Percutaneous radiofrequency trigeminal rhizotomy for the treatment of idiopathic trigeminal neuralgia: Experience in 106 patients

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Abstract

Objective: The aim of our study is to analyse the results of percutaneous radiofrequency trigeminal rhizotomy for treatment of idiopathic trigeminal neuralgia.

Methods: We inspected the results of 106 patients with the diagnoses of idiopathic neuralgia that treated with percutaneous radiofrequency trigeminal rhizotomy retrospectively. The scores of visual analog scale (VAS) were noted preoperative and postoperative periods at 1st, 3rd, 6th and 12th months and were used for statistical analysis.

Results: Mean age of 106 patients was 67.31±8.85 years. Duration of symptoms was 19.1±13.1 months. Duration of symptoms did not change significantly according to gender (p=0.755), or site of trigeminal pain (p=0.158). There was not any statistical significance between gender, effected branch of trigeminal nerve and side of the pain. Preoperative mean VAS score was 9.6±0.75. Postoperative mean VAS score values were 3.25±2.44 at first month, 3.23±2.43 at third months, 3.12±2.78 at sixth months and 2.59±3.18 at postoperative twelfth months. We found statistically significant difference between preoperative and postoperative 1st, 3rd, 6th and 12th months VAS scores (p<0.001).

Conclusion: Percutaneous radiofrequency trigeminal rhizotomy is the minimally invasive treatment modality with lower complication rates and it has a high rate of efficacy when compared with invasive methods. It is most cost-effective procedure to choose if the pain recurs.

Keywords: Radiofrequency, rhizotomy, trigeminal neurologia

INTRODUCTION

Trigeminal neuralgia (TN) is defined as “sudden, usually unilateral, severe, brief, stabbing, recurrent episodes of pain in the distribution of one or more branches of the fifth cranial nerve” by The International Association for the Study of Pain (1, 2). The incidence of TN is 3 to 27 persons per 100,000 population in the literatures whereas the incidence of idiopathic trigeminal neuralgia (ITN) is reported as 4-5 patients per 100,000 population (3, 4). This type of neuralgia mainly affects especially women at the middle-ages and olders. It is unilaterally affected at onset encountered (5). The symptoms of TN with severe pain is described as excruciating and poses serious impairment quality of life (6). Patient who had more and severe episodes complains the symptoms like conjunctival hyperemia, lacrimation, salivation, facial redness, tilted mouth to one side, and reflexive facial tic (7). Despite the efforts of pharmacological researches on TN; medical management fails in most cases.

Many treatment modalities were suggested for TN that include medical and surgical options. The drugs available for medical treatment are carbamazepine, oxcarbazepine, lamotrigine, baclofen and pimozide (8). The poor drug tolerance is the main problem with medical management that is connected with many factors (9). Surgical and percutaneous treatments for TN include microvascular decompression (MVD), glycerol rhizotomy (GR), balloon compression (BC), percutaneous radiofrequency thermo-rhizotomy (PRT) and gamma-knife radiosurgery (10-14). Mentioned procedures above generally show effective pain relief that derives from directed injury to the pain fibers in the trigeminal nerve for all treatments. However, they are different on type of injury inflicted and with the selectivity of trigeminal divisions.


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To date, percutaneous treatments which are BC, GR and PRT have been accepted for the treatment of TN patients who had resistance to medication. We reported the results of our patients who were treated with PRT of the trigeminal Gasserian ganglion, as more effective and minimally invasive treatment modality.

METHODS
One hundred and six patients with ITN were treated with PRT between 2007 and 2013 at Department of Algology. This is a retrospective study which is adequate with Helsinki Declarations that reported from patients files. Written informed consent was obtained from patients who participated in this study. All of the 106 cases had unilateral ITN and they were using single medicine which was recommended by several disciplines before presenting to our clinic. These medicines were carbamazepine, gabapentin and pregabalin. The diagnosis was made by anamnesis, definition of paroxysmal pain as electric shock-like. Patients have no pathologies on magnetic resonance imaging (MRI) of cranium and no benefit from medical therapy. The exclusion criteria for selection of the patients were pathological neurological findings related to the trigeminal nerve, any involvement of artery, vein or intracranial mass reported with cranial MRI, local infection at procedure site or systemic infection, uncontrollable hypertension, coagulopathy, major depression and psychotic disorders. All selected patients had unilateral ITN, PRT was applied only once and medical treatment were stopped immediately after the procedure. Visual Analog Scale (VAS) scores were evaluated at the time of procedure and postoperative 1st, 3rd, 6th and 12th months.

