Retrospective Analysis

Predictive Factors Associated with Success and Failure for Radiofrequency Thermocoagulation in Patients with Trigeminal Neuralgia

Hyun Seung Jin, MD[1], Ji Yeon Shin, MD[1], Yong-Chul Kim, MD, PhD[1], Sang Chul Lee, MD, PhD[1], Eun Joo Choi, MD[2], Pyung-Bok Lee, MD, PhD[2], and Jee Youn Moon, MD, PhD[1]

From: [1]Seoul National University Hospital, Seoul, Korea; [2]Seoul National University Bundang Hospital, Gyonggi-do, Korea

Address Correspondence:
Jee Youn Moon, MD, PhD
Anesthesiology and Pain Medicine,
Seoul National University Hospital
110 Daehang-ro, Jongno-gu,
Seoul, 110-744, Korea
E-mail:
jymoon0901@gmail.com

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Background: Radiofrequency thermocoagulation (RFT) has been widely used to manage trigeminal neuralgia (TN) refractory to oral medication. Careful selection of patients for managing TN with RFT can decrease morbidity and improve treatment efficacy.

Objectives: The goal of this study was to determine clinical variables related to the treatment outcome in patients with TN undergoing RFT.

Study Design: Retrospective analysis.

Setting: University hospital in Korea.

Methods: Demographic and clinical data were garnered by billing records for patients with TN who received RFT by one pain physician between January 2005 and August 2014. A successful outcome was pre-defined as at least 50% pain relief on a 0 – 10 NRS pain score for longer than 6 months after RFT. Variables evaluated for their association with outcome included age, gender, baseline pain score, etiology, type of pain, co-existing psychopathology, and history of previous intervention.

Results: Among 90 patients who underwent RFT for managing TN, 75 patients (83.3%) reported a successful outcome (> 50% pain relief at 6 months after RFT procedure). Pain characteristics was the most significant predictor associated with successful outcomes of RFT in both univariate and multivariate logistic analysis; odds ratio of provoked paroxysmal pain was 131.516 and mixed type of pain was 20.602 in multivariate analysis.

Limitations: Prospective studies are recommended to confirm our findings and ascertain which additional variables can be taken into account to improve the likelihood of a successful outcome for RFT in patients with TN.

Conclusion: A provoked paroxysmal pain or mixed pain condition was associated with a positive outcome for RFT in patients with TN. In addition, bilateral TN, high baseline NRS pain score, or co-morbid psychiatric condition was related with negative outcomes in univariate analysis. Pain clinicians should consider these findings when selecting patients for managing TN to increase the efficacy of RFT.

Key words: Facial pain, outcome assessment, predictive value, radiofrequency thermocoagulation, trigeminal neuralgia

Clinical Trial Registration: IRB No. 1403-118-569

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Trigeminal neuralgia (TN) is a painful neurologic condition, typically confined within the trigeminal nerve distribution. Patients with TN usually complain of unilateral, severe, electric shock-like pain which may be provoked by light contact. Some patients, however, continue to have idiopathic, spontaneous facial pain that is predominantly constant (1,2). Although it is not a common disease with incidence ranging from 12.6 to 28.9/100,000 person-years (3,4), TN significantly decreases quality of life by resulting in psychological distress due to severe pain and may even lead to suicide (5).

Initially, an antiepileptic drug, carbamazepine, can provide excellent pain relief for TN (6,7). However, up to 10% of TN patients may not respond to oral medication (8). In such cases, further interventions such as microvascular decompression (MVD) or minimally invasive procedures including Gamma-Knife radiosurgery (GKS) or percutaneous treatments, such as balloon compression, glycerol rhizotomy, and radiofrequency thermocoagulation (RFT) are useful options. Among the procedures, RFT has been widely used to manage TN since its effectiveness for pain relief was first published in 1975 (9). Several studies have reported that RFT has a success rate of 80% – nearly 100% for managing TN (10-15). Compared to MVD or GKS, RFT may be viable for poor surgical risk patients or elderly patients, and it can also be repeated in the same patient (11-14,16,17). In addition, compared to the other 2 percutaneous procedures, RFT allows for more selective destruction of trigeminal divisions, which is beneficial for patients with TN in single nerve distribution.

