Pain (IASP), post-thoracotomy pain syndrome (PTPS) is defined as "recurrent or persistent pain along the thoracotomy incision at least two months after surgery"[8].

Methods: In this study, the medical records of all the patients were reviewed for age, gender, size, thoracic level, cause of pain, and visual analog scale (VAS) and DN4 scores from the patient files maintained in the archive of the Department of Algology. Two cycles of pulse radiofrequency (PRF) were administered for 2 min each. Then, a total of 5 ml of dexamethasone, lidocaine, bupivacaine, and isotonic solutions of 4 mg, 20 mg, 5 mg, and 5 mg, respectively, were added through the RF cannula at the DRG level in each application.

Results: In total, 40 patients, including 25 men (62.5%) and 15 women (37.5%), were analyzed in this study. The mean age of the patients was 60.5 ± 12.4 years, and the median duration of pain was 2 years (0.2–15 years). When PHN and PTPS groups were compared on the basis of the pain etiology, the VAS values before treatment were not statistically different (p = 0.129), whereas the VAS values after treatment were significantly lower in the PTPS group than in the PHN group (p = 0.001).

Conclusions: This study aimed to investigate the effectiveness of DRG PRF therapy on the causes of chronic thoracic pain and in different etiologies. The results revealed that PRF therapy is more effective in treating patients with PTPS than those with PHN. We also found that factors such as age, gender, and size did not significantly affect the treatment.

Keywords: *Postherpetic neuralgia, post-thoracotomy pain syndrome, pulsed radiofrequency*

1. Introduction

The causative agent of herpes zoster (HZ) is the reactivated varicella-zoster virus. This virus is known to cause dorsal root ganglion inflammation along with peripheral nerve and local tissue injury along the descending sensory nerve. HZ leads to severe and painful rashes in older patients; these rashes can be accompanied by prolonged pain, i.e., postherpetic neuralgia (PHN). The incidence of HZ has been reported to be 2.5–5.8/1000 person-years[1,2], and 5%–30% of these patients develop PHN[3]. Moreover, the incidence of HZ has been reported to be higher in people aged >50 years[4,7]. PHN exhibits a complex etiology and is difficult to treat; therefore, new treatment modalities need to be developed.

According to the International Association for the Study of Pain (IASP), post-thoracotomy pain syndrome (PTPS) is defined as "recurrent or persistent pain along the thoracotomy incision at least two months after surgery"[8]. The primary causes of PTPS include acute postoperative pain, surgery-related nerve damage, and changes in neuroplasticity in the central nervous system[9-12]. Management of PTPS is difficult, and several modalities, including epidural analgesia, preemptive gabapentinoids, and intravenous ketamine, can prevent its development. Antineuropathic medications and lidocaine or 8% capsaicin patches are used as the current standard treatment for PTPS[13,14]. However, pharmaco-

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therapy may be inadequate for treating PTPS, and interventional pain procedures ranging from nerve blocks to nerve ablation and neuromodulation may be required[15-17].

The dorsal root ganglion (DRG) contains primary sensory afferent neurons. These neurons transmit peripheral nerve impulses to the spinal cord and central nervous system. Therefore, DRG has become a crucial target area for treating PHN and PTPS[1,9]. Pulse radiofrequency (PRF) uses intermittent (4*120 msec) RF current (300–500 kHz) for sufficient heat dissipation time for temperatures below 42°C to ensure preservation of the structure and function of nerve fibers[15]. This procedure has the following advantages: minimal invasiveness; monitoring of the electrical stimulation and measurement of impedance to locate specific nerves; neuromodulation effect that does not cause nerve damage or complications, such as decreased sensation and skin numbness; and easy repeatability of the treatment if needed. PRF has been widely applied in various painful conditions, including intractable lower back pain and joint pain[16-18]. However, the therapeutic effects of PRF reported in the literature are contradictory, and effective guidelines on the treatment parameters are still lacking[19].

This study aimed to retrospectively compare the effectiveness of DRG PRF treatment based on the visual analog scale (VAS) and Douleur Neuropathique 4 Questions (DN4) results in patients diagnosed with PHN and PTPS in the Cukurova University Algology Department between 2019 and 2022.

2. Materials and methods

The medical records of the patients were scanned for age, gender, size, thoracic level, cause of pain, and VAS and DN4 scores from the patient files in the archive of the Department of Algology. Patients included in the study were >18 years of age, with unilateral and neuropathic pain in thoracic dermatomes. (T2–T12). They were unresponsive to medical treatment and were suffering from pain for over 6 months. They had a VAS score of ≥5. The VAS and DN4 scores before and 1 month after Thoracal DRG PRF treatment were recorded and compared. For our study, we received the ethics committee decision numbered 6.1.2023-129 from the Cukurova University Ethics Committee.

