ORI GIN A L A R C I C LE

Combined pulsed and thermal radiofrequency versus thermal radiofrequency alone in the treatment of recurrent trigeminal neuralgia after microvascular decompression: A double blinded comparative study

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Abstract

Background: Recurrent trigeminal neuralgia (RTN) is a common clinical problem and pain recurs in many patients after microvascular decompression (MVD). We evaluated the effect of adding pulsed radiofrequency to radiofrequency thermocoagulation at 60°C compared to radiofrequency thermocoagulation at 70°C alone in the treatment of recurrent trigeminal neuralgia after microvascular decompression.

Methods: 40 patients with recurrent trigeminal neuralgia after microvascular decompression were randomly divided into two equal groups. Group A: received prolonged duration of pulsed radiofrequency followed by less destructive thermocoagulation, while group B: received sole thermocoagulation. Then patients followed up for 2 years to evaluate the success rate by the Barrow Neurological Institute Pain Intensity (BNI) Scale, complications, and the need to medical treatment.

Results: The success rate was 100% in both groups at discharge (BNI < III). It was 83.3% and 78.7% after 6 months, 77.8% and 68.4% after 12 month, 72.2% and 68.4% after 18 months and 66.7% and 63.1% after 24 months in group A and B, respectively (p > .05). In group A 88.9% of patients stopped tegretol treatment after the procedure compared to 84.2% in group B (p = .32). 88.9% compared to 89.5% % in group A and B, respectively, did not use tricyclic antidepressant (p = .61). The overall complications in group A was 5.61%, while it was 36.8% in group B (p = .025).

Conclusion: Combined pulsed and thermal radiofrequency can significantly reduce the incidence of the side effects/complications with similar success rate than using thermal radiofrequency alone in treatment of recurrent trigeminal neuralgia after microvascular decompression.

Site of the study: The study was carried out in Pain Unit of Assiut University Hospitals, Assiut University, Assiut, Egypt.

Clinical Trials Registration Number: NCT03396406.
INTRODUCTION

Trigeminal neuralgia (TN) is a clinical neurological syndrome characterized by severe paroxysmal attacks of facial pain, which has a greater impact on quality of life and causes severe psychological disturbance in these patients (Bonathan, Zakrzewska, Love, & Williams, 2014). There are three options for treatment of severe and unresponsive TN; which are microvascular decompression (MVD), Gamma Knife surgery (GKS) and gasserian ganglion (GG) percutaneous interventional procedures (Liu, Zhong, Liao, Yang, & Zhang, 2016). MVD is considered the best choice because it restores normal function of the nerve and facial sensation, and its pain relief persists for a long period, and has less facial numbness and discomfort (Lai, Tang, Wang, Qin, & Ni, 2015).

However, pain recurs in many patients after MVD and treatment of refractory cases of TN is still a big problem; with an annual incidence of recurrent TN range from 1% to 5% (Oesman & Mooij, 2011). Percutaneous radiofrequency thermocoagulation (RFT) of GG has gained popularity and it is considered as an effective and less invasive procedure (Lopez, Hamlyn, & Zakrzewska, 2004). A comparison of effect and side effects of RFT at 75°C and 68°C, showed slightly higher success rate in the high temperature group at the expense of and increased incidence and severity of complications as face numbness and severe pain (Yao, Hong, Wang, et al., 2016).

Pulsed radiofrequency (PRF) is an alternative way of using radiofrequency current and the available evidence suggests that PRF is studied with regard to a variety of painful conditions, such as trigeminal neuralgia (Erdine et al., 2007), groin pain and orchialgia (Cohen & Foster, 2003), neuropathic pain (Day 1999), back pain (Sluijter, 2000), the results are varied. Optimizing PRF parameters and increasing the intraoperative output voltage may provide better pain relief in patients with TN (Luo et al., 2013). The outcome of PRF treatment could be improved by increasing the PRF dose and modifying intraoperative parameters (Luo, Wang, Lu, & Ji, 2015). The treatment of recurrent TN cases after surgery or percutaneous interventional procedure remains a big challenge for many physicians, and needs to be addressed to find an excellent method to solve this problem.

We assume that adding four cycles of 120 s PRF to conventional RF at 60°C would give comparable efficacy but fewer side effects than conventional RF at 70°C alone. Therefore, the aim of the study was to evaluate the effect of adding extended duration PRF to RFT in the treatment of recurrent TN after MVD in comparison with RFT alone.

