Original Article

# Outcome of Radiofrequency Rhizotomy for Treatment of Trigeminal Neuralgia


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## ABSTRACT

**Background:** Trigeminal Neuralgia (TN) is a debilitating condition characterized by unilateral, paroxysmal pain along the trigeminal nerve. Although anticonvulsants such as Carbamazepine are first-line therapy, many patients become refractory or develop intolerable side effects. Radiofrequency rhizotomy (RFR) is a minimally invasive alternative; however, local data on its efficacy and safety are limited. This study aimed to determine the effectiveness of RFR in TGN for pain relief.

**Methods:** This descriptive case series study was conducted at the Department of Neurosurgery, Sir Ganga Ram Hospital, Lahore, Pakistan, between January 2025 and December 2025. The patients aged 18 to 75 years, of either gender, diagnosed with TGN involving V2 and V3, were refractory to medical treatment. Data on patient demographics (age, gender, comorbidities) and baseline clinical characteristics (disease duration, laterality, affected nerve branch, preoperative Numeric Rating Scale score) were collected before the procedure. Pain relief was assessed using the numeric rating scale at baseline, the 0$^{th}$ postoperative day, the 1$^{st}$ postoperative day, and at 4 weeks.

**Results:** Of the total 60 patients included, there were 40% (24) males and 60% (36) females with a mean age of 50.4 ± 11.3 years. The mean preoperative NRS pain score was 7.6 ± 0.6, which was reduced to 0.90 ± 0.65 on the first postoperative day after RFR, 0.10 ± 0.30 at 1$^{st}$ postoperative day, followed by almost no pain recorded at 4 weeks. All patients reported NRS≤3 at final follow-up at 4 weeks, with efficacy reported to be 100% (60), loss of corneal reflex in 5% (3), and anesthesia dolorosa in 1.7% (1) patients, and no recurrence at 1-month follow-up.

**Conclusion:** Radiofrequency rhizotomy is a safe and effective treatment strategy for the management of trigeminal neuralgia refractory to conservative therapy, with immediate pain relief and no recurrence at one month follow-up.



**Keywords:** Trigeminal Neuralgia, Conservative Treatment, Neurosurgery, Radiofrequency Ablation, Outcome Measures


## INTRODUCTION

Trigeminal neuralgia (TGN), also known as clinically refractory neuralgia, is characterized by a typical unilateral, transient and paroxysmal electric current-like pain along the distribution of the trigeminal nerve, usually triggered by common stimuli such as washing, shaving, talking, brushing and many others.[1] According to recent estimates, TGN is prevalent in almost 0.03% to 0.3% of patients globally.[2] TGN is treated by medications including Carbamazepine, phenytoin, baclofen and several others primarily treat TGN.[3] Patients resistant to pharmacological management are treated surgically via various surgical modalities, including Microvascular Decompression, Glycerol Rhizolysis, Partial sensory Rhizotomy, Balloon compression, Gamma Knife Surgery and Radiofrequency Rhizotomy.[4] All of these surgical treatment modalities have their own associated merits and demerits, while the ideal surgical treatment option for TGN is not known yet.[5] Radiofrequency Rhizotomy is a percutaneous radiofrequency ablation of the Gasserian ganglion performed under local anesthesia via Fluoroscopic guidance and localization of the foramen ovale.[6] It is considered in patients who are unfit for microvascular decompression, reluctant to undergo an invasive procedure or in recurrent TGN after microvascular decompression.[6,7] actually works on the principle of thermal ablation, in which either the transmission of pain, or the technique of Radiofrequency thermocoagulation signal is inhibited by destroying the nerve via high temperature reaching up to 90°C, or the nociceptive function of the trigeminal nerve is modulated at various temperatures up to 42°C.[7] Almor et al. reported a 44.9% reduction in pain intensity after RFR at 6 months follow up.[8]

Despite frequent use of RFR, the optimal temperature and duration are not standardized and vary according to institutional protocols and the surgeon's


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preference, underscoring the need for evidence-based guidelines. Although studies have reported the effectiveness of RFR in pain management in TGN, data on patient-reported outcomes are limited.[8,9] This study, therefore, aimed to determine the effectiveness of RFR in TGN in terms of pain relief.

