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Research Article

COMPARISON OF RADIOFREQUENCY THERMOCOAGULATION AT HIGH TEMPERATURES WITH COMBINED RADIOFREQUENCY THERMOCOAGULATION AND PULSED RADIOFREQUENCY IN TRIGEMINAL NEURALGIA

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ABSTRACT

Objective: The aim of this study was to compare the Radiofrequency Thermocoagulation (RFT) applied at high temperatures and RFT combined Pulsed Radiofrequency (PRF) to improve the efficacy in trigeminal neuralgia.

Materials and Methods: Demographic, clinical examination findings and VAS scores of the patients who underwent combined RFT + PRF and RFT for trigeminal neuralgia in the Algology clinic between May 2014 and March 2022 were recorded before the procedure and evaluated at 1 month, 12 months and 24 months after the procedure.

Results: The results of 43 patients (24 females, 19 males) were evaluated in 2 groups according to whether 20 patients underwent high-temperature RFT and 23 patients underwent PRF+ high-temperature RFT. At 1 month, 12 months and 24 months post-procedure follow-up, VAS scores were significantly lower in both groups compared to pre-procedure ($p<0.001$, $p<0.001$, respectively). The duration of pain control was 25.8±4.8 months in the RFT group and 25±3.4 months in the PRF+RFT group ($p=0.5$). At 24 months follow-up, recurrence was observed in 3 patients (2 patients in RFT group, 1 patient in PRF+RFT group) ($p=0.5$). Complications (masseter atony and dermatomal hypoesthesia) occurred in 10 patients in the RFT group and 5 patients in the PRF+RFT group ($p=0.052$). The mean time to resolution of complications was 75±35.61 days in the RFT group and 40±18.17 days in the RFT+PRF group ($p=0.04$). No irreversible complication was recorded in any patient.

Conclusion: PRF combined with RFT at high temperatures is an appropriate treatment option to prevent complications and shorten the regression time to side effects.

Keywords: Trigeminal neuralgia, radiofrequency ablation, pulse radiofrequency

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INTRODUCTION

Trigeminal neuralgia (TN) is characterized by transient, electric shock-like pain symptoms. Due to the severity of pain, patients' daily activities are significantly affected, and their quality of life is diminished. Surgical methods such as microvascular decompression and Gamma Knife radiosurgery can be applied in patients who cannot achieve adequate pain control through medical treatment or who cannot tolerate the side effects of medications. Less invasive percutaneous methods such as radiofrequency application, pulsed radiofrequency (PRF), and percutaneous balloon compression are preferred for patients who are unwilling or unsuitable for surgery (1). Gasserian ganglion RFT is a highly effective treatment for TN, with immediate pain relief achieved in 90-100% of cases (2). Comparative studies suggest that combined RFT and PRF treatment is more effective (3). In addition, some studies propose that combined RFT+PRF application reduces side effects, despite showing no difference in efficacy (4). There is no standardized protocol for temperature regulation in RFT. High-temperature RFT is often chosen to reduce the recurrence rate of TN; however, higher temperatures are associated with an increased risk of serious complications. In this study, we compared high-temperature (85°C) RFT with combined high-temperature (85°C) RFT+PRF for TN , focusing on efficacy duration, recurrence, and safety, based on 24-month follow-up results.

MATERIALS AND METHODS

The study employed a comparative retrospective design by collecting and analyzing data from patients who underwent high-temperature (85°C) RFT and combined high-temperature (85°C) RFT + PRF for TN.

Ethical approval was obtained from the Clinical Research Ethics Committee (2024/76, 527865). This study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all patients. Demographic and clinical examination data, including gender, age, distribution of involved nerves, side, medications used, and VAS scores, were collected from patients who underwent combined RFT + PRF and RFT for TN in the Algology clinic between May 2014 and March 2022. Visual Analog Scale (VAS) pain scores, clinical and neurological examination results, pain control duration, recurrence, and complications were recorded 24 months post-procedure.

Primary endpoint

Patients who underwent combined PRF+ high temperature RFT with high temperature RFT in TN were evaluated for pain control time and recurrence with long-term follow-up.

