

# Peripheral Nerve Pulsed Radiofrequency For Trigeminal Neuralgia Treatment: Is It An Effective Method?

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## Research

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# Abstract

## Objective

Trigeminal neuralgia is a paroxysmal and shock-like pain in the trigeminal nerve area. Various treatment options have been used for trigeminal neuralgia such as medical treatment, interventional procedures and surgical operations. Pulsed radiofrequency (PRF) is a minimally invasive percutaneous technique which seems to be safer and easier to perform.

This retrospective study aims to evaluate the analgesic effect, duration of efficacy and side effects of PRF procedures in the peripheral branches of the trigeminal nerve.

## Methods and Material

The data of the patients with trigeminal neuralgia who were followed up in our hospital's algology clinic from 2016 to 2018 were reviewed retrospectively. Patients aged between 18-70 who didn't respond to medical treatment or couldn't use medication due to side effects, were treated with PRF procedure for peripheral branches of trigeminal nerve were selected for this study. Demographic profile, clinical presentation, pain intensity, duration of efficacy and complications were evaluated from their files.

## Results

21 patients who underwent ultrasonography (USG) guided PRF procedures were included the study. Mean visual analog scale (VAS) value of the patients was found to have decreased from  $9.25 \pm 0.63$  to  $1.55 \pm 0.88$  at the end of the first month ( $p < 0.001$ ). The painless period for the patients lasted up to 12 (9-21) months and no complications occurred.

## Conclusion

PRF procedure seems to be an effective and safe method in patients who respond to block of the peripheral branches of the trigeminal nerve.

**Key message:** The use of pulsed radiofrequency method for the treatment of trigeminal neuralgia seems to be an effective and safe method. In addition, being easily applicable and repeatable is another advantage of the method.

## Introduction

Trigeminal neuralgia is defined by the International Headache Society as a unilateral, paroxysmal and shock-like pain in the ophthalmic, maxillary and/or mandibular nerve area that progresses with attacks(1). The incidence of trigeminal neuralgia has been reported between 5 and 25 per 100,000 people. It is 1.7–2.2 times more common in women(2). The trigeminal nerve has three main branches, and the disease may occur in any of these branches. The most affected nerve branches are mandibular and maxillary nerves. Ophthalmic nerve is rarely affected(3).

The etiology and pathophysiology of trigeminal neuralgia is unclear because there are counter-examples for all the existing theories. The strongest hypothesis is about the factors causing demyelination of the nerve.

The main goal of any treatment is to reduce pain and relieve symptoms. Antiepileptics are the first line of medical treatment. Pharmacologic treatment is used for pain relief but does not provide a permanent cure. Various interventional and surgical methods can be used in patients who do not respond to medical treatment or cannot tolerate medication due to side effects. Percutaneous interventional procedures such as radiofrequency rhizotomy may have complications that anesthesia dolorosa, keratitis, aseptic meningitis, bacterial meningitis, nerve damage, and rarely, intracranial hematoma(4). Local anesthetic block of the peripheral branches of the trigeminal nerve such as supraorbital, infraorbital and mental nerves provides short-term pain relief in some cases. Pulsed radiofrequency (PRF) procedures may provide longer pain relief for the patients who have short term pain relief with the local anesthetic block. In our clinical experience, PRF procedures have become an accepted treatment modality in patients with trigeminal neuralgia who respond to the prognostic nerve block with local anesthetics. However, literature review did not reveal any published scientific data about the effectiveness and side effects of these procedures.

This retrospective study thus aims to evaluate the analgesic effect, duration of efficacy and side effects of PRF procedures on the peripheral branches of the trigeminal nerve.

## **Material And Method**

### **Study design and study population**

Following the approval of the institutional ethics committee (no. 25403353-050.99-E.56900 of 13.05.2019), the data of the patients with trigeminal neuralgia who were followed up in our hospital's algology clinic from 2016 to 2018 were reviewed retrospectively. The treatment algorithm in trigeminal neuralgias was included medical treatment in the first step. Since the patients did not benefit from medical treatment, their treatment was reduced and stopped before the procedure. In cases who did not respond to medical treatment or could not tolerate side effects, a local anesthetic block was applied to the appropriate peripheral branch of the trigeminal nerve according to the symptoms of the patient and pulsed RF was applied to the same peripheral branch / branches for those who relieved with the block. Patients who had pulsed RF applied to the peripheral branches of the trigeminal nerve were included in the study.