## PATIENTS AND METHODS

This prospective descriptive case series was conducted in the Department of Neurosurgery at Sir Ganga Ram Hospital, Lahore, Pakistan, between January 2025 and December 2025. The ethical approval for this study was obtained from the Ethical Review Committee of the Fatima Jinnah Medical University, Lahore, Pakistan (Reference No. 176-MS-Neurosurgery/IRB-ERC; dated: 22 July 2024). A total of 60 patients were enrolled in the study, with the sample size determined using the anticipated 46.7% pain relief rate after RFR, a 95% confidence interval, and a 5% margin of error.[8]

Patients aged 18 to 75 years of either gender diagnosed with TGN involving V2 and V3 according to International Classification of Headache Disorders, 3rd edition (ICHD-3 criteria),[10] refractory to medical treatment (poor pain control even after 600mg/day carbamazepine for at least 6 weeks or intolerance to first-line agents) or MVD were included in this study. Patients with TGN of the V1 branch, secondary TGN (caused by pathologies like Space-occupying lesions or Multiple Sclerosis), Patients suffering from any local site infection, Patients with a history of migraine, temporomandibular joint dysfunction and bleeding disorder, patients with a history of any psychiatric illness were excluded.

Patients were placed in the supine position, with the head rotated and extended up to 15° so that the foramen ovale faced the surgeon. With the help of a C-arm, an anteroposterior image was taken in a way that the foramen ovale was clearly visible midway between the maxilla medially and the rami of the mandible laterally, and its lower margin just touched the horizontal shadow of the petrous part of the temporal bone. Local anesthetic agent was infiltrated in the cheek, and the RF cannula was introduced into the foramen ovale, perfectly parallel to the rays of the C-arm and perpendicular to the foramen ovale, so that the cannula looks like a dot in imaging (Bull's eye). After negotiating the cannula through the foramen ovale, the stylet was withdrawn, and CSF egress was ensured. In a true lateral view, the placement of the cannula with respect to the clival line was observed, and the cannula was manipulated so that its tip came in the same line as the clival line for V2. 0.5 mm anterior to clival line for V1, and 0.5 mm inferior to clival line for V3 (Figure 1).

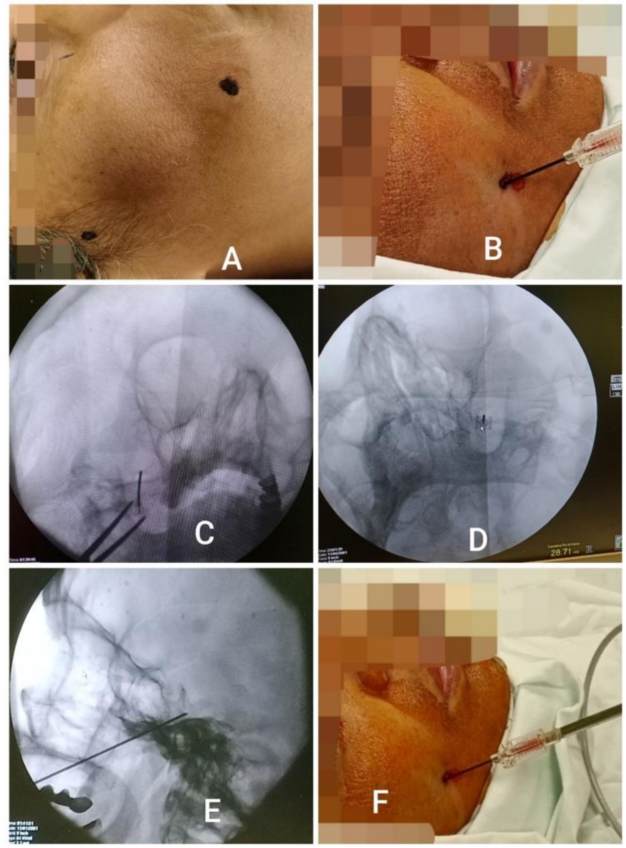


**Figure 1: A) surface landmark for insertion of RF canula, B) insertion of RF canula, C) fluoroscopic image of entry of RF canula into foramen ovale on AP view, D) Bull's eye view, E) fluoroscopic image showing tip of RF canula up to clival line, F) RF electrode placed in canula to generate lesion.**