Surgical Protocol
Patient was prepared with supine position on the X-ray compatible table. Head and shoulders were positioned on a headboard with the head extension over the end of the table. The continuous monitoring of pulse oxygen saturation, electrocardiography and noninvasive blood pressure were prepared. About 3 L/min oxygen was given through a nasal airway. During the procedure anesthesia was given with intravenous injection of 0.03-0.05mg/kg midazolam depending the age of the patient.

The optimal view of the foramen ovale is obtained on the side of the lesion with a C-arm fluoroscope by 20° extension up and 15-20° rotation far away from the pain localization. About 1% lidocaine was used for the local anesthesia and 22-G disposable straight electrode with a 2-mm active end (NeuroTherm®, Radionics, Burlington, MA, USA) was inserted with stylet to the localization 2.5 cm away from mouth angle with the perioral approach. When the optimal position has been obtained the stylet was then removed. Mostly there is a cerebrospinal fluid free-flow which is the landmark to confirm the localization of the needle placed inside foramen ovale. After the end of the electrode had been placed appropriately in the Gasserian ganglion, the final location was decided by the patient’s response to the electrical stimulation between 0.1 to 1.5 V at 50-100 Hz. If the satisfactory localization of electrode end has been decided, PRT procedure was applied with the temperature of 70°C for 60 seconds (Neurotherm Radio Frequency Lesion Generator Service Manual Model NT1100).

The patient was asked and examined for sensation of the sides of the face and bilateral corneal reflexes were checked and compared. If there was no effective pain relief, the PRF was repeated until the effective pain relief was achieved. Usually the patient stays in hospital for 1 day to follow for any complications that could occur. Medication with antibiotics were administered for five days but medications for ITN were completely stopped after procedure.

Statistical Analysis
The chi-square statistic was used to show whether or not there was a relationship between two categorical variables. The Kolmogorov-Smirnov test was used to compare the cumulative distributions of two data sets. The comparison of three or more samples was made with nonparametric Kruskal-Wallis test. The comparison of two unpaired groups were made with the Mann-Whitney test. The Mann-Whitney test was also used for post-hoc comparisons after Kruskall-Wallis test. The association between two ranked variables is tested with the Spearman rank correlation. In this probability of committing a Type I error was 5%. IBM SPSS Statistics V21.0 (IBM Corp.; Armonk, NY, USA) was used for statistical analysis.

Follow-up
Follow up periods were 1 month, 3 months, 6 months and 1 year after the procedure for all patients. They were examined for dysesthesia, facial hypoalgesia and questioned for side effects and any complications. VAS scores were collected each time.

RESULTS
All patients were managed with a single PRF procedure. Fifty-nine (55.7%) patients were woman and 47 (44.3%) were man. Mean age of patients was 67.3±8.85 years. Age, length and weight of the patients were shown at Table 1. Duration of symptoms was 19.1±13.1 months. Duration of symptoms did not change significantly according to gender (p=0.755), or site of trigeminal pain (p=0.158) (Table 2). The relation of affected branch of trigeminal nerve to gender and site of trigeminal pain was shown in Table 3. There was no relation between affected branch of trigeminal nerve and gender and site of the pain.

Immediately after the procedure, 42 patients have had different degrees of facial numbness. This facial numbness disappeared after 7 days. Regarding these 42 patients, 38 of them had pain relief after the procedure, however in four patients there was facial numbness and no pain relief. One patient had
causalgia, 3 patients had pain at needle insertion site and 2 patients had ecchymosis which recovered in ten days at needle insertion site.