Secondary endpoint

Patients who underwent combined PRF+ high temperature RFT with high temperature RFT in TN were evaluated with long-term follow-up for complications.

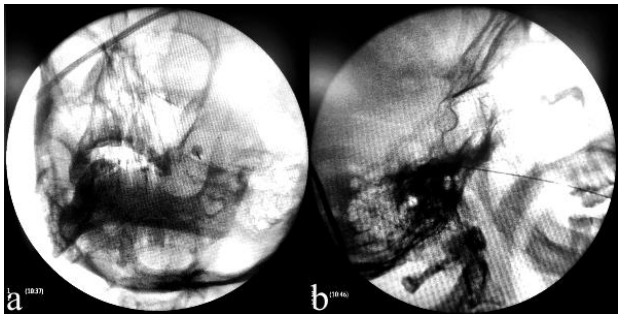

Figure 1. (a) Fluoroscopic image of cannula positioned in the foramen oval in oblique position **(b)** Fluoroscopic image of the cannula positioned in the foramen oval in lateral position

Interventional Procedure (RFT, RFT and PRF) patient was taken to the operating room in the supine position. The patient was administered intravenous fentanyl (1 µcg/kg), midazolam (0.05 mg/kg) as mild sedation, provided he was awake enough to respond to the test with electrical stimulation. In fluoroscopy, oblique projection was angled to approximately 15 degrees lateral to approximately 30 degrees to caudal, and foramen ovale was seen in the upper inner quadrant. The entry point was 2 to 3 cm side of the commissura labialis directed towards the pupil when viewed from the front of the face. 10 cm long 10 mm active tip radiofrequency cannula was inserted into the foramen ovale as a tunnel vision (Figure 1a), fluoroscopy was taken laterally, and the cannula entered into the bone tunnel of the foramen ovale (Figure 1b). The direction of the needle was verified in submental, lateral and Posterior-anterior view under fluoroscopy so that the tip of the cannula does not exceed 2 mm from the Clivus plane. Sensory and motor stimulis were given before radiofrequency. Paresthesia was taken in the appropriate dermatome area at 0.1- 0.5 V and 50 Hz at appropriate localization for sensorial stimulation. Masseter contraction was observed by stimulating 0.1 to 1.5 V at 2 Hz for the mandibular branch for motor stimulation.

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In the combined PRF+high temperature RFT group, after the placement of the cannula in the foramen ovale and the completion of sensory and motor stimulation, PRF was first applied at 42°C for 240 seconds.After PRF, RFT was applied after the patient provided deep sedation with either midazolam, fentanyl and propofol (0.5mg/kg). RFT was performed at 85 °C for 60 seconds.

In high temperature RFT group after the placement of the cannula in the foramen ovale and the completion of sensory and motor stimulation, patient provided deep sedation with either midazolam, fentanyl and propofol (0.5mg/kg). RFT was performed at 85 °C for 60 seconds. The patient was observed for 24 hours after the procedure for side effects.

Statistical Analyses

The research data were evaluated using the SPSS 21.0 statistical program. The conformity of continuous variables to normal distribution was investigated using visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). Descriptive statistics of the study were summarized using number (n), percentage (%), mean, standard deviation (SD), median, minimum and maximum. Chi-Square Test was used to show whether there was a difference between categorical variables in the study. The Student-t Test was used to compare the parametric properties of continuous variables in independent groups, the Mann Whitney U Test was used to compare the non-parametric properties of continuous variables in independent groups, and the Wilcoxon Test or Friedman Test was used to compare the non-parametric properties of continuous variables in dependent groups. For statistical significance, a p-value lower than 0.05 was set.