The cannula placement was further confirmed by direct stimulation of TGN. Motor stimulation was done at 2 Hz, and sensory stimulation at 50 Hz. Sensory stimulation was confirmed by reproducing pain in the disease territory, and motor stimulation was confirmed by visualizing fibrillation of the cheek for V2 and the mandible for V3. Patients were sedated, and RFR was performed with the electrode tip at 75° for 60 seconds.

Patients were awakened, and the numbness of the territory of the concerned branch was ensured. If numbness was not present, the procedure was repeated. 1.0 mg (0.5 mL) of dexamethasone was infiltrated through a cannula before removal, and a local dressing was applied.

Data on patient demographics (age, gender, comorbidities) and baseline clinical characteristics (disease duration, laterality, affected nerve branch, preoperative Numeric Rating Scale score) were collected before the procedure. After the surgical procedure, patients were shifted to the ward and a neurological examination was conducted for pain relief, deficit or complication on day 1. Corneal reflex was assessed clinically using neurological examination protocol and whether anesthesia dolorosa was identified based on patient-reported symptoms. Pain relief was assessed using the Numeric Rating Scale score, i.e., in a 0-10 NRS, individuals are asked to choose the single number that best represents their pain intensity, on a 0 ("No Pain") to 10 ("Worst pain") scale.[11] Follow-up evaluations were conducted at 4 weeks for the NRS scale score, recurrence and complications (if any). The procedure was labelled as effective if NRS < 3 at 1 month of follow-up after RFR.

The data was analyzed using SPSS version 29.0. Quantitative data, such as age was were presented as mean ± SD whereas NRS-11 scores were presented as median and interquartile ranges. Frequencies and percentages were calculated for categorical variables, including gender, comorbidity, laterality of disease and the branch of nerve involved. The data was tested for normality by the Shapiro-Wilk test. A nonparametric Friedman test was applied to assess differences in NRS pain scores across time points of patient follow-up. Post-hoc pairwise comparisons were performed using the Wilcoxon signed-rank test with Bonferroni correction (adjusted $\alpha = 0.0125$). Data were stratified by age, gender, lesion laterality and nerve branch involved, and treatment outcomes were assessed using the Chi-square test. Post-stratification Fried was applied to compare pain scores before and after treatment. The chi-square test was used to compare the efficacy of outcomes across stratified groups.

## RESULTS

Of the 60 patients included, 40% (24) were male, and 60% (36) were female, with a mean age of 50.4 ± 11.3 years. The pain was lateralized to the left in 60% (36) of patients, with most cases involving the maxillary branch of the trigeminal nerve (V2), i.e., 53.3% (32). The demographic and baseline clinical characteristics of study participants are summarized in Table 1.

The median preoperative NRS pain score was 8 (IQR: 7-8), which was reduced to 1 (IQR: 0-1) on the 0$^{th}$ day of RFR, followed by almost no pain recorded at 1$^{st}$ postoperative day and 4 weeks. The mean NRS scores at various follow up time points are provided below in Figure 2).

The differences in NRS pain scores across time points revealed a significant improvement (Friedman $\chi^2$ (3) = 160.9, $p < 0.001$). Post-hoc pairwise Wilcoxon signed-rank tests with Bonferroni correction (adjusted $\alpha = 0.0125$), revealed a significant improvement in NRS pain score at all-time points except between day 1 and 4 weeks, suggesting a significant improvement in the immediate postoperative period, after which the scores remained static (Table 2).

