Prospective Study

Effects of Pulsed Versus Conventional Versus Combined Radiofrequency for the Treatment of Trigeminal Neuralgia: A Prospective Study

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Background: During radiofrequency bursts of energy are applied to nervous tissue. The clinical advantages of this treatment remain unclear.

Objectives: We compared the effectiveness and pain relief for idiopathic trigeminal neuralgia (TN) after continuous radiofrequency (CRF), pulsed radiofrequency (PRF), and combined continuous and pulsed radiofrequency (CCPRF) treatment of the Gasserian ganglion (GG).

Study Design: We conducted a randomized prospective study. Forty-three patients were included. Eleven patients were treated with PRF at 42°C for 10 minutes (PRF group), 12 patients received CRF for 270 seconds at 75 °C (CRF group), and 20 patients received PRF for 10 minutes at 42°C followed by CRF for at 60°C for 270 seconds (CCPRF group).

Setting: Assuit University Hospital, Pain and Neurology outpatient clinics.

Methods: Patients were assessed for pain, satisfaction, and consumption of analgesics at baseline and 7 days, one month, 6 months, 12 months, and 24 months after the procedure. The incidence of complications, anesthesia dolorosa, weakness of muscles of mastication, numbness, and technical complications, was evaluated after the procedure.

Results: Excellent pain relief was achieved after 6, 12, and 24 months, respectively in 95%, 85%, and 70% of patients with CCPRF; 75%, 75%, and reduced to 50% among patients with CRF; and 82%, reduced to 9.1%, and 0% of patients with PRF. No complications were recorded in 75% of patients in the CCPRF and PRF groups. There was one case of anesthesia dolorosa, 4 cases of masseter muscle weakness, and 5 cases of severe numbness recorded in the CRF group.

Limitation: There was a small number of patients in each group.

Conclusion: The best results were observed in the CCPRF group, followed by the CRF group, and then the PRF group.

Key words: Pulsed, continuous, radiofrequency, trigeminal neuralgia, Gasserian ganglion

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Trigeminal neuralgia (TN) is a unilateral disorder characterized by brief electric shock-like pains, abrupt in onset and termination, limited to the distribution of one or more of 3 divisions of the trigeminal nerve. Pain is commonly evoked by trigger factors (trivial stimuli, including washing, shaving, smoking, talking, and/or brushing the teeth) and frequently occurs spontaneously. Tigger areas are small areas in the naso-labial fold and/or chin that may be particularly susceptible to the precipitation of pain. This pain usually remits for variable lengths of time (1). The age-specific prevalence rate of TN in Egypt is 29.5/100,000 (2).

Treatment of TN is conservative, surgical, or interventional. Pharmacotherapy with carbamazepine is tried early in cases of TN. Carbamazepine may reduce symptoms in 70% of cases with TN but has many side effects (3,4). Other medications that can be used in the treatment of TN, with similar efficacy, include oxycarbazepine, gabapentin, pregabalin, baclofen, valproate, clonazepam, phenytoin, and lamotrigime. Interventional therapies for TN are of variable efficacy and safety, and have different results for different periods of time before the recurrence of symptoms. The most clinically appropriate treatment includes surgical microvascular decompression (MVD), stereotactic radiation therapy, gamma knife (SGK), percutaneous balloon decompression, percutaneous glycerol rhizolysis, percutaneous radiofrequency (RF) of the Gasserian ganglion (GG), and GG stimulation and/or neuromodulation (5). In our research, we studied some non-pharmacological methods. RF thermos-coagulation of the GG is thought to selectively destroy the pain fibers (Ad and C fibers) by thermos-coagulation at > 65°C, that helps reduce pain and prevent triggering, but can cause bothersome dysesthesia (6,7). Another method, pulsed radiofrequency (PRF), is an ideal technique in the treatment of chronic pain as it does not cause thermal damage to the tissue (8). Thus, a short exposure at the same temperature will result in less tissue destruction. Moreover, Simopoulos et al (9) reported that combined conventional (CRF) and pulsed radiofrequency (PRF) (CCPRF) achieved comparable pain relief to PRF treatment alone in patients with chronic pain. We hypothesized that if PRF is an option for treating TN with no adverse neurological outcomes, the combination of PRF and CRF would increase the effect of CRF (10) and reduce the need for long-duration CRF (LCRF) and its attendant side effects. This randomized prospective study is designed to further investigate the different modalities: PRF versus CRF versus CCPRF in the treatment of TN.