Patients with local pathology, such as infection at the needle insertion site, and abnormal anatomy of the thoracic vertebrae, such as scoliosis or severe kyphosis; pregnant women; and patients with uncorrected coagulopathy and hypersensitivity to the drugs used in the procedure were excluded from the study.

The enrolled patients were taken to the pain intervention room that consisted of an anesthesia machine, monitor, fluoroscopy, and RF devices. They were placed on the surgical table in the prone position and basic monitoring (pulse oximetry, electrocardiogram, and noninvasive blood pressure) was performed. Oxygen was administered at a flow rate of 4 L/min. An intravenous cannula was inserted and 1 mg of dormicum was administered for sedation. Then, the thoracic spine was disinfected and draped. On counting from top to bottom, the first thoracic vertebra was identified by the characteristic features that distinguished it from the last cervical vertebra.

For the DRG PRF procedure, an anteroposterior (A–P) image was obtained. Then, the C-arm was caudocephally adjusted to align the endplate of the vertebra of interest. Later, the image of the rib was superimposed on the image of the transverse process, following which the C-arm was oriented obliquely by approximately 20–25 degrees. The skin entry point was determined just below the pedicle of the relevant level. The skin was infiltrated with 2 mL of 2% lidocaine at the entry point and a 22-G RF needle (10 cm) was inserted under the active straight tip, 1-cm C-arm (Figure 1). It was obtained so that the needle tip could be seen just behind the posterior border of the foramen when viewed from the side. In this position, 0.2 mL of radiopaque material was injected to observe it spread laterally under the pedicle, and the opaque material outlined the medial border of the pedicle and spread upward (characteristic image of a transforaminal epidural). After the opaque material was observed as a vertical line behind the foramen when viewed from the side, the sensory stimulation threshold at this point was aimed to be <0.5 volts in all cases. PRF was delivered for two cycles of 2 min each, with pulses of 20 ms every 500 ms (20 ms 500-kHz RF pulses delivered at a frequency of 2 Hz). The maximum temperature voltage was automatically set to 42°C. After the procedure, a total of 5 ml of dexamethasone, lidocaine, bupivacaine, and isotonic solutions of 4 mg, 20 mg, 5 mg, and 5 mg, respectively, were added through the RF cannula at the level of DRG in each application (Figure 2)