MATERIALS AND METHODS

2.1 Study design

This prospective, double blinded, interventional study was conducted in 40 patients with a history of recurrence of unilateral paroxysmal classical TN after MVD in Pain Unit from 2010 to 2016.

2.2 Ethical consideration

All patients were given adequate and informative data about the nature of the study, interventional procedure and its possible complications, and a well-informed written consent was obtained from each patient after approval by our local Institutional Review Board IRB00008718 and registration in ClinicalTrials.gov, ID: NCT03396406.

2.3 Eligibility criteria

2.3.1 Inclusion criteria

Adult male and female patients (age > 18 years) with recurrent TN for more than 6 months after previous MVD and were not suitable/willing to receive MVD, non-satisfactory pain relief with medical treatment or/and intolerable side effects using medical drugs.

Diagnosis of classical TN based on ICHD-2 (Headache Classification Subcommittee of the International Headache S, 2004) as follow:

- Paroxysmal attacks of sudden brief facial pain lasting for seconds or few minutes with no apparent etiology other than vascular compression and without neurological deficits. The pain affects one or more divisions of the trigeminal nerve
- Pain is intense, sharp, shocklike, stabbing and superficial.
- Different factors may trigger pain as light stimulation of cheeks, shaving, talking, smiling, drinking or eating.
- Stereotypic pain character for each patient.

2.3.2 Exclusion criteria

Known concurrent neurological or neurodegenerative diseases such as multiple sclerosis, and myasthenia gravis, breast feeding or pregnant women, advanced malignancy or brain stem tumours, coagulopathy or patients on anticoagulant medications, allergy/sensitivity to lidocaine anaesthetic or/and non-ionic contrast media, presence of progressive motor or sensory deficit in the distribution of trigeminal nerve, active psychological or mental diseases and uncontrolled medical conditions.

2.3.3 Randomization

The patients were divided randomly by a computer generated program [Random Allocation Software (RAS)] into group A and group B (blind randomization), which were placed in sealed envelopes prior to the study initiation and opened prior...
to the procedure by pain specialist who did not participate in the procedure or clinical assessment. Interventions were done by an independent consultant who design and followed the randomization process.

2.4 | Procedures

All interventions were done in a specialized well-equipped pain unit. Patients were fasted for at least 6 hr before the procedure. Intravenous access was obtained and prophylactic antibiotic was administered within one hour before the procedure. Continuous monitoring with pulse oximetry, blood pressure and ECG applied for each patient. All patients were lightly sedated by intravenous (IV) propofol 0.5 mg/kg and IV midazolam 0.01 mg/kg. After the sensory stimulation, sedation was maintained by IV 1 µg/kg fentanyl and propofol infusion at the rate of 25–75 µg kg⁻¹ min⁻¹.

Under complete aseptic condition, the skin over the needle entry point was infiltrated with 1% lidocaine prior to insertion of radiofrequency needle, skin sensitivity was tested between each of the cycles to be sure that anaesthesia was achieved.

In a supine position with slightly extended head and under fluoroscopic control, C-arm rotated caudo-cranially and ipsilateral to produce an oblique submental view and visualize foramen ovale beside the ramus of the mandible. The point of entry varied according to the affected branch, but it ranged from 0.5 to 1.5 cm from the corner of the mouth. C-arm has been rotated laterally to confirm the depth of penetration once the needle entered into Meckel’s cavity. Radiofrequency electrode (22 G, 10 cm needle, with a curved 5 mm active tip, Neurotherm 1,100) was used and the exact position of the needle confirmed by sensory and motor stimulation and negative aspiration according to the following criteria:

- Sensory stimulation (50 Hz) threshold between 0.1 and 0.3 V which made paresthesia and/ or tingling in the affected painful area. Patient was awake to respond to the sensory stimulation.
- Motor stimulation at 2 Hz with 0.1–1.5 V caused muscle contraction of the lower mandible.

2.5 | Study groups

After confirming the position of the radiofrequency electrode, patients divided randomly into two equal groups (n = 20 in each):

- Group A: PRF was applied for four cycles of 120 s (8 min in total) at 45 V and temperature was set at 42°C, then RFT was applied for three cycles of 90 s at 60°C.
- Group B: RFT was applied gradually for three cycles of 90 s at 70°C.