### **Interventions**

A prognostic block was applied by 1-2 ml of 0.5% bupivacaine on the peripheral nerve branch of the site of pain. Patients with a temporary pain relief (50% or more reduction in the visual analog scale (VAS) score were planned to undergo PRF procedure in the next session after the block was resolved.

It was seen from the hospital records that the same standard protocols were applied to all patients for procedures; in supine position intravenous access was obtained and standard monitoring (electrocardiogram, blood pressure monitoring and pulse oximetry) was applied before the procedure. The symptomatic side of face skin was cleaned with a sterile solution and sterile drapes were used. The

procedure was performed under the guidance of ultrasound (Figure 1 and Figure 2). After the location of the nerve was determined with ultrasonography (USG), a 21-gauge 50-mm radiofrequency needle with a 5mm active tip was inserted. After the location of the nerve was verified by creating paresthesia in the concordant trigeminal distribution of the patient's usual symptoms by a 50 Hz sensorial stimulation, 0.5 ml of 0.5% bupivacaine was injected followed by a PRF procedure at 42 °C for 240 seconds.

## **Follow up**

Patients were observed for 2 hours after the procedure for the acute complications of the procedure such as hematoma formation. Patients were reevaluated for the pain relief and complications of the procedure such as anesthesia dolorosa, keratitis, and nerve damage at the first month after the procedure. At the post-procedural 3rd and 6th month controls, patients were asked whether their pain started again or not, and VAS values were asked if their pain started again. Paracetamol and NSAIDs were prescribed for post-procedure pain.

Pain intensity was evaluated by VAS. The time between the procedure and the recurrence of pain was accepted as the duration of analgesia.

All these data of patients was taken from the hospital records for this study.

## **Statistical Analysis**

Statistical analyses were performed with the IBM SPSS 21 (Statistical Package for the Social Sciences) package software. For descriptive analysis; average, standard deviation, median, and 25-75 percentile values were expressed in the continuous data. The suitability of variables to normal distribution was examined by analytical methods (Shapiro-Wilk test). ANOVA test with Bonferroni correction were used for repeated VAS values. A p value below 0.05 was considered statistically significant.

## **Results**

Of the 21 patients who were retrospectively analyzed, 14 were female and 7 were male, and their mean age was  $58.6 \pm 12.1$ . PRF procedures were performed in the infraorbital nerve in 8 patients, the mental nerve in 7 patients, and the supraorbital nerve in 6 patients. Demographic characteristics of the patients included in the study are presented in Table 1.

None of the patients experienced complications and side effects such as vasovagal reaction, hematoma, infection, sensory processing disorder, or motor disorder during the procedure. These complications were also not observed in the early and late follow-up of the patients.

The mean VAS value of the patients included in the study decreased from  $9.25 \pm 0.63$  to  $1.5 \pm 0.88$  one month after,  $1.50 \pm 0.761$  3 three months after and  $1.65 \pm 0.813$  six months after procedures. Immediately after the procedure, no patients have had any pain. We think this is because of the local anesthetic injected during the procedure. Pre- and post-procedural VAS values of the patients by the nerves treated are shown in Table 2. The decrease in the VAS value of the patients was statistically significant at each follow up period

( $p < 0.001$ ). Post-procedural VAS values was similar at 1<sup>th</sup>, 3<sup>rd</sup> and 6<sup>th</sup> month controls. Pain started again in two of the infraorbital PRP patients 5 and 6 months after procedure. Other than these, no patients identified an increase in pain at the 3<sup>rd</sup> and 6<sup>th</sup> month controls. The painless period of the patients lasted up to 12 (9-21) months. Duration of painless period for infraorbital, supraorbital and mental nerves, and all branches are presented in Table 3.

## Discussion

Trigeminal neuralgia is a headache that affects quality of life and can disrupt socioeconomic life. Treatment options are medical treatment, interventional pain treatment, and surgery. Antiepileptics such as carbamazepine, oxcarbazepine, and lamotrigine are recommended in the first line of treatment(5). The first-line drug carbamazepine in particular has serious side effects such as aplastic anemia, hepatotoxicity, thrombocytopenia, leucopenia, and hyponatremia(6). In patients with systemic diseases and in the elderly population, these drugs may cause much more serious problems. Due to these side effects, many patients cannot tolerate medical treatment, and treatment doses are thus insufficient. Therefore, it seems more reliable to try minor interventional methods before medical treatment in trigeminal neuralgia during pregnancy because of side effects.

