DOI: 10.37990/medr.1342293 Med Records 2023;5(Suppl 1):60-4

MEDICAL RECORDS-International Medical Journal

Research Article

Comparison of Peripheral Nerve Conventional and Pulse Radiofrequency Applications in Patients with Primary Trigeminal Neuralgia: A Retrospective Analysis

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Abstract

Aim: This study aims to retrospectively investigate the results of continuous radiofrequency (CRF) and pulsed radiofrequency (PRF) applications to the peripheral branches of the trigeminal nerve in patients with trigeminal neuralgia (TN).

Material and Methods: Patients who experienced a significant reduction in pain symptoms after local anesthetic application to the peripheral branches of the trigeminal nerve were divided into two groups. The first group received PRF treatment and the second group received CRF treatment. Pain intensity scores of both groups at 1 and 3 months were compared. The results were analyzed retrospectively.

Results: Among the participants, 10 received PRF treatment and another 10 received CRF treatment. At the 1st month follow-up, both groups demonstrated considerable reductions in pain levels. By the 3rd month, no substantial disparities were noted between the two groups in terms of pain-related disability and pain intensity.

Conclusion: Both PRF and CRF interventions emerge as effective and secure techniques applicable to the peripheral branches of the trigeminal nerve. They should be contemplated as valuable options in cases where conventional medical treatments fall short in delivering adequate pain control.

Keywords: Trigeminal neuralgia, radiofrequency ablation, ultrasound, nerve block

INTRODUCTION

Trigeminal neuralgia (TN) is characterized by unilateral facial pain resulting from the involvement of the fifth cranial nerve. The condition is classified as classic TN (cTN) or secondary TN (sTN). sTN refers to cases where a specific lesion, like multiple sclerosis, tumor, or cerebral aneurysm, occupies a particular location. While TN can manifest at any age or gender, its prevalence is higher among females and increases with age (1). Pain often affects the distribution of the second (maxillary [V2]) or third (mandibular [V3]) branches of the trigeminal nerve (2).

Treatment success for TN is evaluated differently in medical and surgical research. In medical studies, success is generally defined as at least a 50% reduction in pain from baseline, while surgical research defines success as complete pain elimination (3). Treatment options encompass anticonvulsant drugs, antidepressants, and, if inadequate or accompanied by undesirable side effects, alternative interventions like interventional procedures (1,2). Surgical interventions such as neurectomy, alcohol injections, or radiofrequency lesions can be conducted on the trigeminal nerve, aiming to establish an anesthetic zone corresponding to the affected facial area (2).

Radiofrequency ablation (RFA) utilizes radio waves directly applied to the nerve to block pain signals. RFA comprises two main subtypes: continuous radiofrequency (CRF) and pulsed radiofrequency (PRF) (4,5). For TN, RFA of the Gasser ganglion is a minimally invasive procedure, initially providing significant pain relief. Another approach is RFA of the peripheral branches of the trigeminal nerve, proven to be both safe and effective. Peripheral branch RFA is considered secure due to its extra cranial procedure nature, reducing complications such as nerve

CITATION

Senturk IA, Gonullu E. Comparison of Peripheral Nerve Conventional and Pulse Radiofrequency Applications in Patients with Primary Trigeminal Neuralgia: A Retrospective Analysis. Med Records. 2023;5(Suppl 1):60-4. DOI:1037990/medr.1342293

Received: 13.08.2023 **Accepted:** 14.09.2023 **Published:** 05.10.2023
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and vessel damage. Although peripheral branch RFA may offer immediate relief post-procedure, its recurrence rate surpasses that of Gasser RFA (6).

The objective of this study is to retrospectively analyze the comparative clinical outcomes of peripheral PRF and CRF applications in patients with TN who exhibited clinically significant reduction in symptoms following diagnostic local anesthesia block under ultrasound guidance to the peripheral branches of the V2 and/or V3 trigeminal nerve, within a short-term period of 3 months.

MATERIAL AND METHOD

Participant Data Collection

This study conducted a retrospective examination of patients who had sought treatment at the pain clinics of Bakırçay University Faculty of Medicine and Bağcılar Training and Research Hospital. These patients met the diagnostic criteria for TN as outlined in the third edition of the international classification of headache disorders (ICHD-3) (7). The data collection period spanned from January 1, 2022, to January 1, 2023 (İzmir Bakırçay University Non-Interventional Ethics Committee, decision no: 1143).