**Table 1: Demographic and Baseline clinical characteristics of study participants**

| Variable | N (%) |
|---|---|
| Age (years), M ± SD | 50.4 ± 11.3 |
| **Gender, n (%)** | |
| Males | 24 (40) |
| Female | 36 (60) |
| **Comorbidities** | |
| Hypertension | 18 (30) |
| Diabetes | 5 (8.3) |
| Others (IHD, TB, Hep C) | 2 (3.3) |
| None | 35 (58.3) |
| **Laterality of lesion** | |
| Left | 36 (60) |
| Right | 24 (40) |
| **Branch of TGN involved** | |
| V2 | 32 (53.3) |
| V3 | 13 (21.7) |
| V2-V3 | 15 (25) |
| **Preoperative NRS score, Median (IQR )** | 8 (7-8) |

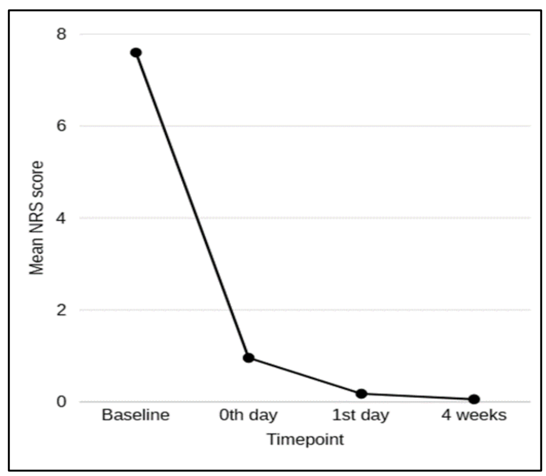


**Figure 2: Mean NRS score at various time points of follow-up**

**Table 2: NRS pain score at various timepoints of follow-up**

| NRS pain score | Median (TP1-TP2) | Z-statistics | p-value* |
|---|---|---|---|
| Preoperative-0$^{th}$ day | 8-1 | -6.81 | <0.001 |
| 0$^{th}$ day-1$^{st}$ day | 1-0 | -6.09 | <0.001 |
| 1$^{st}$ day-4weeks | 0-0 | -1.94 | 0.052 |
| Preoperative-4$^{th}$ week | 8-0 | -6.90 | <0.001 |

**Abbreviations: TP1**: Timepoint 1, **TP2**: Timepoint 2
*Wilcoxon signed rank

**Table 3: Association between demographic and clinical characteristics of study participants with postoperative complications**

| Variable | Postoperative Complications | | $\chi^2$ (df) | p-value |
|---|---|---|---|---|
| | Yes | No | | |
| **Gender** | | | | |
| Male | 1 (4.1) | 23 (95.8) | 3.52 | 0.171 |
| Female | 3 (8.3) | 33 (91.6) | | |
| **Laterality** | | | | |
| Left | 2 (8.3) | 22 (91.6) | 1.56 | 0.457 |
| Right | 2 (5.8) | 34 (94.4) | | |
| **Branch of the trigeminal nerve** | | | | |
| V2 | 1 (3.1) | 31 (96.8) | 6.69 | 0.153 |
| V3 | 1 (7.6) | 12 (92.3) | | |
| V2,V3 | 2 (8) | 23 (92) | | |

All patients reported NRS≤3 at final follow-up at 4 weeks, with efficacy reported to be 100% (60), loss of corneal reflex in 5% (3) and anesthesia dolorosa in 1.7% (1) patients, with no recurrence within 1 month of follow-up. Although the occurrence of postoperative complications was higher in females, in left-sided TGN, and in TGN involving both V2 and V3 branches. The chi-square test revealed no significant association between demographic and clinical characteristics of study participants with postoperative complications (Table 3).

There was no significant difference in preoperative NRS score between patients who had postoperative complications and patients who experienced no complication i.e., 23.63 versus 33.9 (p= 0.350).

## DISCUSSION

This study provides prospective evidence on the safety and effectiveness of RFR for the treatment of clinically refractory TGN, as measured by patient-reported pain outcomes. A significant reduction in NRS score after RFR supports the findings of Faizo et al.[9], who also reported significant improvements in patient-reported pain and satisfaction outcomes at 6 weeks of treatment.