Methods

This randomized prospective study was conducted at Assuit University, Departments of Neurology and Anaesthesia and Pain Management.

Informed Consent

Written consent was obtained from patients or their relatives after receiving oral or written information about the study. The local ethical committee of Assiut University Hospital approved the study. This study is in agreement with the Helsinki Declaration of Research Ethics.

Case Ascertainment

Forty-three patients with classical TN were included in this study. Patients were diagnosed in accordance with the International Headache Society (10) and with a visual analog score (VAS) for pain of at least 7 or more for a minimum of 3 months. Diagnostic criteria:

A. At least 3 attacks of unilateral facial pain fulfilling criteria B and C
B. Occurring in one or more divisions of the trigeminal nerve, with no radiation beyond the trigeminal distribution
C. Pain has at least 3 of the following 4 characteristics:
   1. Recurring in paroxysmal attacks lasting from a fraction of a second to 2 minutes
   2. Severe intensity
   3. Electric shock-like, shooting, stabbing, or sharp in quality
   4. Precipitated by innocuous stimuli to the affected side of the face
D. No clinically evident neurological deficit
E. Not better accounted for by another ICHD-3 diagnosis

Patients with local infection at the needle puncture site, coagulopathy, epilepsy, severe mental or psychiatric disorders or a history of drug abuse, high intracranial tension, and history of previous interventions to manage TN, or glycerol injection were excluded from the study. The possibility of vascular loop compression and other causes of TN were excluded. Magnetic resonance imaging (MRI) of the brain for all cases was done to exclude secondary causes of TN.

Patients' Evaluation

Using a table of random numbers, patients were randomly assigned to one of 3 treatment groups (n = 20 per group). Patients received either 75°C CRF for 270 seconds (CRF group), PRF at 42°C for 10 minutes (PRF group), or 42°C PRF for 10 minutes followed by 60°C CRF for 270 seconds (CCPRF group).

The sealed envelope defining the group for each patient was opened immediately prior to application of the procedure, and CRF or PRF or CCPRF was performed accordingly. The patients and the specialist, who evaluated the patients during the follow-up visits, were blinded to the treatment group. Eleven patients did not come for follow-up at different times at 6 months, 12 months, or 24 months. We tried to connect with them by phone, 6 traveled out of the country and we failed to connect with them, 2 died from causes other than TN, and 2 refused to complete the follow-up without

definite cause. One case failed treatment after 6 months and transferred to another type of treatment.

Full clinical and neurological examination of all patients provided the following information: age, gender, age at onset, preoperative pain duration, visual analog scale (VAS) score and distribution, response to medical treatment, trigger stimuli, carbamazepine dose, preoperative associated symptoms, and side effects (facial numbness, dysesthesia, ocular complications, jaw weakness, diplopia, and intracranial complications). The degree of the initial sensory loss was classified as follows: anesthesia (loss of both pain and touch perception); analgesia (loss of pain perception without loss of touch perception); dense hypalgesia (loss of pain, touch perception, and temperature 75% of pain perception without loss of touch perception); and mild hypalgesia (loss of 75% of pain perception without loss of touch perception).

Additional information was obtained at 2-year follow-up by using a VAS, which is a measurement instrument that tries to measure a characteristic or attitude that is believed to range across a continuum of values and cannot easily be directly measured. The follow-up questionnaire included: VAS score, dose of carbamazepine, and patients' satisfaction rated by percentages (0% – 100%). Patients rated the outcome of the procedure as follows: excellent (pain-free without side effects), good (pain-free with minor side effects), fair (pain recurrence or major side effects that do not require treatment), poor (major side effects that require treatment), or failed (no pain relief after surgery).