The participants consisted of individuals who had previously undergone evaluations by specialists and received a diagnosis of cTN. This group of patients either experienced insufficient pain control despite undergoing medical treatments or were unable to tolerate medical interventions. As a result, these patients were considered for interventional procedures in the subsequent phase to attain effective pain management.

Demographic information, encompassing factors like age, weight, height, gender, employment status, marital status, educational background, and the presence of any concurrent medical conditions, was meticulously documented for every participant. Comprehensive data concerning the pain experienced, including its precise location, duration since diagnosis, and characteristics, were meticulously recorded. Before undergoing any procedural interventions, the intensity of pain was gauged employing the Numeric Rating Scale (NRS), while the level of pain-related impairment was assessed through the application of the Headache Impact Test-6 (HIT-6).To maintain the study's targeted scope, specific individuals were excluded from participation. This excluded category encompassed patients dealing with cancer, bilateral facial pain, persistent pain attributed to systemic conditions (such as rheumatological disorders), as well as those presenting with non-neuralgiform facial pain (referred to as atypical facial pain).

Ultrasound-Guided Peripheral Nerve Blocks: The procedural steps were carried out utilizing the MyLab 6 ultrasound device (Esaote Europe B.V., Maastricht, Netherlands), and the corresponding sonographic images are presented in Figure 1 and Figure 2. A high-frequency linear transducer with an operational frequency of 10–12 MHz was employed to meticulously scan superficial anatomical structures. The Power Doppler mode was engaged to facilitate the identification of vascular components. For the execution of the superficial nerve block, a 5 cm peripheral nerve block needle was meticulously positioned under the guidance of ultrasound. Subsequently, 1-2 ml of a local anesthetic solution, typically 0.5% lidocaine, was carefully administered.

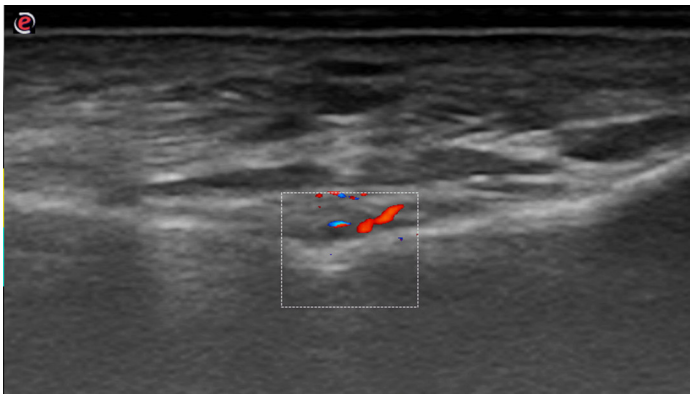

Figure 1. Ultrasonographic identification of infraorbital foramen, artery, and nerve. Images sourced from the archive of Dr. Ilteris Ahmet Senturk

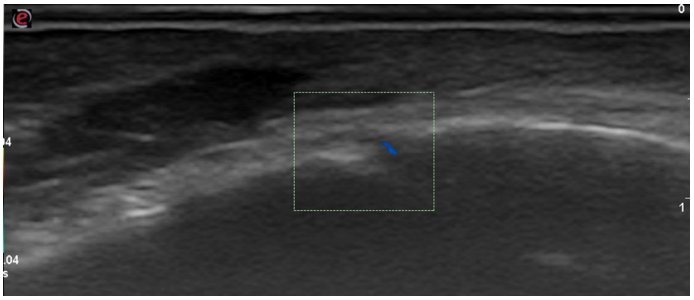

Figure 2. Mental nerve and associated vessels, along with mental foramina. Images sourced from the archive of Dr. Ilteris Ahmet Senturk

Radiofrequency Nerve Ablation: For patients diagnosed with cTN who reported significant, albeit short-term, relief from pain following peripheral nerve blocks, the decision was taken to advance to the subsequent stage, which involved performing RFA. Prior to this, patients were presented with detailed information and their informed consent was obtained.

The core technique of RFA entails the strategic positioning of an electrode in proximity to a nociceptive pathway. This positioning disrupts pain signals through the controlled delivery of radiofrequency currents, facilitated by a catheter-guided approach. In the CRF technique, the current is terminated once the desired temperature is attained, and then reactivated to maintain tissue temperature at a predefined level. This cyclic alternation between open and closed currents sustains the designated tissue temperature. Nerve tissue disruption commences at temperatures surpassing 45 degrees Celsius. During the PRF approach, radiofrequency currents are administered for duration of 120 seconds at a frequency of 2 Hz, with each pulse lasting 20 milliseconds. Voltage adjustment is performed to ensure that the maximum temperature remains below 42 degrees Celsius (8).