2.6 | Outcome measures

After treatment all patients were hospitalized for 24 hr in the pain unit and observed for pain relief and early complication, including facial hematoma, headache, nausea, vomiting, external auditory meatus bleeding, corneal hypoesthesia, facial numbness, masticatory muscle weakness and other complication related to the technique.

Our primary endpoint was success rate 24 months after the procedure. After discharge, the patient follow-up was performed by investigator blinded to the patient’s procedure through pain clinic visit, once per month during the first 6 months and thereafter once every 3 months during the next 1.5 years. Information on post-procedural pain relief, patients’ requirement of additional medications as tegretol or tricyclic antidepressants and late complications were recorded.

Success rate was evaluated according to the patient's level of pain using Barrow Neurological Institute Pain Intensity (BNI) Scale (I = No pain, no medication; II = Occasional pain, no medication required; III = Some pain, adequately controlled with medication; IV = Some pain, not adequately controlled with medication; V = Severe pain or no pain relief) (Rogers et al., 2000). Success of the procedure was defined as BNI < III.

Follow-up for complications was done during routine visits in the pain clinic, by telephone or messages.

The corneal hypoesthesia was assessed as follows: with the patient staring to the side and unable to observe the activity of the tester, a piece of cotton was applied gently to the lateral-inferior side of the homolateral cornea in a lateral-to-medial direction, and whether or not a contraction of bilateral musculus orbicularis oculi occurred was noted (I, no corneal hypoesthesia; II, corneal hypoesthesia; III, severe corneal hypoesthesia, absent corneal reflex).

- Facial numbness was evaluated using the BNI facial numbness scale (Tang et al., 2014) as follows: I, no facial numbness; II, mild facial numbness; III, moderate facial numbness; IV, severe numbness.
- Masticatory muscle weakness: “0” no impact, “1” tolerable masticatory muscle weakness, without significant impact on life or work; “2” moderate masticatory muscle weakness, with significant impact on life; “3” severe masticatory muscle weakness. Masticatory muscle weakness was considered when score > 1.
- Dysthesia: defined as any unpleasant abnormal sensation of touch especially pain.

2.7 | Sample size calculation

A sample size calculation was performed based on a previous study (Yao, Hong, Zhu, et al., 2016) in order to detect 18% difference in the success rate between both techniques with α
error of 0.05 and 80% power of the study we need to include 34 patients in total. Forty patients were recruited to compensate for violation of the study protocol.

2.8 Statistical Analysis

Statistical Analysis: Data were analysed by using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Shapiro-Wilk test was used to verify the normality of distribution of variables, comparisons between groups of categorical variables was assessed using Chi-square test (Fisher or Monte Carlo). Student t-test was used to compare two groups with normally distributed quantitative variables while the Mann-Whitney test was used to compare between two groups with abnormally distributed quantitative variables. The significance of the obtained results was judged at the 5% level.

3 RESULTS

Forty patients were included in the study randomly allocated to two groups 20 patients in each. Three patients were excluded from the study due to failure of communication. Group A included 18 patients and group B included 19 patients as shown in the flow diagram (Figure 1).

Demographic and clinical data (Table 1): There were 25 females and 12 males for a total of 37 patients involved in the study and the average age was 56.9 ± 7.5 years and 54.4 ± 9.2 years for group A and B, respectively, with no statistical difference (p = .165). There were no statistical differences between the groups regarding gender, BMI, recurrence times and the affected side. Right side was affected in about 65% of cases in both groups. Regarding the affected cranial nerve (CN), 55.6% and 42.1% of cases had pain in the distribution of both Maxillary (V2) and Mandibular (V3) in group A and B, respectively, and sole V3 was the second common nerve affected at 22.2% and 26.3% with no statistical difference between both groups (p = .872).

At the end of 24 month post-procedure follow-up, 16 patients in group A were assessed in person and to patients were
assessed by telephone. In group B, 16 patients were assessed in person and three patients were assessed by telephone.