Table 1. Comparison of demographic and clinical characteristics of the groups

		RFT (n=20)	RFT+PRF (n=23)	p
Age				
	Mean±SD	65.2±11.19	65.91±12.38	0.845*
	Median (min-max)	65 (43-82)	65(42-86)	
Gender				
	Female	8(40)	16(69.6)	0.052
	Male	12(60)	7(30.4)	
Semptom Duration (year)				
	Mean±SD	8.1±7.49	9.13±7.76	0.651**
	Median (min-max)	6.5 (1-30)	6(1-30)	
Side				
	Left	9(45)	10(43.5)	0.92
	Right	11(55)	13(56.5)	
Segment				
	V2	8(40)	3(13)	0.029
	V3	8(40)	11(47.8)	
	V1+V2	2(10)	0(0)	
	V2+V3	2(10)	9(39.2)	
Drug used				
	Gabapentinoid	2(10)	2(8.7)	0.959
	Carbamazepine	7(35)	9(39.1)	
	Combined	11(55)	12(52.2)	

*Parametric test **Non parametric test

RESULTS

Table 2. Comparison of VAS scores of both groups before and after the procedure at 1st month, 12th month and 24th month

		RFT (n=20)	RFT+PRF (n=23)	p value
VAS (0)	**Mean±SD**	7.25±1.45	7.57±0.9	0.543*
	Median (min-max)	7 (3-9)	8 (6-9)	
VAS (1)	**Mean±SD**	2.05±1.19	2.22±1.31	0.706*
	Median (min-max)	2 (0-4)	2 (0-5)	
VAS (12)	**Mean±SD**	2.2±1.15	2.09±1.38	0.516*
	Median (min-max)	2(0-4)	2(0-6)	
VAS (24)	**Mean±SD**	2.75±1.33	2.7±1.64	0.687*
	Median (min-max)	2.5(1-6)	2(1-8)	
p value		<0.001*,1,2,3	<0.001*,1,2,3	

1 There is a statistically significant difference between VAS 0-VAS 1;
2 There is a statistically significant difference between VAS 0-VAS 12;
3 There is a statistically significant difference between VAS 0-VAS 24;
*Non parametric test

The clinical and demographic characteristics of the groups were similar and are shown in the table (Table 1). The results of 43 patients (24 females, 19 males) were evaluated in 2 groups according to whether 20 patients underwent high-temperature RFT and 23 patients underwent PRF+high temperature RFT. VAS scores were significantly lower in both groups compared to the pre-procedure period at 1 month, 12 months and 24 months after the procedure (p<0.001, p<0.001, respectively)(Table 2).

Table 3. Comparison of recurrence and pain relief duration of the groups

		RFT (n=20)	RFT+PRF (n=23)	p
Recurrence				
	(-)	18(90)	22(95.7)	0.59
	(+)	2(10)	1(4.3)	
Pain relief duration	**Mean±SD**	25.8±4.8	25.04±3.4	0.553*

*Non parametric test

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The mean duration of pain control was 25.8±4.8 months in the RFT group and 25±3.4 months in the PRF+RFT group (p=0.5)(Table 3). At 24 months follow-up, 3 patients (2 patients (10%) RFT group, 1 patient (4.3%) PRF+RFT group) recurrence was observed (p=0.5)(Table 3). Complications (masseter atony and dermatomal hypoesthesia) were observed in 10 patients in RFT group and 5 patients in PRF+RFT group. There was no significant difference between the two groups in terms of complications (p=0.052) (Table 4). The mean time to resolution of complications was 75±35.61 days in the RFT group and 40±18.17 days in the RFT+PRF group (p=0.04) (Table 4). No irreversible complication was recorded in any patient.

Table 4. Evaluation of complication development and complication regression duration of the groups

		RFT (n=20)	RFT+PRF (n=23)	p
Complication				
	(-)	10(50)	18(78.3)	0.052
	(+)	10(50)	5(21.7)	
Complication type				
	Masseter atoni	4(40)	1(25)	0.615
	Hypoesthesia	6(60)	4(75)	
Complication relief duration				
	Mean±SD	75±35.61	40±18.17	
	Median(min-max)	75(15-120)	37.5(15-60)	0.04*