Alternative methods to medical treatment of trigeminal neuralgia are peripheral neurectomies, percutaneous radiofrequency rhizotomy (PRR), percutaneous glycerol rhizotomy (PGR), percutaneous balloon compression (PBC), stereotactic radiosurgery (gamma knife radiosurgery (GKRS), CyberKnife) and microvascular decompression (MVD). Percutaneous radiofrequency rhizotomy, percutaneous glycerol rhizotomy and percutaneous balloon compression may cause major complications such as nerve damage, anesthesia dolorosa, keratitis, aseptic meningitis, bacterial meningitis, and decreased corneal sensation.(7, 8)

Peripheral neurectomy as a minimal invasive surgical procedure is an old technique that can provide analgesia for about two years. Although it is usually performed under local anesthesia, general anesthesia may be needed(9). There is no major complication but complications such as infection, sensorial loss and anesthesia dolorosa were reported (10).

Microvascular decompression surgery is the first-line surgical method in patients with neurovascular compression together with magnetic resonance imaging, and it has been shown to be painless for a long time, especially in men(11, 13). However, the effectiveness of MVD in trigeminal neuralgia caused by multiple sclerosis is much less. This procedure may also cause serious complications such as nerve damage, anesthesia dolorosa, cerebellar hematoma or infarction and even death(12, 14).

Percutaneous radiofrequency rhizotomy, which is more reliable than MVD, is performed with high temperature ablation by using radiofrequency needle, accompanied by imaging methods. Although its effectiveness is close to microvascular decompression surgery in the short term, it decreases after one year(15, 16). The high temperature (60–80 degrees Celsius) created in this procedure may cause nerve damage and anesthesia dolorosa. To avoid these serious complications, PRF was tested for percutaneous

radiofrequency rhizotomy, but found to be ineffective(17). On the other hand, it gives better results than microvascular decompression surgery in multiple sclerosis-related trigeminal neuralgia(18).

Percutaneous glycerol rhizotomy and balloon decompression provide almost complete relief approximately in 75% of the patients, but these procedures may also cause complications such as nerve damage, aseptic meningitis, bacterial meningitis, and decreased corneal sensation(19, 20).

To avoid complications of the thermal lesion, PRF can be successfully applied in many neural structures such as dorsal root ganglion, sphenopalatine ganglion and suprascapular nerve(21–23).PRF seems to be a less destructive alternative technique which consists of regular intermittent RF waves and silent periods(21,24,25). It can be performed between 90 seconds and 240 seconds, but there is no consensus on the optimal lesion time(26). The temperature of the PRF site remains constant at 42 degrees Celsius, so it is known that there are no serious complications such as neural damage. The mechanism of action of the PRF is still not fully explained, but it may be related to the rapidly changing electric field regardless of temperature(27).

Interventional procedures on the peripheral branches of the trigeminal nerve usually do not cause serious neurological or vascular complications because they are not close to these important anatomical structures. The fact that PRF application is far from the neurological complications that may occur in conventional RF application makes the treatment completely safe(17,28). In our study none of the patients had serious complications such as anesthesia dolorosa, keratitis, aseptic meningitis, bacterial meningitis, decreased corneal sensation or nerve damage.

Results of this retrospective study showed that the duration of analgesia in various nerves that underwent PRF was different. For example, pain relief in mental nerve PRF procedure was longer than infraorbital and supraorbital nerve procedures. However, we concluded that the number of patients is insufficient for this assertion. In future studies it may be more accurate to evaluate this point of view with a larger number of patients.

This retrospective study showed that the PRF procedure in the peripheral branches of the trigeminal nerve may lead to pain relief for nearly one year. It has a lower risk of complications than other interventional methods. Another advantage is that it can be applied safely in many situations contraindicated for other procedures, pregnancy, coagulation defects and old age.

There are some limitations of this study. First of all, the retrospective design of our study makes it difficult to evaluate the treatment response. In addition, increasing the number of participants and adding a control group can enable a better evaluation of the treatment effect.

## **Conclusion**

We believe that USG guided PRF procedure to peripheral branches of trigeminal nerve is an effective and safe interventional method for the patients with trigeminal neuralgia. It can be performed safely to patients who do not benefit from appropriate medical treatment or who cannot use it due to side effects, as well as

patients with limited benefit from medical treatment. We think that the major advantages of the procedure are that there are no complications after the procedure, no need for general anesthesia or sedation, easy and repeatable.

## Declarations

Availability of data and materials: All data are included in the publication

Ethics Committee Approval: No. 25403353-050.99-E.56900 of 13.05.2019 by Eskisehir Osmangazi University Ethics Committee

Informed Consent: Written informed consent was obtained from the participants.