All interventions were conducted within a specialized pain unit. The procedures employed a 5 cm peripheral nerve block needle furnished with a 5 mm active tip, a disposable 20-gauge caliber, and an electrode. Additionally, a radiofrequency device (Diros Technology Inc, Markham, Ontario, Canada) was employed as an integral component

of the procedure.

The outcomes were assessed within two distinct groups: individuals who underwent CRF applications and those who underwent PRF applications. Pain intensity and pain-associated disability scores for all patients were meticulously recorded at both the initial and third months.

Statistical Analysis

The data of the study were analyzed by SPSS 25.0 (IBM®, New York, USA). The findings were expressed as frequency and percentages. Normality analysis was carried out using the Shapiro-Wilk test. The variables without normal distribution are presented as the median (min-max). Wilcoxon signed rank, and Friedman tests were used to compare numeric rating scale pain scores over time. Spearman Correlation analysis was performed to determine possible correlations with HIT-6 score. The statistical significance value was set at $p<0.05$ value.

RESULTS

Ultimately, the medical records of twenty (20) patients were subjected to analysis, following the exclusion of records with three missing data points and insufficient information. The mean age of the participants was calculated as 56.55±14.80 years, with an age range spanning from 28 to 75 years. The diagnosis of TN was more frequently established in female patients, with a female-to-male ratio of 7:3. Among the participants, hypertension emerged as the most commonly observed systemic ailment, afflicting 11 individuals (55% of the cohort). Regarding the interval between the onset of symptoms and the point of referral, patients self-reported an average duration of 27.0 months, with a range spanning from 3.0 to 240.0 months. Among the twenty participants, the initial pain intensity before the procedural interventions was assessed at 9.0 (on a scale of 0-10), indicating severe pain (9). Additionally, the baseline pain-related disability was documented to be ≥60 points, signifying a severe impact (10).

Subsequently, the Numeric Rating Scale (NRS) scores were determined to be 3.0 (ranging from 0.0 to 6.0) at the 1-month mark and 5.0 (ranging from 2.0 to 7.0) at the 3-month assessment. This observed alteration in scores between the 1-month and 3-month follow-up points post-treatment exhibited statistical significance ($p<0.001$). Furthermore, substantial and statistically significant distinctions were evident across all paired comparisons ($p<0.001$ for NRS-baseline and NRS-1st month, and NRS-baseline and NRS-3rd month comparisons; $p<0.01$ for NRS-1st month and NRS-3rd month comparison). Notably, there was a marginal increase in pain intensity scores noted during the 3-month evaluation.

Concise summaries of sociodemographic data and pain characteristics are provided in Table 1.

A total of 10 patients received CRF treatment, while another 10 patients underwent PRF treatment. The pain intensity results of these patients were recorded at 1 month and 3 months after the procedures. When comparing the pain intensity results of both groups during these time intervals, no statistically significant differences were observed. The outcomes are presented in Table 2.

Table 1. Sociodemographic characteristics of the patients (n=20)

	N (%)	Mean±SD	Median (min-max)
Age		56.55±14.80	
Gender			
Female	14 (70.0)		
Male	6 (30.0)		
BMI		28.27±5.30	
Smoking			
Yes	8 (40.0)		
No	12 (60.0)		
Working status			
Working	3 (15.0)		
Quitted job	2 (10.0)		
Housewife	7 (35.0)		
Retired	8 (40.0)		
Educational status			
Literacy course	5 (25.0)		
Primary school	5 (25.0)		
Secondary school	4 (20.0)		
High school	3 (15.0)		
University	3 (15.0)		
Marital status			
Married	16 (80.0)		
Widower	4 (20.0)		
Concomitant systemic diseases			
DM	2 (10.0)		
HT	11 (55.0)		
CAD	1 (5.0)		
Thyroid dysfunction	6 (30.0)		
Asthma-COPD	4 (20.0)		
Others	2 (10.0)		
Pain duration (history) (months)			27.0 (3-240.0)
Pain intensity (baseline)			9.0 (4.0-10.0)
Pain intensity (1st. month)			3.0 (0.0-6.0)
Pain intensity (3rd. month)			5.0 (2.0-7.0)
Pain disability (baseline)			61.70± 6.12