Success rate (Table 2): All patients showed good response at hospital discharge, where success rate was 100% in both groups. After 6 months, 15 patients in each group had BNI < III indicating successful outcome from procedure [83.3% (CI 64.3–102.4%) in group A and 78.7% (CI 58.7–99.1%) in group B (p = .532)]. After 12 months of the procedure 14 patients 77.8% (CI 56.5–99.1%) in group A and 13 patients 68.4% (CI 45.4–91.1%) in group B showed good response (p = .395). After 18 months number of patients with good response decreased to 13 72.2% (CI 49.3–95.1%) in group A, while in group B still the same as at 12 months, this number decreased again after 24 months to 12 patients [66.7% (CI 42.5–90.8%) and 63.1% (CI 39.3–87.0%)] in both groups, respectively (p = .548). Statistically, there were non-significant differences between both groups at all times of the study as regard the success rate.

BNI score and medical treatment (Table 3): no statistically significant difference was found between BNI score in both groups 24 months after the procedure, 88.9% (CI 72.8–104.9%) in group A and 79.5% (CI 58.8–99.1%) in group B showed reduction in tegretol dose with non-significant difference (p = .571), while 11.1% (CI −4.9%–27.2%) in group A and 10.5% (CI −4.7%–25.7%) in group B were still in need for tricyclic antidepressant (p = .677).

Complications (Table 4): At the time of hospital discharge, the study recorded no early complications in any patient. During 24 months of follow-up, only one case [5.6% (CI −6.1%–17.2%)] in group A showed complication to the procedure in the form of mild degree of facial numbness, seven patients [36.8% (CI 12.9%–60.7%)] in group B showed numerous complications as follow: three patients[15.3% (CI −2.3%–33.8%)] suffered from facial numbness (two of mild degree and one of moderate degree), three patients [15.3% (CI −2.3%–33.8%)] complained from tolerable masticatory muscle weakness and one patient [5.3% (CI −5.8%–16.3%)] complained of dysesthesia with no reported cases of the later two complications in group A. At the end of 24 month follow-up, the overall complications showed significant differences (p = .323), masticatory muscle weakness (p = .125) or dysesthesia (p = .514) between both groups.

### Table 2: Success rate after treatment of recurrent trigeminal neuralgia in patients receiving pulsed radiofrequency plus thermal radiofrequency (group A) or thermal radiofrequency alone (group B)

<table>
<thead>
<tr>
<th>At hospital discharge</th>
<th>Group A (N = 18)</th>
<th>Group B (N = 19)</th>
<th>p-value</th>
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<tr>
<td>6 months</td>
<td>15 (83.3%)</td>
<td>15 (78.7%)</td>
<td>.532</td>
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<td></td>
<td>(CI 64.3–102.4%)</td>
<td>(CI 58.7–99.1%)</td>
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<tr>
<td>12 months</td>
<td>14 (77.8%)</td>
<td>13 (68.4%)</td>
<td>.395</td>
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<tr>
<td></td>
<td>(CI 56.5–99.1%)</td>
<td>(CI 45.4–91.4%)</td>
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<tr>
<td>18 months</td>
<td>13 (72.2%)</td>
<td>13 (68.4%)</td>
<td>.543</td>
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<tr>
<td></td>
<td>(CI 49.3–95.1%)</td>
<td>(CI 45.4–91.4%)</td>
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<tr>
<td>24 months</td>
<td>12 (66.7%)</td>
<td>12 (63.1%)</td>
<td>.548</td>
</tr>
<tr>
<td></td>
<td>(CI 42.5–90.8%)</td>
<td>(CI 39.3–87.0%)</td>
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Note: Data were presented as a number and proportion (95% confidence interval).

### Discussion

The current prospective, interventional study on treatment of recurrent TN after MVD showed that the use of PRF at 42°C for 8 min plus RFT at 60°C for 3 min was associated with comparable success rate but with fewer complications than using RFT at 70°C for 3 min alone. The need for medical treatment was reduced in both groups with no significant difference.

The authors decided not to add another group with only RFT at 60°C for comparison. Two previous studies with more than 1,000 patients each stated that RFT alone at temperature less than 68°C is not effective for treatment of TN especially when V2 and V3 branches are affected (Tang et al., 2016; Yao, Deng, et al., 2016).

MVD is a surgical removal of the vascular compression of root entrance of the trigeminal nerve. The main advantage of this procedure is extended effective pain relief with maintaining the normal facial sense and less discomfort after the procedure (Elias & Burchiel, 2002). However, some studies have revealed that the pain did not disappear completely after the MVD. The adhesion of the interposed Teflon between the nerve and offending artery, inadequate decompression, the blood vessels compressing the nerve again and the development of new veins around the nerve root might be reasons (Tyler-Kabara et al., 2002). Another disadvantage of this procedure is high recurrence rate, Cho et al., 1994; reported that MVD procedure in the first year has 14% recurrence rates with growth of 2% to 3.5% per year and > 25% after 5 years (Cho et al., 1994).