The demographic pattern of TGN in our study follows the typical demographic trend previously described in the literature, with a frequent presentation in the middle-age range (50 to 70 years) and a female-to-male ratio of 3:2.[12] Approximately 30% of patients were hypertensive, supporting the hypothesis that chronic hypertension induces arteriosclerotic and tortuous vascular changes, predisposing to neurovascular compression at the trigeminal root entry zone, focal demyelination, and subsequent trigeminal neuralgia.[13] Mandibular branch was the most commonly involved branch in TGN, i.e., 53.3%. This is consistent with the findings of Kumaran et al.[14], who reported frequent involvement of the V2 branch in the TGN.

Hong et al.[7] reported that there is no specific standard for temperature in RFR in their review, with temperature values utilized in past ranging from 60 degrees Celsius to 95 degrees Celsius, with one study claiming that temperature below 80 degrees Celsius results in selective destruction of Aб and C unmyelinated nerve fibers, while Aα and Aβ nerve fibers remained safe, hence the transmission of pain remains stopped. In contrast, the facial tactile sensations remain intact.[7] Although the effectiveness of RFR in our study was reported to 100%, Loss of corneal reflex and anesthesia dolorosa was observed in 6.6% patients, which might alert neurosurgeons to evaluate the safety of lesioning at 75 degrees for 60 seconds. In contrast, none of these vision-threatening complications were reported by Faizo et al.[9] using the same temperature and duration of RFR. Similarly, a lesioning temperature as high as 80 degrees for 90 seconds has been employed safely by Waseem et al.[15] with no reported case of anesthesia dolorosa and loss of corneal reflex only in 1.9% patients, implying that factors other than lesioning temperature and duration, like surgical expertise, might affect the treatment outcomes.

Compared with the conventional treatment option for TGN, the 100% success rate reported in our study is superior to medical treatment, which carries additional risks and side effects from chronic use.[16] Similarly, although MVD is reported to provide pain relief in up to 90% patients, it is not suitable for all patients and is associated with surgery-related complications.[17] Yan et al.[18] have also reported superior efficacy of RFR for immediate pain relief compared with percutaneous glycerol injections, i.e., OR: 2.65, 95% CI: 1.29–5.44. Similarly, Texakalidis et al.[19] reported increased odds of immediate pain relief after RFR compared with percutaneous balloon compression in TGN (OR 2.65, 95% CI: 1.29–5.44). This is consistent with the findings of our study, which showed a significant immediate improvement in pain score after RFR, with a static response lasting up to 4 weeks. On the other hand, some studies have demonstrated that although radiofrequency rhizotomy provides excellent initial analgesia in trigeminal neuralgia, its efficacy declines with time because of recurrence, with long-term pain-free rates decreasing substantially on extended follow-up, underscoring the importance of longitudinal surveillance and retreatment strategies.[20]

Although we reported no recurrence in our study, this might be attributed to the short-term follow-up period. Wasim et al. reported a recurrence rate of 6.14% after RFR at 6 months of follow-up.[15] Zhang et al. reported a 5-year recurrence rate of 32%, further underscoring the importance of long-term follow-up.[21]

Although the study adds to the local literature supporting the clinical effectiveness and safety of RFR, it is limited by a small sample size and short-term follow-up. Additionally, the association between disease duration and previous medical treatment with follow up outcomes need to be addressed in future studies with large sample sizes and long-term follow-up to draw generalizable conclusions.

## CONCLUSION

Radiofrequency rhizotomy is a safe and effective treatment strategy for the management of trigeminal neuralgia refractory to conservative therapy, with immediate pain relief and no recurrence at one month.


### Author Contributions

**TS:** Concept, Design, Analysis, Data interpretation, Literature review, Critical review, Accuracy, Integrity of work, Final approval
**TA:** Conception, Analysis, Drafting the article, Accuracy of data, Final approval
**AI:** Data collection, Analysis, Data interpretation, Drafting the article
**WI:** Acquisition of data, Conception, Design, Analysis and interpretation
**RA:** Acquisition of data, Conception, Design, Analysis and interpretation
**SF:** Analysis and interpretation of data, Proofreading
**KS:** Conception, Design, Analysis and interpretation of data


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