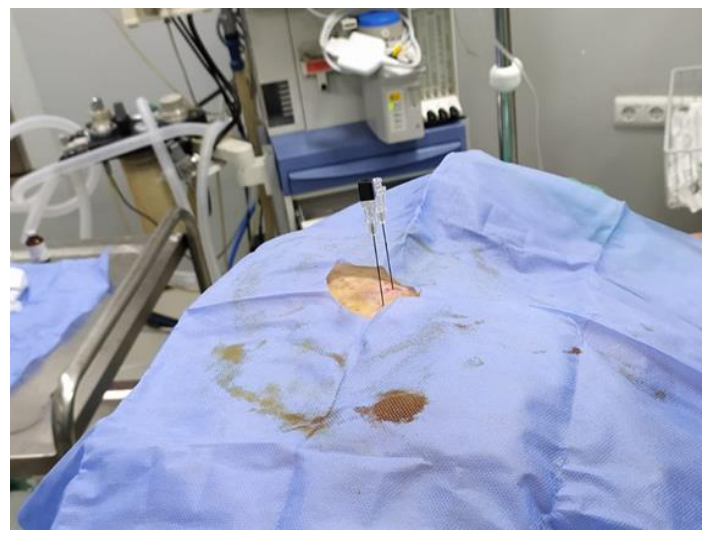

Figure 1
Thoracic DRG Skin Entry

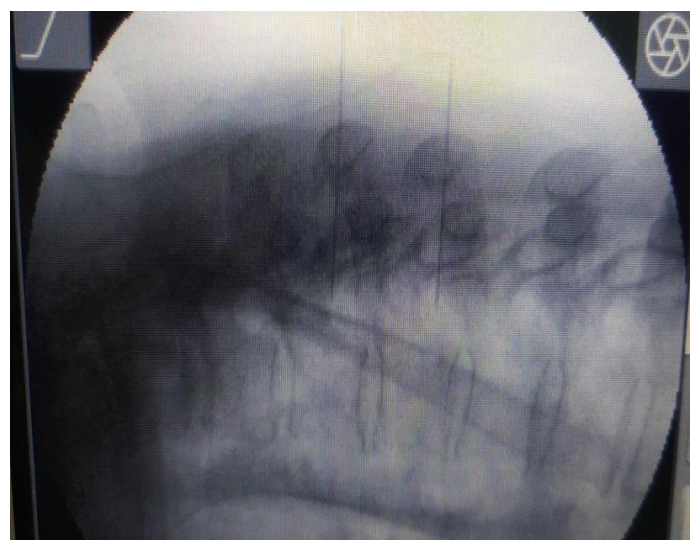

Figure 2
Thoracic DRG Skin Entry

2.1. Statistical analysis

Statistical analysis was performed using SPSS software (Version 25.0, SPSS Inc., Chicago, IL, USA). All numerical data are expressed as median values (Minimum-Maximum). For each continuous variable, normality was checked by Kolmogorov Smirnov and Shapiro-Wilk tests and by histograms. Comparisons between groups were applied using Kruskal Wallis test and post-analysis Mann Whitney U test were used for the data not normally distributed. Pre-post measures data were analysing Wilcoxson test and Repeated Measures Analysis for group comparison. Values of $p < 0.05$ were considered statistically

3. Results

This retrospective study analyzed data collected from patients with chronic pain in the thoracic region who had undergone thoracic DRG PRF treatment. In total, 40 patients, including 25 men (62.5%) and 15 women, (37.5%) were analyzed in this study. The mean age of the patients was 60.5 ± 12.4 years, and the median duration of pain was 2 years (0.2–15 years) (Table 1).

Table 1

Demographic and Clinical Characteristics of the Patients

	Min–Max	Mean ± SD	Median
Age	30–82	60,5 ± 12,4	62
Pain duration (years)	0,2–15	3,6 ± 3,9	2
Gender, n (%)			
• Men		25	62,5
• Women		15	37,5
Side			
• Right		19	47,5
• Left		21	52,5
Medical treatment			
• Gabapentin		21	52,5
• Pregabalin		19	47,5

A total of 23 patients had PHN (57.5%), 15 had thoracotomy pain (37.5%), and 5 (5%) had pain after video-assisted thoracic surgery (VATS). The mean time to treatment admission was 2 years (0.2–15 years). Patients with PHN and PTPS did not differ in terms of demographic characteristics (age, gender, and pain duration). The areas treated ranged from T2 to T12, with different levels and ranges for each patient. T6–T8 level was the most treated level (12 patients). The procedure was performed on the right side in 19 patients (47.5%) and on the left side in 21 patients (52.5%).

Table 2

Etiologic Distribution of Patients

Diagnosis	n	%
Postherpetic Neuralgia	23	57,5
Thoracotomy	15	37,5
VATS	2	5,0

VATS: Video-assisted thoracic surgery

Table 3

Effect of Thoracic DRG on VAS and DN4 Scores

	Before Procedure	After Procedure	P
VAS score	7(5-9)	3(0-7)	0,0001
DN4 score	5(2-7)	2(1-5)	0,0001

VAS: Visual analog scale, DN4: Douleur Neuropathique 4 Questions

After PRF treatment, the patients were re-evaluated at 1-month follow-up for the chronic analgesic effect. The mean VAS scores before and after the procedure were 7 (5–9) and 3 (0–7), respectively. The mean DN4 scores before and after the procedure were 5 (2–7) and 2 (1–5), respectively. The VAS and DN4 scores had decreased significantly after treatment in all patients ($p = 0.0001$) (Table 3). Regardless of gender and size, both in the PHN and PTPS groups, the VAS and DN4 scores of the patients decreased significantly ($p = 0.0001$). In other words, the VAS and DN4 scores of the patients decreased after treatment, regardless of their size and gender.When the correlations between other variables were analyzed, no statistically significant correlation was observed between age and pain duration until treatment and between pretreatment and post-treatment VAS and DN4 scores. However, a positive correlation was observed between VAS and DN4 scores after the treatment ($r = 0.66$, $p = 0.0001$). In summary, when VAS scores decreased after treatment, the DN4 scores also decreased significantly.

When the PHN and PTPS groups were compared based on the etiology of pain, no significant difference in the VAS scores before treatment was observed ($p = 0.129$), whereas the VAS scores after treatment were significantly lower in the PTPS group than in the PHN group ($p = 0.001$). When evaluated before and after treatment, the decrease in VAS score was found to be greater in the PTPS group than in the PHN group. When DN4 scores before and after treatment were evaluated, it was found that DN4 scores before the procedure were significantly lower in the PTPS group than in the PHN group ($p = 0.001$). Hence, the change in DN4 scores after the procedure was not statistically significant ($p = 0.162$) (Table 4).