Procedure

In the operating theatre, standard monitors such as electrocardiogram (ECG) (10), non-invasive blood pressure monitoring, and pulse oximetry were connected to the patient, and O_2 was administered via a nasal prong. The patient was placed in the supine position with slight hyperextension of the neck to facilitate the oblique submental view by fluoroscopy.

The percutaneous technique was performed as first described by Sweet and Wepsic (11) in 1974. In this procedure, the patient lies comfortably in a supine position with the head slightly extended. ECG, pulse oximetry, and blood pressure readings are obtained for continuous hemodynamic monitoring. The C-arm is introduced in a postero-anterior fashion and rotated caudo-cranially to produce a submental view (Fig.1). A 5 – 10-degree tilt to the ipsilateral affected side may be required to obtain oblique submental view which improves visualization of the foramen ovale (12). Foramen ovale is an oval shaped opening in the middle cranial fossa located at the posterior base of the greater wing of the sphenoid bone, lateral to the lingula. It transmits the mandibular division of the trigeminal nerve (CN Vc), accessory meningeal artery, emissary veins between the cavernous sinuses and pterygoid plexus, otic ganglion, and occasionally the nervus spinosus and lesser petrosal nerve.

Fig. 1. *The C-arm is introduced in a postero-anterior fashion and rotated caudo-cranially to produce a submental view.*

The skin over the needle entry point is anesthetized with 2% lidocaine using an aseptic technique by applying betadine and 70% alcohol. The needle entry point is 1 – 3 cm from the corner of the mouth. The needle introduced in one line with the image intensifier of the C-arm in tunnel view. The needle is directed towards the ipsilateral pupil. We follow the practice of keeping one finger in the mouth of the patient to reduce the chance of needle entry into the oral cavity. If the oral cavity is breached, the needle is replaced to reduce the rate of infectious complications.

Closeness of the needle entry site to the corner of the mouth varies depending on the affected division for the mandibular branch. We choose the most medial skin entry point which is about 1 cm from the angle of the mouth aiming to introduce the needle in the lateral part of the foremen ovale and for ophthalmic

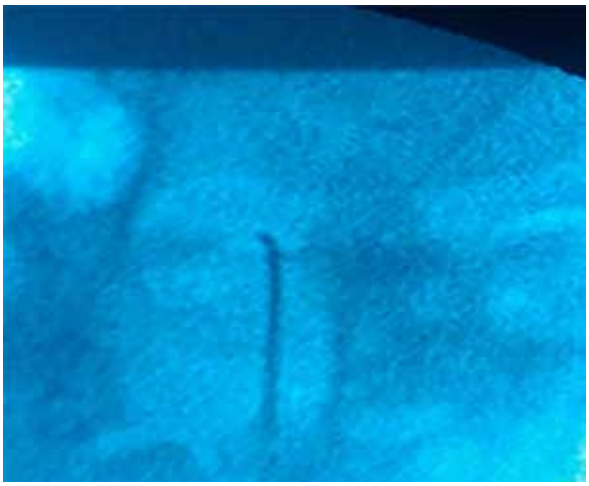

Fig. 2. *The needle at the plane of clivus in V2 division.*

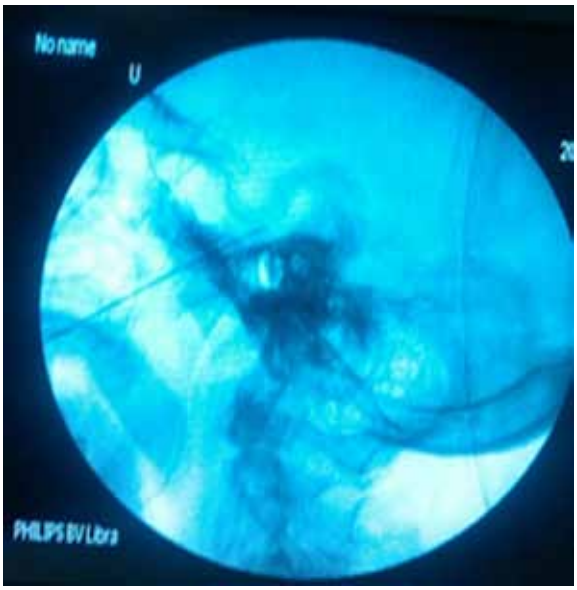

Fig. 3. *Submental view showing RF needle end-on in the foramen ovale.*

division we use the most lateral skin entry point which is about 2.5 cm from the angle of the mouth aiming to introduce the needle in the medial part of the foramen and in between for maxillary division to enter the middle of the foramen (Fig. 2).