Although RFT may have significant benefits for some patients, the recurrence rate appears to be higher (15 – 20% in 12 month and 46% in 5 years) than that of MVD (18.3% in 5 years) (14). Furthermore, RFT can carry significant risks including corneal numbness, anesthesia dolorosa, or arteriovenous fistula (13,18,19). Therefore, it may be necessary to refine the selection criteria for performing RFT for TN in several ways, such as improving patient outcome and decreasing overall complications. However, we believe no one has sought to identify factors associated with treatment outcome of RFT for managing TN.

Accordingly, we performed the study to investigate which demographic, clinical, and treatment factors were associated with a successful outcome for RFT in patients with TN.

Methods

This study was approved by the Institutional Review Boards in Seoul National University Hospital, a large civilian teaching institution in South Korea. We examined the data identified by billing records assessing the patients with TN who received RFT by one pain physician (YCK).

Inclusion criteria were as follows: 1) age > 18 years, 2) a pain intensity of > 4 points on a 0 – 10 numerical rating scale (NRS) pain score, 3) > 3 months duration refractory to conventional treatments (e.g., carbamazepine, anticonvulsants, antidepressants, analgesics such as NSAIDs or tramadol, and sympathetic chain block such as stellate ganglion block), 4) diagnosis with TN in accordance with anatomic symptom distribution in trigeminal nerve and ≥ 50% pain relief by a previous diagnostic nerve block, and 5) presence of brain MRI/MRA to find any lesions such as brain tumors or vascular compression.

Exclusion criteria were as follows: 1) patients with TN in accordance with anatomic symptom in V1, 2) patients with trigeminal neuropathy due to any traumatic nerve injury, 3) patients with post-herpetic neuralgia in trigeminal nerve distribution, 4) patients with atypical facial pain, possibly derived from a somatoform origin other than TN, 5) absence of brain MRI/MRA, or 6) absence of 6-month follow-up data.

Treatment

All RFT procedures were performed under fluoroscopic guidance in a sterile fashion. Patients fasted for at least 6 hours before the procedure and prophylactic antibiotic was administered one hour before the procedure. Intravenous access was obtained and standard monitors including electrocardiogram, blood pressure monitoring, and pulse oximetry were applied. A low flow of oxygen (1 – 2 L/min) was delivered to patients by nasal cannula. Patients lay in the supine position with neck slightly extended and chin up (reverse occipitomental position). The C-arm was tilted 25 to 30 degrees caudally and rotated 10 to 15 degrees obliquely to the affected side to visualize the foramen ovale [Anterior Posterior Oblique view, APO view (submental view)]. The skin entry point was usually 2 – 3 cm lateral to the commissura labialis (angle of the mouth) on the affected side. A 22-gauge, 10-cm Sluijter-Metha cannula (SMK) with a 2 mm active tip was used via curved needle technique. After administration of local anesthesia superficially, the cannula was advanced

in a coaxial manner (tunnel view) to the x-ray beam toward the foramen ovale (Fig. 1). We asked patients about any sensation on their tongue in the oral cavity to make sure that the buccal mucosa had not been perforated. After we confirmed the cannula was in front of the foramen ovale on the lateral fluoroscopic view, we sedated the patients by injecting 0.5 mg/kg of propofol intravenously. Upon confirming patient sedation, the cannula was advanced to the trigeminal ganglion. The stylet was removed from the cannula and we checked the drainage of cerebrospinal fluid. Then, the electrode was advanced 2 – 4 mm further through the canal of the foramen ovale such that the tip of the electrode reached the junction of the petrous ridge of the temporal bone and the clivus on lateral (Fig. 2) and AP view (Fig. 3). In this position, the trigeminal cistern is oriented with the mandibular division in the most inferior and lateral portion, the ophthalmic division in the most superior, and the maxillary division in the middle portion of the foramen ovale in APO view (20). In order to confirm the correct lesion, we fully awoke patients and oriented them by asking their name, birth date, current date, and the name of our hospital. Then, we checked if the paresthesia was in the concordant trigeminal distribution of the patient's usual symptoms (V2 or V3 divisions) at 50 Hz for one msec pulse duration was reproduced at 0.2 – 0.5 V. If paresthesia had been only obtained above 0.5 V stimulation, the needle was redirected to get the same response at a lower volt-