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Authors' contributions;

IDEA/CONCEPT (Constructing the hypothesis or idea of research and/or article): Ayten Bilir, Sacit Gulec

DESIGN (Planning methodology to reach the conclusions): Ayten Bilir, Sacit Gulec

CONTROL/SUPERVISION (Organizing, supervising the course of progress and taking the responsibility of the research/study) : Ayten Bilir, Sacit Gulec

DATA COLLECTION AND/OR PROCESSING (Taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments): Tuba Tanyel

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LITERATURE REVIEW (Taking responsibility in necessary literature review for the study): Tuba Tanyel

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CRITICAL REVIEW (Reviewing the article before submission scientifically besides spelling and grammar) :  
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## Abbreviations

PRF: Pulsed radiofrequency, USG: Ultrasonography, VAS: Visual analog scale

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## Tables

	Infraorbital Nerve	Supraorbital Nerve	Mental Nerve	All Branches
Age	58.25± 11.29	54.1± 17.2	62.85± 7.3	58.6±12.1
Female	6	3	5	14
Male	2	3	2	7

Table 1. Demographic data.

	Infraorbital Nerve		Supraorbital Nerve		Mental Nerve		All Branches	
	Mean± SD	Median (25.p-75.p)	Mean± SD	Median (25.p-75.p)	Mean± SD	Median (25.p-75.p)	Mean± SD	Median (25.p-75.p)
VAS 1	9.43 ± 0.787	10 (9-10)	9.33± 0.516	9 (9-9)	9.00 ± 0.577	9 (9-10)	9.25 ± 0.639	9 (9-10)
VAS 2	1.43 ± 0.787*	2 (1-2)*	1.50± 1.049*	1 (1-3)*	1.71 ± 0.951*	1 (1-3)*	1.55 ± 0.887*	1 (0-3)*
VAS 3	1.14 ± 0.690 1 (1-2)*		1.83 ± 0.753 2 (1-2)*		1.57 ± 0.787 (1-2)*	1	1.50 ± 0.761 (1-3)*	1
VAS 4	1.29 ± 0.951 1 (1-2)*		2.00 ± 0.632 2)*	2 (1-2)*	1.71 ± 0.756 (1-2)*	1	1.65 ± 0.813 (1-3)*	2
p value	0,000☒		0,000☒		0,000☒		0,000☒	

Table 2. VAS scores before and after the PRF procedure relief for infraorbital, supraorbital and mental nerves and all branches (VAS 1: Before PRF, VAS 2: 1 month after PRF, VAS 3: 3 months after PRF, VAS 4: 6 months after PRF)

☒p<0.001 (VAS 1-2, 1-3, 1-4)

	Infraorbital Nerve		Supraorbital Nerve		Mental Nerve		All Branches	
	Mean± SD	Median (25.p-75.p)	Mean± SD	Median (25.p-75.p)	Mean± SD	Median (25.p-75.p)	Mean± SD	Median (25.p-75.p)
Duration of painless period	16.5 ±11.2	16.5 (7-27)	18.4 ± 7,1	10, 66 (12-24)	10,6 ± 4,1	18.42 (7.5-13.5)	15.4±8.6	12 (9-21)

Table 3. Duration of painless period for infraorbital, supraorbital, and mental nerves and all branches