One mg/kg of propofol is used to sedate the patient during the initial needle penetration into the foramen ovale. Once the needle enters the foramen ovale into Meckel's cavity, the C-arm is then rotated laterally to ascertain the depth of penetration. The final position of the needle tip is just past the angle formed by the petrosal ridge of the temporal bone and the clivus (petroclival junction). As the tip of the electrode reaches the petroclival junction, the stylet is then removed from the cannula (Fig. 3), and aspiration is performed to ensure that there is no cerebrospinal fluid (CSF), propofol sedation is discontinued and the patient is allowed to awaken.

For the mandibular nerve, the nerve is stimulated at 2 Hz between 0.5 and 1 Hz. Muscle contraction of the lower jaw is seen (mandibular bite) and this confirms that the needle tip is lying on the trigeminal roots. Next, feelings of paresthesia occurs in the concordant trigeminal distribution of the patient's usual symptoms (V1, V2, or V3 divisions) at 50 Hz, 1 msec pulse duration reproducible at 0.3 V. If paresthesia is only obtained above 0.5 V stimulation, the needle is redirected to get the same response at a lower voltage. After appropriate stimulation parameters have been achieved, 0.5 mL of 0.25% bupivacaine with 40 mg of triamcinolone should be injected. After waiting for at least 30 seconds, RF is carried out; impedance usually is from 150 to 350 Ω.

In the PRF group, PRF is applied for 10 minutes at 45 V, with a pulse width of 10 ms and a pulse frequency of 4 Hz at 42°C. In the CRF group, the cut-off needle tip temperature was set at 75°C and thermal lesion is applied for 270 seconds. In the CCPRF group, we started with PRF for 10 minutes and then continuous radiofrequency at 60°C for 270 seconds.

Statistical Analysis

SPSS version 16 (SPSS Inc., Chicago, IL, USA) was used for the data analysis. Non-parametric tests were used for analysis. We used the chi-squared test, Kruskal Wallis Test, and K independent samples as needed. To compare between means of VAS scores among the same group, we used non-parametric test, dependent k related tests, Kendall's W. Descriptive data as number, percentages, means ± SD were used for data according to need. *P* value ≤ 0.05 was considered as statistically significant.

Results

Forty-three patients were included in our study. Demographic data reported in Table 1 showed no significant difference regarding age, gender, laterality, and division of trigeminal nerves. The most recorded trigger stimuli were movement of jaw (n = 17; 39.5%).

Table 1. *Baseline characteristics of patients treated for trigeminal neuralgia.*

Parameter	PRF group (N = 12)	CRF group (N = 11)	CCPRF group (N = 20)	*P* values
Age (years; mean ±SD)	55.75 ± 11.23	56.00 ± 10.68	52.60 ± 9.78	0.594
Gender (female / male)	6/6	5/6	13/7	0.515
Duration of symptoms (months; mean ± SD)	120.09 ± 10.82	55.82 ± 3.46	152.42 ± 26.91	0.430
Lateralization (unilateral/ bilateral)	11/1	11/0	18/2	0.565
Division of trigeminal nerve, n (%)				
V2 V3 V2 & V3 V1, V2 & V3	0 0 10 (83.3%) 2 (16.7%)	1 (9.1%) 1 (9.1%) 8 (72.7%) 1 (9.1%)	1 (5%) 1 (5%) 18 (90%) 0	- - 0.494 -
Trigger stimuli (n & %)				
Moving of jaw Exposure to sun Touch Non	5 (41.7%) 0 1 (8.3%) 6 (50%)	5 (45.5%) 1 (9.1%) 0 5 (45.5%)	7 (35%) 0 2 (10%) 11 (55%)	- 0.634 - -
Associated symptoms (headache)	1 (8.3%)	2 (18.2%)	0	-
Exaggerated by				
Cold Speaking Eating Exposure to heat or air Touch Stress	2 (16.7%) 2 (16.7%) 7 (58.3%) 0 1 (8.3%) 0	0 1 (9.1%) 7 (63.6%) 1 (9.1%) 1 (9.1%) 1 (9.1%)	1 (5%) 2 (10%) 15 (75%) 0 2 (10%) 0	0.528 - - - - -
Tigger zone (nasolabial)	5 (41.7%)	5 (45.5%)	8 (40%)	0.957
Medical disease association	1 (8.3%)	0	1 (5%)	0.635
Previous surgery				
Maxillectomy Neurectomy	4 (33.3%) 0	2 (18.2%) 0	2 (10%) 1 (5%)	0.451 -
Hypotheses	4 (33.3%)	0	1 (5%)	0.020