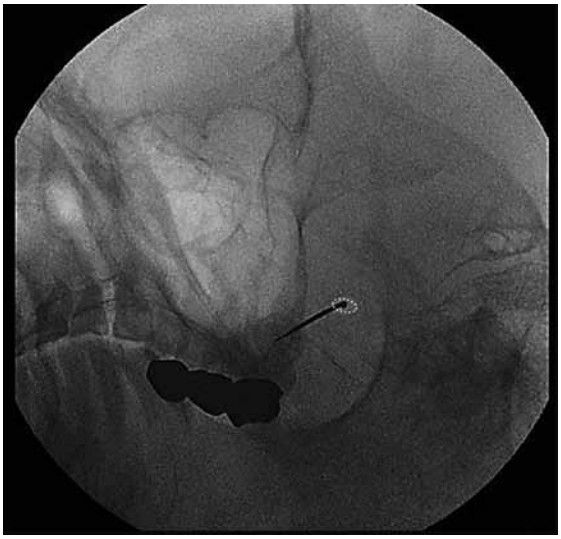

Fig. 1. *Anterior posterior oblique view (submental view) under fluoroscope. The cannula is inserted in a coaxial manner (tunnel view) to the x-ray beam toward the foramen ovale.*

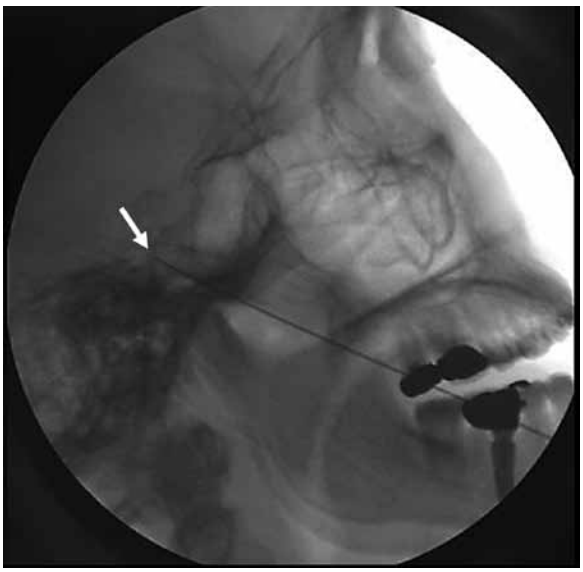

Fig. 2. *Lateral view under fluoroscope. The needle tip is located 2 – 4 mm further through the canal of the foramen ovale (white arrow).*

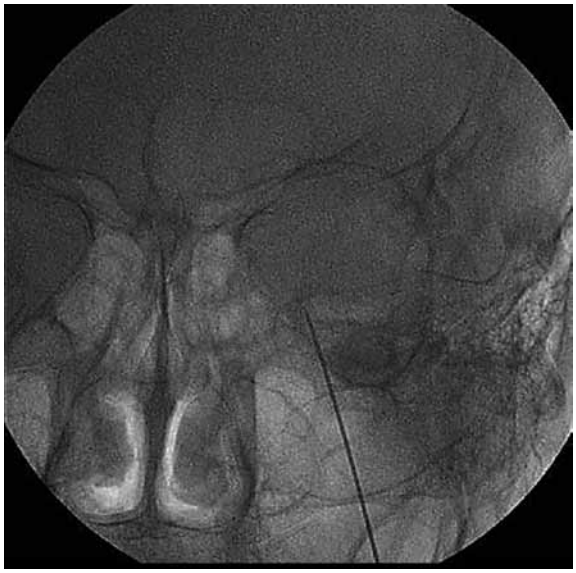

Fig. 3. *Anterior posterior view under fluoroscope. The tip of the electrode reached the junction of the petrous ridge of the temporal bone and the clivus.*