## Figures

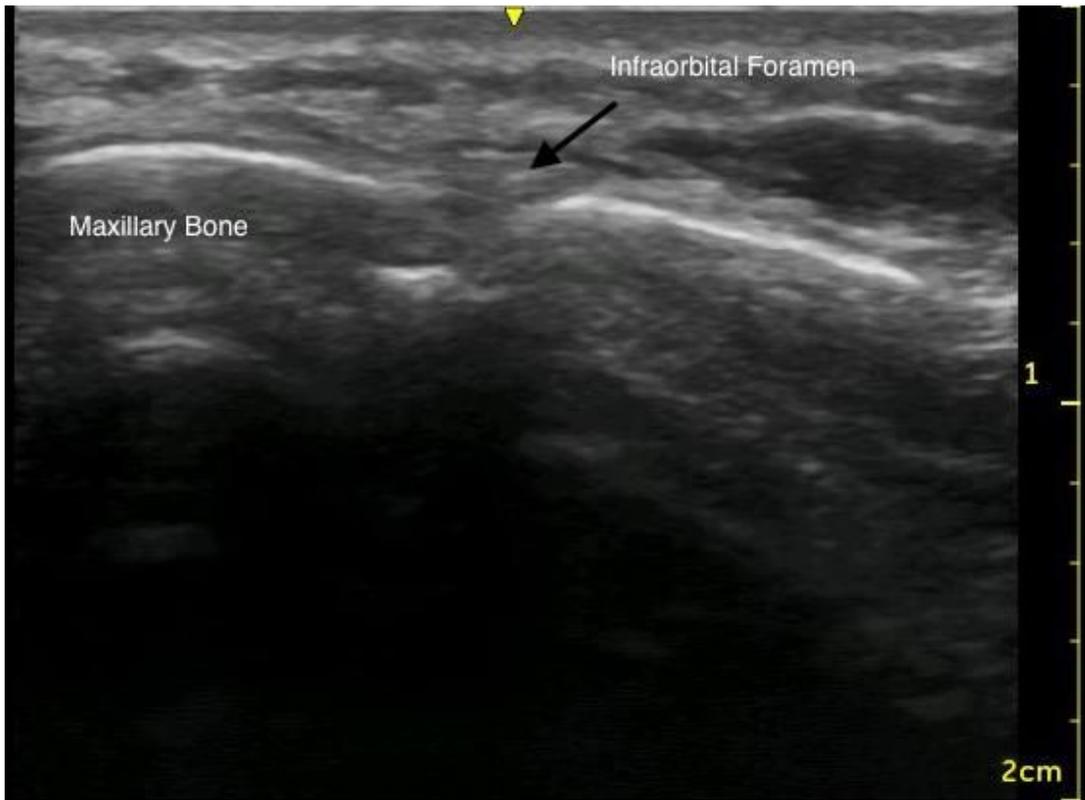


Figure 1

Scanning of the infraorbital foramen with hockey stick ultrasound probe.

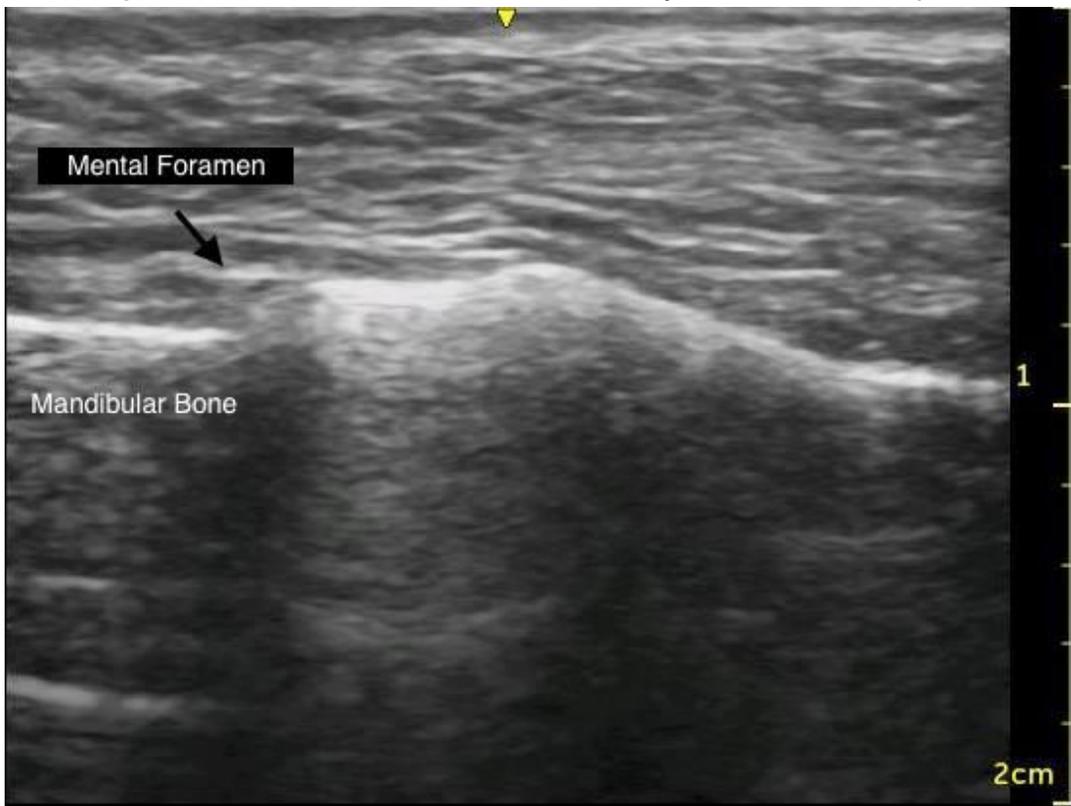


Figure 2

Scanning of the mental foramen with hockey stick ultrasound probe.