N: number, SD: standard deviation, BMI: body mass index, DM: diabetes mellitus, HT: hypertension, CAD: coronary artery disease, COPD: chronic obstructive pulmonary disease
Pain intensity was calculated by the numeric rating scale (NRS)
Pain disability was calculated by the headache impact test (HIT-6)

Table 2. The comparison of numeric rating scale scores of the pulsed and continuous radiofrequency treatment groups

	Pulsed RF (n=10)	Continuous RF (n=10)	P
NRS-baseline	8.5 (4.0-10.0)	9.0 (5.0-10.0)	0.631
NRS-1st month	3.0 (0.0-6.0)	3.0 (2.0-5.0)	0.631
NRS-3rd month	5.0 (2.0-7.0)	5.0 (2.0-7.0)	0.393

n: number, NRS: numeric rating scale, RF: radiofrequency

DISCUSSION

TN presents as a severe and distressing facial pain, typically localized unilaterally within one or more areas of the trigeminal distribution (11). The incidence of TN increases with age, women are more at risk than men, and may be associated with hypertension (12). Our results were consistent with these demographics. In cases where TN patients do not respond to conservative medical approaches or encounter difficulties in tolerating medication side effects, minimally invasive interventional procedures come into play as treatment options (11).

The focus of this study was to compare the results of PRF and CRF treatments applied to the peripheral branches of the trigeminal nerve. We found significant results in both treatment groups in the evaluation of pain intensities in the first and third months after the procedures. There was no difference between the groups in the comparison between the two groups. It is worth noting that relatively few studies have evaluated the efficacy and safety of RFA procedures on peripheral branches of the trigeminal nerve.

In a recent review and meta-analysis published (6), the effectiveness and reliability of CRF treatment on peripheral nerves were compared with CRF treatment on the Gasser ganglion. The study indicated that there were no significant differences in terms of pain scale, and complications. The authors observed that CRF treatment of peripheral branches showed better early results compared to CRF treatment of the Gasser ganglion, but this was associated with a higher recurrence rate. They attributed this discrepancy to the fact that Gasser ganglion contains cell bodies of pseudomonopolar neurons, whereas peripheral nerves contain Schwann cells. In our study, we did not directly compare Gasser's ganglion RFA procedures, but retrospectively analyzed the short-term results of RFA procedures to peripheral nerves. Therefore, we cannot provide information about possible recurrence rates for CRF.

Zeng et al. (13) stated their initial suggestions for the possible reasons of higher recurrence rates with peripheral RFA compared to the study by Wan et al. (14). They mentioned that they performed ablation at a lower temperature (75°C), which might contribute to the higher recurrence rate. They refrained from using higher temperatures due to the potential risk of causing severe mandibular motor dysfunction. Similarly, in our study, we used a temperature of 75°C for CRF treatment.

Luo et al. (15) compared the 1-year outcomes of high-voltage PRF and standard-voltage PRF treatments in patients with refractory infraorbital neuralgia and found that high-voltage PRF was significantly more effective. Similarly, Fang et al. (16) conducted a similar comparison for Gasser ganglion PRF and also found high-voltage PRF to be more effective. The authors have suggested from these results that high-voltage PRF technology is likely to substantially reduce the number of patients requiring ablative procedures. However, there are comparative studies on the Gasser ganglion reporting that PRF is ineffective compared to CRF (17). In a study by Tanyel et al. (18), PRF treatment was applied to the peripheral branches of the trigeminal nerve, highlighting appropriate pain control over approximately one year, and they reported no complications or side effects. In our study, we used standard PRF. Taking into consideration the assessments of Luo and Fang, we believe that a comprehensive and prospective evaluation of the comparison between CRF and high-voltage PRF for peripheral branches, informed by our study, would contribute to scientific knowledge.

CONCLUSION

We believe that PRF and CRF procedures for the peripheral branches of the trigeminal nerve are effective and safe interventional methods in patients with TN. In our study, clinical outcomes were similar in both groups. Based on this, considering that the procedure-related recurrence risk is minimal, PRF treatment could be considered a first-line option for patients who do not respond to medical treatment or cannot undergo medication due to side effects.

Financial disclosures: *The authors declared that this study has received no financial support.*

Conflict of Interest: *The authors declare that they have no competing interest.*

Ethical approval: *İzmir Bakırçay University Non-Interventional Ethics Committee, decision no: 1143.*

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