Preoperative and postoperative 1st, 3rd, 6th and 12th months VAS scores were compared. Preoperative mean VAS score was 9.6±0.75. Postoperative mean VAS score values were 3.25±2.44 at first month, 3.23±2.43 at third months, 3.12±2.78 at sixth months and 2.59±3.18 at postoperative twelfth months. Statistically significant difference was found between preoperative and postoperative first, third, sixth, and twelfth months VAS scores (p<0.001). VAS scores were presented in Table 4.

**DISCUSSION**

Trigeminal neuralgia is diagnosed by paroxysmal ancinating and very severe facial pain in the territory of the 5th cranial nerve (15). TN is the most common type of cranial neuralgia (16). Even it is usually seen unilaterally, systemic diseases must

### Table 1. Age, length and weight of the patients with trigeminal neuralgia

<table>
<thead>
<tr>
<th></th>
<th>All group</th>
<th>Male</th>
<th>Female</th>
<th>Statistical difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Age (year)</td>
<td>67.31</td>
<td>8.85</td>
<td>68.49</td>
<td>8.60</td>
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<tr>
<td>Length (cm)</td>
<td>165.92</td>
<td>8.11</td>
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<td>7.14</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>78.36</td>
<td>8.90</td>
<td>83.04</td>
<td>7.61</td>
</tr>
</tbody>
</table>

SD: standard deviation; cm: centimeter; kg: kilograms

### Table 2. Duration of trigeminal pain according to gender and site of the pain

<table>
<thead>
<tr>
<th></th>
<th>All group</th>
<th>Male</th>
<th>Female</th>
<th>Statistical difference</th>
<th>Right side</th>
<th>Left side</th>
<th>Statistical difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>p</td>
</tr>
<tr>
<td>Duration (month)</td>
<td>19.1</td>
<td>13.1</td>
<td>20.5</td>
<td>15.0</td>
<td>17.9</td>
<td>11.3</td>
<td>0.755</td>
</tr>
</tbody>
</table>

SD: standard deviation

### Table 3. Trigeminal nerve branches according to side of the pain and age of the patient

<table>
<thead>
<tr>
<th></th>
<th>All group</th>
<th>Right side</th>
<th>Left side</th>
<th>Statistical difference</th>
<th>Male</th>
<th>Female</th>
<th>Statistical difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>p</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Ophthalmic (-)</td>
<td>83</td>
<td>78.3</td>
<td>45</td>
<td>83.3</td>
<td>38</td>
<td>73.1</td>
<td>0.242</td>
</tr>
<tr>
<td>(+)</td>
<td>23</td>
<td>21.7</td>
<td>9</td>
<td>16.7</td>
<td>14</td>
<td>26.9</td>
<td></td>
</tr>
<tr>
<td>Maxillary (-)</td>
<td>43</td>
<td>40.6</td>
<td>28</td>
<td>51.9</td>
<td>15</td>
<td>28.8</td>
<td>0.019</td>
</tr>
<tr>
<td>(+)</td>
<td>63</td>
<td>59.4</td>
<td>26</td>
<td>48.1</td>
<td>37</td>
<td>71.2</td>
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<tr>
<td>Mandibular (-)</td>
<td>36</td>
<td>34.0</td>
<td>17</td>
<td>31.5</td>
<td>19</td>
<td>36.5</td>
<td>0.683</td>
</tr>
<tr>
<td>(+)</td>
<td>70</td>
<td>66.0</td>
<td>37</td>
<td>68.5</td>
<td>33</td>
<td>63.5</td>
<td></td>
</tr>
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</table>

n: number of patients

### Table 4. VAS score changes after percutaneous radiofrequency rhizotomy

<table>
<thead>
<tr>
<th></th>
<th>VAS (start)</th>
<th>VAS (1 month)</th>
<th>VAS (3 month)</th>
<th>VAS (6 month)</th>
<th>VAS (12 month)</th>
<th>Statistical difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>VAS</td>
<td>9.60</td>
<td>0.75</td>
<td>3.25</td>
<td>2.44</td>
<td>2.23</td>
<td>2.43</td>
</tr>
</tbody>
</table>