Data described as number (%) or mean ± SD; SD: standard deviant; PRF: pulsed radiofrequency group; CRF: conventional radiofrequency group; CCPRF: combined conventional and pulsed radiofrequency group

The maneuver of eating is considered the most exaggerated factor (n = 29; 67.4%). Assessment of pain by VAS showed significant reduction in scores among the CCPRF group, followed by the CRF, and then the PRF group (Table 2). The CRF group had the most complications, 45.45%, followed by the PRF group, 25%, and the CCPRF group, 20%. The complication most recorded was numbness and weakness, 18.2%, among the CRF group followed by paresthesia, 10%, among the CCPRF group (Table 3). There were non-significant differences between doses of carbamazepine before the intervention in all groups. Gradual reductions of doses were observed among groups and the least observed among the CCPRF group (Table 4). Patients expressed significantly higher satisfaction about intervention in the CCPRE group at one and 6 months after the intervention. Moreover, the highest percentages of satisfaction were in the CCPRF group followed by the PRF group, and then the CRF group (Table 5). Comparison of excellent responses after the intervention is shown in Fig. 4.

Discussion

In this study, our main goal was to examine and compare the effectiveness of PRF, CRF, and CCPRF in patients with TN. Our results revealed that CCPRF was the best method for treatment of TN with least post-operative complications. CCPRF showed significant reduction in VAS scores, excellent pain relief, and better patient satisfaction rates compared with the other groups.

Most of TN problems occur early, RFT has widespread application in the treatment of TN, by using different temperatures (55° – 90°C) during operation determined by the experience of the doctor (13). There is no standard optimal temperature to maximize pain

Table 2. *Visual analog scale for pain assessment before and after treatment of trigeminal neuralgia.*

Groups	Before Intervention (baseline)	Immediately after intervention	One week after intervention	One month after intervention	6 months after intervention	12 months after intervention	24 months after intervention	Kendall's W (*P*-value)
PRF	8.67 ± 2.53	1.17 ± 0.15	1.19 ± 0.3	1.33 ± 0.27	0	0.833 ± 0.28	1.83 ± 0.36	0.0001
CRF	9.00 ± 0.89	2.00 ± 0.17	1.27 ± 0.17	0.636 ± 0.9	00	1.18 ± 0.17	2.63 ± 0.14	0.0001
CCPRF	9.15 ± 1.13	1.45 ± 0.15	1.20 ± 0.15	0.255 ± 0.07	0	0	0	0.000
Kruskal Wallis Test	0.718	0.512	0.970	0.784	-	0.014	0.000	-

Data described as means ± SD, PRF: pulsed radiofrequency group; CRF: conventional radiofrequency group; CCPRF: combined conventional and pulsed radiofrequency group

Table 3. *Complications following intervention.*

Variable	PRF group (N = 12)	CRF group (N = 11)	CCPRF group (N = 20)	*P*-values
No complications	9 (75%)	7 (63.63%)	15 (75%)	0.067
Bleeding	0	1 (9.1%)	0	
Fits	1 (8.3%)	0	0	
Hematoma	1 (8.3%)	0	0	
Neuralgia of 9 CN, rt glossodynia	1 (8.3%)	0	0	
Masseter weakness	0	2 (18.2%)	1 (5%)	
Dysesthesia/Dysisthesia	0	0	2 (10%)	
Vomiting	0	1 (9.1%)	1 (5%)	
Recurrent	0	1 (9.1%)	0	