Table 4

Effectiveness of Thoracic PRF DRG on Etiology

	Postherpetic Neuralgia	Thoracotomy	p	p*
VAS Before	8 (6–9)	7 (6–8)	0,129	0,016
VAS After	4 (1–7)	2 (1–5)	0,001	
DN4 Before	6 (5–7)	5 (2–6)	0,001	0,162
DN4 After	3 (1–5)	2 (1–3)	0,041	

4. Discussion

This study aimed to investigate the effectiveness of DRG PRF therapy on the causes of chronic thoracic pain and in different etiologies. The results revealed that PRF therapy is more effective in treating patients with PTPS than those with PHN. We also found that factors such as age, gender, and size did not have a significant effect on the treatment.

Radiofrequency treatments are applied to DRG for several different pain syndromes. Its popularity has recently increased because it is a clinically safe and effective treatment[20]. It can rapidly change the electrical field in neuronal membranes and alter electrolyte conduction and ongoing depolarization; these characteristics play a role in the treatment mechanism[21].

Severe PHN is persistent pain that is difficult for patients to tolerate[22]. In PHN, many inflammatory cells invade the DRG, and inflammatory mediators released from these cells cause central sensitization and pain. PRF therapy is also involved in the modulation of neuropathic pain by activating descending serotonergic and noradrenergic inhibitory pathways[23]. Because PRF therapy is a minimally invasive and selective targeted therapy, it can be used for PHN pain[24]. Utilizing these effects, PRF therapy has been applied in treating PHN. In a study by Ding et al., it was shown that DRG PRF treatment of PHN at different stages under computed tomography guidance was effective and safe. In addition, this treatment caused a significant decrease in the VAS scores of patients[25]. In a retrospective study of 58 patients with herpetic neuralgia, patients were divided into two groups, namely the early-stage patient group (within the first 90 days of the onset of shingles zoster) and the PHN patient group, and DRG PRF treatment was applied. There was a significant decrease in numerical rating scale scores after treatment in both groups[26]. In this study, it was found that the VAS and DN4 scores of the patients decreased significantly after DRG PRF treatment in the PHN patient group.

Post-thoracotomy pain can transform into chronic pain in 22%–67% of patients, depending on the surgical procedure. Considering the increase in the geriatric population and the increasing life expectancy of cancer patients, the treatment of chronic post-thoracotomy pain unresponsive to medical treatment gains importance. In a study of 49 patients with chronic thoracic pain after surgical interventions, such as thoracotomy, sternotomy, and mastectomy, the effectiveness of DRG PRF, intercostal nerve PRF, and medical therapy was compared. In the sixth week of follow-up, no difference among the treatments was observed. However, in the 3rd month of follow-up, the treatment success rate was significantly higher in the group receiving DRG PRF than in the group receiving intercostal nerve PRF and medical treatment[27]. In this study, the VAS scores decreased significantly in the PTPS group in the 1st-month follow-up after DRG PRF treatment. At the same time, when post-thoracotomy pain and PHN were compared, it was found that the decrease in VAS scores after treatment was greater in the post-thoracotomy pain group than in the PHN group. When DN4 scores before and after treatment were evaluated, it was found that DN4 scores before the procedure were significantly lower in the PTPS group than in the PHN group. Therefore, the change in DN4 scores after the procedure was not statistically significant.

In the pathophysiology of PHN, the fact that a viral agent occurs after a long DRG latency period may cause high pain severity and treatment resistance. On the other hand, in PTPS, there is a condition that develops secondary to surgery and occurs in a shorter time than PNH. We attribute the significant differences in the results of our study to this.

5. Conclusions

DRG PRF treatment is an effective and safe method for treating patients with PTPS and PHN. However, the higher treatment success in favor of the post-thoracotomy group can be explained by the difference in the pathophysiology of chronic pain. Further randomized controlled trials are needed to demonstrate the short and long-term analgesic effects of this treatment in different chronic pain syndromes.

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Statement of ethics

The study was approved from Cukurova University Ethics Committee (6.1.2023-129)and was conducted in accordance with the Declaration of Helsinki.

Conflict of interest statement

The authors declare that they have no financial conflict of interest with regard to the content of this report.

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Author contributions

All authors contributed to the design and writing of the study. All authors reviewed and accepted the final version of the study.

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