SD: standard deviation; VAS: visual analog scale
be remembered when it is seen bilaterally (17). Involvement of second and third branches are more encountered than first branch of trigeminal nerve (18-20). Diagnosis of TN could be made by anamnesis and definition of pain (16). MRI could separate secondary TN from ITN. The pathophysiology of pain with TN remains controversial. The probable pathogenic process was reported that pulsatile or sustained microvascular compression causes demyelination on sensory axons in the trigeminal root by Dandy (21). Rappaport and DeVor reported ignition hypothesis that trigeminal microcompression renders trigeminal afferent neurons, both axotomized somata and injured axons, hyperexcitable (22). The hyperexcitable afferents induce pain paroxysms as a result of synchronized after discharge activity that originates at ectopic pacemaker sites of trigeminal ganglion or in the root. The quality of life of TN patients were affected significantly because the ignition factors including washing of the face and going out in cold wind, shaving, applying of make-up, teeth brushing, vibrations from walking can evoke paroxysmal pain (6, 16). Depression, anxiety and sleep disturbance are pain-related comorbidities that have a significant effect on quality of life (22).

First historical description about TN belong to Cappadocien Aretaeus at A.D. 2nd century according to Stokey and Ransohoffs’ research (23). Rethi with who tried to electrocoagulate the Gasserian ganglion rootlets and trigeminal nerve first developed the radiofrequency lesioning in 1913 (9). White and Sweet had showed procedure to be effective for pain relief in 1975 (24, 25). Then Tew and van Loveren pioneered the use of thermocoagulation (26, 27).

Up to date two types of radiofrequency thermocoagulation system have been mostly in use. Conventional radiofrequency thermocoagulation is a clinically effective treatment for reducing neuropathic pain. It produces 45°C or more of temperature with a constant output of high-frequency electric current, resulting in neuroablative thermocoagulation (28). Pulsed radiofrequency thermocoagulation, supports short “pulses” of high-voltage, radiofrequency range electric current to maintain the same voltage fluctuations in the localization of treatment which occur during conventional radiofrequency thermocoagulation treatment, but not to a degree that causes tissue coagulation (28). The heat supported is instead dissipated between the pulses. Pulsed radiofrequency can reduce the risk of nerve injury by providing pulses of high frequency current with heat dissipation between pulses. Pulsed radiofrequency is not preferred for an effective procedure of pain treatment modality for TN (19). We use conventional PRF at our patients. The exact mechanism of PRT on TN treatment could not be explained clearly. One of the potential mechanisms of pain relief using PRT technique is the differential thermocoagulation of the trigeminal rootlets which proposes that the action potentials of nociceptive fibers (A-delta and C) are blocked at lower temperatures than those that transmit tactile sensation (4). Another mechanism is hypothesized as reducing the recruitment of ectopic neural activity.

There is a huge variety of treatment modalities as pharmacological and surgical for TN. After the invention of phenytoin at 1942, anticonvulsant medicines became the first choice of treatment for TN. Carbamazepine have been the gold standard medical therapy. The first step has medical therapy of the drugs available are oxcarbazepine and carbamazepine. The second step is lamotrigine, pimozide and baclofen. Clonazepam, levetiracetam, phenytoin, gabapentin, valproate, topiramate and tocainide could be also given. Poor drug tolerance is the main problem with medical management that related to many reasons (9).

Unluckily, nobody could describe a method or medication for the complete relief of the intolerable pain without recurrence of TN. Radiofrequency of the semilunar ganglion, peripheral branch rhizotomy, semilunar ganglion sacculus proprius compression, avulsion, retrogasserianectomy or carding manipulation, retrogasserian glycerol ectomy, MVD and gamma knife surgery are the surgical treatment modalities of TN (29, 30). Correction of the hypothesized vascular etiology could be only made with MVD by repositioning the vessel (31). This technique not only have the lowest rate of pain recurrence but also supplies the highest rate of long-term patient’s satisfaction (12). MVD is the only treatment that can cure TN pain without coagulating or destroying the trigeminal nerve whereas it has a high recurrence rate and unsuccessful patient population (12, 31, 32). Four thousand, eight hundred and eighty-four patients were reported by Tatli with MVD procedure and found the initial pain relief, follow-up pain free and recurrence rates of the MVD patients range between 76.4–98.2%, 62–89% and 4–38% (33, 34).