Data described number (%), PRF: pulsed radiofrequency group; CRF: conventional radiofrequency group; CCPRF: combined conventional and pulsed radiofrequency group

Table 4. *The doses mg/day of carbamazepine consumption.*

Variable	PRF group (N = 12)	CRF group (N = 11)	CCPRF group (N = 20)	*P*-values
Before intervention	916.66 ± 75.53	654.55 ± 41.07	840.0 ± 63.77	0.695
One month after intervention	450.00 ± 41.0	436.36 ± 37.75	300.0 ± 30.7	0.764
6 months after intervention	0	0	0	-
12 months after intervention	16.67 ± 5.7	0	0	-
24 months after intervention	22.22 ± 6.6	0	0	-

Data described as means ± SD, PRF: pulsed radiofrequency group; CRF: conventional radiofrequency group; CCPRF: combined conventional and pulsed radiofrequency group

relief and minimize complications. The choice of which temperature to use during RFT is influenced by the voltage required during motor and sensory stimulations before the thermoscoagulation procedure. If > 0.1V produces paraesthesia and/or twitching, the operator is likely to use a temperature of ≤ 70°C. If 0.1 to 0.3 V is required, 75°C is likely to be chosen, whereas if > 0.3 V is required, a temperature of ≥ 80°C is likely to be used. The voltage required to produce effective stimulation reflects the distance of the needle tip from its target nerve tract in the GG; the smaller the distance the less voltage required. This needs to be considered when choosing a voltage which is likely to be effective, while minimizing the risk of painful dysesthesia (14). And for PRF, thermal lesions are not produced, but it suggests that microscopic damage to axonal microfilaments and microtubules can occur, with greater changes seen in C fibers than A-β or A-δ fibers (15).

At 6 months after treatment, our patients reported excellent pain relief, patients' satisfaction, and decrease in VAS scores in the CCPRF group. At 12 months 85% of patients and at 24 months 70% of patients were still free from pain. In addition, the response associated with reduction of dose of concomitant carbamazepine stopped completely among CCPRF and CRF groups. That matched Simopoulos et al report that PRF combined with CRF achieved comparable pain relief to PRF treatment alone in patients with chronic lumbar radicular pain (9). Also, a large study by Kanpolat et al (16) reported early pain relief was observed in 97.6% of patients, 92% after 6 months, 57.7% after 5 years, and 41% after 10 years of follow-up.

Table 5. *Patient satisfaction records as percentages from 100.*

Variable	PRF group (N = 12)	CRF group (N = 11)	CCPRF group (N = 20)	*P*-values
Immediately after intervention	82.5000 ± 16.58312	83.6364 ± 14.33369	83.7500 ± 11.57072	0.967
One weak intervention	75.4545 ± 33.87141	87.7273 ± 16.33457	71.4706 ± 32.58473	0.361
One month after intervention	96.6667 ± 6.51339	92.7273 ± 4.67099	97.8095 ± 4.09460	0.033
6 months after intervention	96.6667 ± 6.51339	92.7273 ± 4.67099	97.8095 ± 4.09460	0.033
12 months after intervention	89.1667 ± 22.34373	92.4242 ± 3.82707	92.7500 ± 3.79577	0.704
24 months after intervention	91.3158 ± 25.69458	95.2632 ± .00000	97.6316 ± 2.42995	0.451

Data described as means ± SD, PRF: pulsed radiofrequency group; CRF: conventional radiofrequency group; CCPRF: combined conventional and pulsed radiofrequency group

Table 6. *Comparison of excellent pain relief rate at different times for patients treated for trigeminal neuralgia.*