There have been many reports on reoperation after MVD (Ugwuanyi & Kitchen, 2010; Ward & Hardwidge, 2010), but surgical interventions to treat recurrent TN after MVD carry a high risk of complications due to arachnoid adhesion and distorted anatomy (Gu & Zhao, 2014; Yang, Jiang, Chen, & Wang, 2015). Bakker, Dijk, Immenga, Wagemakers, and Metzemaekers (2014) recorded new paresthesia or numbness in 27% of patients (Bakker et al., 2014) and Amador and Pollock (2008) reported that more than half of patients experienced facial numbness (52%) after repeated MVD (Amador & Pollock, 2008). Radiofrequency therapy is a suitable intervention for recurrent TN especially for old people or patients
who are unfit for surgical operation as it does not need general anaesthesia or a long hospital stay (Lai et al., 2015).

RFT interrupts the nociceptive impulses by thermocoagulating the neural tissues; possible patient complications are discomfort, motor weakness, and deafferentation pain (Fang et al., 2014). PRF has proved to be of high clinical value for treatment of chronic pain; it is a safe, minimally invasive, and simple technique (Chua, Vissers, & Sluijter, 2011). Some clinical trials have found that PRF is reasonably effective in treatment of TN (Van Zundert, Brabant, Kelft, Vercruyssen, & Buyten, 2003), while Erdine et al., 2007 stated that it as an inefficient measure compared to RFT (Erdine et al., 2007). Vanneste, Lantschoot, Boxem, & Zundert, 2017; in their studies indicate that PRF has gained a place in treatment of TN due to its long-lasting effects without complications (Vanneste et al., 2017). ElawamyAbdalla & Shehata, 2017; stated that early success after RFT is reported to be 97.4%–100% and the complications was 80% for facial numbness, 0.3%–4% for anaesthesia dolorosa, 7% for corneal anaesthesia and 24% for masseter weakness (Elawamy et al., 2017). Zhao & his colleagues, 2015; concluded that RFT at 70°C could provide an acceptable overall pain relief in the treatment of trigeminal neuralgia than RFT at 75°C. The combined use of PRF and RFT could help eliminate complications such as facial numbness, masticatory muscle weakness and decreased corneal reflex (Zhao et al., 2015).

Many reports have explained the underestimated efficacy of PRF for treatment of chronic pain, including TN. One theory explained by Tanaka et al., 2010; proposed that PRF treatment was more effective when applied in the early stages of mechanical allodynia in rats. Increased exposure time showed a significant anti-allodynic effect without side effects (Tanaka et al., 2010). Chua, Halim, Beems, & Vissers, 2012; found that more beneficial effects of PRF were obtained in treatment of TN by applying PRF for 6 min at a frequency of 4 Hz and with a pulse width of 10 millisecond (ms) and by performing another PRF cycle after changing the direction of the RF needle if more than one branch of the 5th nerve was affected (Chua et al., 2012). From these previous theories we tried to optimize the efficacy of PRF in this study by applying PRF for four cycles of 120 s (8 min in total) at 45 V and temperature was set at 42°C.

Van Zundert et al., 2003; reported that PRF improved VAS for three of five patients (60%) with idiopathic TN (Van Zundert et al., 2003). Despite the small scale of Van Zundert’s work, his results were better than those of the Erdine study, which reported improvement for only 2 of 20 patients (10%) with TN, and for 3 months only (Erdine et al., 2007). Chua et al., 2012; reported beneficial results from PRF for 36 patients with TN. The percentage with > 80% pain relief was 73.5% at 2 months, 61.8% at 6 months, and 55.9% at 12 months (Chua et al., 2012). PRF, for 10 min with a pulse width of 10 ms at 42°C with a pulse frequency of 4 Hz, followed by RFT at 60°C applied for 270 s results in excellent pain relief for more than 70% of patients at 24 months and reduces the consumption of analgesics (carbamazepine) by patients with idiopathic TN (Elawamy et al., 2017).