Percutaneous treatment modalities are chosen for the patients who are resistant to medical therapy, do not want any invasive methods and older than 50 years of age (15). When compared with different operative percutaneous procedures for TN, PRT have some advantages over the other techniques. Recurrence rates of PRT are lower than the rates of GR (35). PRT is more selective and isolated division treatment than BC. Furthermore PRT has proven to be more effective and safer treatment with the diagnosis of TN with multiple sclerosis that have higher recurrence rates or treatment failure (17, 36). Sivahanthan et. al. investigated the most cost-effective treatment modality for the treatment of TN and they reported PRT as the best one according to their criterias (37).

Kanpolat et al. had a huge PRT series that consisted of 1600 patients and stated that complete pain relief was reported to be achieved at five years in 57.7% of the patients that applied a single procedure and overall recurrence rate was found to be 25.1% (3). Tang et al. reported 272 patients treated with PRT at computed tomography guidance and satisfactory rate was 100% after the procedure but the recurrence rate was 25% at 14 years follow-up (38, 39). Teixeira et al. inspected 272 patients after PRT procedure and pain relief after procedure
rate was 100% with a 44% recurrence at one year follow-up (2). There are smaller written series in the literature which are reported by Taha et al., Balevi et al., Nie et al., Singh et al. and Son et al. Their pain relief rates are between 77-100% after procedure and recurrence rates are between 20-40% (7, 9, 40, 41). We have 96.2% pain relief immediately after the procedure in 106 patients and 4 patients had undergone a second procedure for recurrence in our series.

Park et al. categorized the satisfaction rate for the management of the pain after PRT into five categories: excellent, good, poor, failure, and recurrence (42). Borrow Institute also made a pain scale to classify the outcome of TN procedures (4, 16, 29). In our study, we used VAS score at preoperative and postoperative 1st, 3rd, 6th and 12th months to follow success of the procedure.

Although pioneering developments of percutaneous procedures, variety of complications still remain with low incidence. These complications can be considered as corneal hyposthesia, corneal anesthesia, corneal - palpebral reflex deficit, keratitis, corneal ulcer, paresthesia, anesthesia dolorosa, anesthesia of trigeminal branches, herpes simplex infection, numbness sensation, dysesthesia, motor masseteric deficit, paralysis of ocular nerves (2, 8, 43). Dysesthesias are usually associated to more intense sensory deficit. It is probable that higher sensory deficit is an indication of higher success rate (43). Severe complications like intracranial haemorrhage, meningitis, carotid injuries, carotid-cavernous fistulae are rare (44, 45). The severity and number of the lesions could be arranged according to the degree of resulting hypoaesthesia, mandibular deviation and the ciliary reflex changes after each lesion. In our study 42 patients had different degrees of facial numbness, 1 patient had causalgia, 3 patients had pain at needle insertion site and 2 patients had ecchymosis at needle insertion site as reported complications which resolved after at least 10 days. The well-known complications of PRF for the treatment of TN in the first division, such as loss of ciliary reflex and keratitis, were absent in our series.

Percutaneous radiofrequency thermo-rhizotomy must be remembered as a primary percutaneous treatment on selected patients whose medical therapy is ineffective and can not be candidates for surgery. Percutaneous radiofrequency trigeminal rhizotomy is the minimally invasive treatment modality with lower complication rates and it has a high rate of efficiency when compared with invasive methods. It is most cost-effective procedure to choose if the pain recurs.

**Ethics Committee Approval:** Authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki “Ethical Principles for Medical Research Involving Human Subjects” (amended in October 2013).

**Informed Consent:** Written informed consent was obtained from patients who participated in this study.

**Peer-review:** Externally peer-reviewed.


**Conflict of Interest:** Authors have no conflicts of interest to declare.

**Financial Disclosure:** The authors declared that this study has received no financial support.

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