*Parametric test

CONCLUSION

The temperature for RFT treatment varies widely (60°C to 95°C), but there is no standardized temperature. High-temperature RFT is used to enhance procedural efficacy and reduce recurrence rates. However, complications such as severe facial numbness, ptosis, keratitis, diplopia, mandibular deviation, and weakness of the masticatory muscles have been reported with high-temperature RFT (⩾75° C). A recent review evaluated the long-term efficacy and complications of RFT at different temperatures (5). The studies concluded that while the long-term analgesic effects of high-temperature RFT were not superior to those of relatively lower-temperature RFT, the risk of complications increased with temperature (6,7). These studies primarily assessed pain relief percentages but did not evaluate pain control duration or recurrence rates. Some studies have examined recurrence rates to evaluate the efficacy of high-temperature RFT for trigeminal neuralgia. Fraioli et al. reported a mean pain-free period of 8.8 years after RFT at 90–95°C for 10 minutes in 129 patients with trigeminal neuralgia. The recurrence rate was 7.8%, with a follow-up period of 11.6 years (8). Kosugi et al. observed that RFT at 90°C in patients with V2 and/or V3 branch involvement resulted in 1-year and 2-year pain-free rates of 40.5–80.2% and 17.1–54.9%, respectively (9). In this study, we evaluated the efficacy of high-temperature RFT in terms of pain regression rates, pain control duration, and recurrence. The mean duration of pain palliation was 25.8 months for RFT and 25 months for combined RFT + PRF. Our findings indicate that RFT + PRF treatment demonstrated equivalent efficacy in both short- and long-term follow-ups. The mean pain control duration was 25 months, with 24-month pain-free rates of 90% and 95.7%. Unlike previous studies, our long-term pain-free rates were higher, suggesting that our high-temperature RFT application was associated with a longer duration of efficacy.

Higher temperatures are associated with increased complications, with facial numbness and masticatory weakness being the most commonly observed after RFT. Short-term facial numbness incidence after RFT treatment is reported to range from 85% to 100%, typically resolving within one month (10,11). Masticatory muscle weakness, commonly associated with the V3 branch, occurs at temperatures ⩾65° C. Recovery time is approximately six months at ⩽68° C (12) but extends to over one year at 75° C (13). In our study, complications were observed in 10 patients (50%) in the RFT group and 5 patients (21.7%) in the RFT + PRF group. While high temperatures are linked to higher complication rates, we found no irreversible complications in our cohort. The regression time of complications averaged 75 days in the RFT group and 40 days in the RFT + PRF group, demonstrating significantly shorter recovery times in the combined RFT+PRF group. Zhao et al. evaluated 80 patients undergoing combined RFT (70°C and 75°C) and PRF treatment of the Gasserian ganglion under computed tomography guidance (14). They found no significant differences in pain control, but sensory loss, masticatory weakness, and decreased corneal reflex improved more rapidly in the combined group. These findings suggest that, compared to the use of RFT alone, combining PRF with RFT may benefit trigeminal neuralgia treatment by reducing complications.

In a prospective study, Yao et al. concluded that combined PRF and RFT application to the V1 branch in 56 patients reduced corneal hypoesthesia rates, shortened recovery times and decreased recurrence rates, while maintaining efficacy comparable to RFT alone (15). Elawamy et al.

analyzed 43 patients in 3 groups and concluded that combined application of PRF and RFT may reduce RFT-related complications (16). In line with these findings, our study showed that PRF treatment did not potentiate the efficacy of RFT but contributed to the regression process of side effects and side labels that may occur. We propose that the early resolution of complications associated with high-temperature RFT, applied to increase efficacy and reduce recurrence, is attributable to the adjunctive PRF application.

The limitations of our study include the small sample size and retrospective design. Prospective controlled studies will guide our current findings. Prospective, controlled studies are needed to validate our findings. Other major limitations include the absence of neuropathic pain scale records and functional outcome scores.

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AUTHORSHIP CONTRIBUTIONS

Study conception and design: EE, OY, ONA; Data collection: OY; Analysis and interpretation of results: OY, EE; Draft manuscript preparation: EE,ONA ;Critical revision of the article: EE,ONA ;All authors (OY, EE, ONA) reviewed the results and approved the final version of the manuscript

DATA AVAILIBITY STATEMENT

data is available for use.

DECLARATION OF COMPETING INTEREST

Authors have no conflict of interest.

ETHICS

Clinical Research Ethics Committee approval was obtained (2024/76, 527865).

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