Facial numbness was the most common complication in this study, where 15.8% of the patients treated by RFT suffer from facial numbness, compared to 5.6% in PRF plus RFT group. In the study of Lai et al., 2015; facial numbness after RFT was reported in about 87% of patient (Lai et al., 2015). Ali Eissa, Reyad, Saleh, & El-Saman, 2015 observed excellent

<table>
<thead>
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<th>Abbreviations: BNI, Barrow Neurological Institute Pain Intensity Scale. Note: Data were presented as a numbers and proportion (95% confidence interval).</th>
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<tr>
<td><strong>TABLE 3</strong> Reduction in tegretol dose and need for tricyclic antidepressant (TCA) in patients receiving pulsed radiofrequency plus thermal radiofrequency (group A) or thermal radiofrequency alone (group B)</td>
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<table>
<thead>
<tr>
<th>Group A (N = 18)</th>
<th>Group B (N = 19)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNI score; median (range)</td>
<td>1 (1–4)</td>
<td>1 (1–5)</td>
</tr>
<tr>
<td>Reduction in tegretol dose</td>
<td>16 (88.9%)</td>
<td>15 (79.5%)</td>
</tr>
<tr>
<td>(CI 72.8%–104.9%)</td>
<td>(CI 58.8%–99.1%)</td>
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<tr>
<td>Need for TCA</td>
<td>2 (11.1%)</td>
<td>2 (10.5%)</td>
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<tr>
<td>(CI –4.9–27.2%)</td>
<td>(CI –4.7–25.7%)</td>
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| **TABLE 4** Complications in patients receiving pulsed radiofrequency plus thermal radiofrequency (group A) or thermal radiofrequency alone (group B) |

<table>
<thead>
<tr>
<th>Group A (N = 18)</th>
<th>Group B (N = 19)</th>
<th>p value</th>
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<tr>
<td>Overall complications</td>
<td>1 (5.6%)</td>
<td>7 (36.8%)</td>
</tr>
<tr>
<td>(CI –6.1%–17.2%)</td>
<td>(CI 12.9%–60.7%)</td>
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<tr>
<td>Facial numbness</td>
<td>1 (5.6%)</td>
<td>3 (15.8%)</td>
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<tr>
<td>(CI –6.1%–17.2%)</td>
<td>(CI –2.3%–33.8%)</td>
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<tr>
<td>Masticatory muscle weakness</td>
<td>0 (0%)</td>
<td>3 (15.8%)</td>
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<tr>
<td>(CI –1.7%–10.2%)</td>
<td></td>
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<tr>
<td>Dyesthesia</td>
<td>0 (0%)</td>
<td>1 (5.3%)</td>
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<td>(CI –5.8%–16.3%)</td>
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pain relief and reduced consumption of analgesics for more than 6 months in patients who received PRF combined with RFT to the GG for treatment of idiopathic TN (Ali Eissa et al., 2015). Yao, Hong, Wang, et al., 2016; used RFT plus PRF to treat idiopathic TN, and the results suggest that PRF can decrease the recurrence rate of TN, decrease the incidence rate and shorten the recovery time of corneal hypoesthesia (Yao, Hong, Zhu, et al., 2016). Kanpolat, Savas, Bekar, and Berk (2001) reported that the success rate for RFT was 98.6% of 1,600 patients (Kanpolat et al., 2001). In the current study, it was confirmed that the rate of success for both techniques was excellent (100%) and using RFT at 60°C with PRF can improve the outcome with decreasing the incidence of complications.

4.1 | Limitations

Small sample size is the main limitation of this study because the number of patients with TN which need MVD is not too much. Patients had a history of failed previous MVD interventions with no precise details about the duration of clinical improvement after these procedures, another limitation was the use of only BNI score for pain assessment, it was better if combined with other scores as Neuropathic Pain Symptom Inventory. Finally, a significant proportion of our patients were not assessed in person. As some scoring systems as corneal reflex are not validated or impossible to be evaluated at distance, follow-up of complications is better evaluated during physical examination only, not by telephone calls or messages.

5 | CONCLUSIONS

The current study confirms that using pulsed radiofrequency at 42°C for 8 min combined with the conventional thermal radiofrequency at 60°C for three cycles of 90 s can significantly reduce the side effects and/or complications than using conventional thermal radiofrequency at 70°C for 3 min alone in treatment of recurrent trigeminal neuralgia after microvascular decompression. The success rate and the need for medical treatment were similar in both groups.

5.1 | Recommendation

There is a need for further research into this matter on larger sample size.

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