Variable	PRF group (N = 12)	CRF group (N = 11)	CCPRF group (N = 20)	*P*-values
Immediately after intervention	1 (8.3%)	0	2 (10%)	0.269
One weak intervention	2 (16.7%)	3 (27.3%)	4 (20%)	0.819
One month after intervention	4 (33.3%)	3 (27.3%)	11 (55%)	0.141
6 months after intervention	9 (75%)	2 (18.2%)	16 (80%)	0.004
12 months after intervention	9 (75%)	1 (9.1%)	17 (85%)	0.001
24 months after intervention	6 (50%)	0	18 (90%)	0.0001

That can be explained because PRF alters synaptic transmission. In vitro studies show PRF stimuli of organotypic slices of the hippocampus induce a transient decrease in excitatory postsynaptic potential with rapid and complete recovery, while in contrast, CRF creates long-lasting blockade of synaptic transmission even in temperatures < 45°C. So, both CRF and PRF treatments induce distance dependent tissue destruction under the stimulating needle, but the effect was more pronounced in the continuous group (17). A morphological evaluation of the rabbit dorsal root ganglion 2 weeks after sham, CRF, and PRF, illustrated no pathological findings in the control and sham-operated groups, minimal morphological changes in the PRF group, and neurodestruction in the CRF group (18). All these findings together indicate that the effects of PRF are more reversible and less destructive than those of CRF, even when lesions are performed at < 45°C and CCPRF is the better method (19).

In our study, there were less complications associated with the CCPRF and PRF groups compared with 63.6% in the CRF group. Post-interference bleeding was observed in 9.1% of patients in the CRF group. Dysesthesia was reported in 10% of the CCPRF group after one week. Masseter weakness was reported in 5% of the CCPRF group and in 18.2% in the CRF group and was treated with massage within 1 – 6 months. Vomiting occurred in 5% of the CCPRF group and 9.1% of the CRF group that may be due to anesthesia and stopped immediately with treatment. Recurrence was only observed in 9.1% of the CRF group. These complications were minor compared to the large study by Kanpolat et al (16). They reported results from a large retrospective study of 1,600 patients who underwent PRF. Complications were pain recurrence for 7.7% in the early period (less than 6 months) and for 17.4% in the late follow-up period. Diminished corneal sensation was experienced by 5.7% of cases with TN, masseter weakness reported in 4.1%, dysesthesia by 1%, anesthesia dolorosa by 0.8%, keratitis by 0.6%, transient cranial nerves III, IV palsy by 0.8%, CSF leakage by 2 patients, corticocavernous fistula by one patient, and aseptic meningitis by one patient (17). Raj et al (20) stated that early success after conventional RF is 97.4% – 100%. Complications may be 80% for facial numbness, 0.3% – 4% for anesthesia dolorosa, 7% for corneal anesthesia, and 24% for masseter weakness.

These complications can be explained as RF applications caused some structural damage on myelinated, un-myelinated nerve fibers, or both. Destruction was for both small and large fibers (21). Although, PRF does not cause thermal damage to the tissue and is considered as an ideal technique in the treatment of chronic pain, results of previous studies regarding PRF varied for the treatment of TN (22). Several authors reported a positive effect of PRF in relieving pain from TN, with no neurological side effects or complications (23,24). While Erdine et al (25), in a randomized controlled trial, showed that PRF treatment for TN was not as effective as CRF treatment. Exposure time is

one of the most important factors affecting the tissue lesion in the CRF technique. Several studies reported that for each degree increase in temperature above 43°C, there is approximately a 2-fold decrease in the time required to achieve the same biological effect but with more destruction to the tissue (26,27). Thus, a short exposure at the same temperature will result in less tissue destruction. Moreover, PRF may disturb microtubules, mitochondria of the afferent axons of C-fibers (28). So, in our study we tried to decrease these complications by used both methods to reduce time exposure and get more benefit from continuous exposure.

Conclusion

PRF for 10 minutes with a pulse width of 10 ms at 42°C with a pulse frequency of 4 Hz, followed by CRF at 60°C with a thermal lesion applied for 270 second at 60°C (which could result in less destruction of the target tissue, which is feared to cause anesthesia dolorosa) 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. In addition, this group least reported the least complications.

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