age. After appropriate paresthesia was achieved in a range of 0.2 – 0.3 V sensory stimulation, 0.5 – 1 mg/kg of propofol and 0.5 – 1 μg/kg of fentanyl was injected again for pain relief during RFT. After confirming the patient's sedation, we set RFT lesioning at 80°C for 60 seconds or 60°C for 90 seconds depending on patients' response and the number of divisions, and performed 2 or 3 times based on the number of divisions (3 times in patients with TN at single distribution and 2 times for each division in patients with TN at the V2 + V3 distribution). Afterwards, patients were awakened and checked if the usual pain remained by triggering it in the same manner as it was provoked before the procedure. After checking whether the patients' numbness still remained in the concordant trigeminal distribution at the operating room, patients were delivered to the recovery room. When patients fully recovered from the anesthesia, they were admitted to the ward for one night. Patients were then discharged the next day after examining if there were any complications. Follow-ups were conducted every one or 2 months in the outpatient department. Oral medication was usually continued during the follow-up but could be adjusted in accordance with pain intensity and characteristics.

Outcome Data and Follow-up

Follow-up data for each patient was garnered either in person or by telephone by an independent research nurse not involved in the study. A successful outcome was pre-defined as at least 50% pain relief on a 0 – 10 NRS pain score for longer than 6 months after RFT. If one patient had undergone several RFT for managing TN, we only included the first case of RFT to avoid the possibility of correlation among repeated measurements on individual patients. If a patient underwent additional RFT or nerve block in the same lesion during the 6-month follow-up, we defined those cases as a negative outcome for the first RFT.

Electronic medical records were used to obtain demographic data such as age, gender, patients' medical co-morbidities (hypertension and diabetes mellitus [DM]) and co-morbid psychiatric conditions based on a screening evaluation and medical record review. We also garnered the data of clinical characteristics such as etiology of pain [classified into idiopathic, injury (e.g., dental procedure), vascular, or tumor], baseline and postprocedure average pain score over the past week, pain distribution according to anatomic dermatome (V2, V3 or V2 + V3), laterality of pain (Rt., Lt., or bilateral), interval from the first attack until treatment (duration of the disease), and history of previous RFT or GKS. The pain characteristics were divided into 3 types; 1) provoked paroxysmal pain including sharp, shooting, lancinating, or "electric-shock" pain, 2) constant dull and aching pain, or 3) mixed pain.

All patients had been prescribed with usual medication for the treatment of TN such as carbamazepine and/or other medication including pregabalin, gabapentin, oxcarbazepine, antidepressants, and/or analgesics, therefore we excluded medication data from the variables.

Statistical Analysis

Patients were categorized into either negative or positive outcome groups based on the pre-defined success criterion. Patient characteristics by outcome were analyzed using Student's t-test for continuous variables and Chi-square test or Fisher's exact test as appropriate for categorical variables. A *P*-value of less than 0.05 was considered statistically significant.

Binary logistic regression techniques were used to quantify the relation between a successful outcome and the patients' clinical and demographic characteristics. Reference variables were male, no hypertension, no DM, no co-morbid psychiatric condition, V2 location, unilateral symptom, idiopathic etiology, constant dull and aching pain, no previous RFT, and no previous GKS. Variables showing a trend towards statistical significance ($P < 0.2$) using univariate analysis were included in multivariate logistic regression. In order to enhance the power to detect differences in outcome between variables and fortify the logistic regression model, all patients treated between January 2005 and August 2014 meeting the above-noted selection criteria were included in the analysis.

Statistical analysis was performed using the SPSS Statistics program version 22.0 for Windows. All parametric data are presented as the mean (SDs) and nonparametric data as numbers and proportions. Odds ratio (OR) with 95% confidence interval (CI) was also calculated as needed.

Results

Between January 2005 and August 2014, 146 patients were treated with RFT at single or multiple trigeminal nerve division(s), of which 30 were excluded as they had "trigeminal neuropathy" due to traumatic nerve injury, 13 were excluded as they had only been treated with pulsed RF treatment. Another 13 patents were also excluded due to insufficient data: 10 for lack-

Table 1. *Baseline demographic and clinical characteristics of study participants (n = 90).*

Variables	Result
Age (mean in years, SD)	60.2 (14.9)
Gender (male / female)	24 (26.7%) / 66 (73.3%)
Co-morbidity (Hypertension / Diabetes Mellitus)	26 (28.9%) / 8 (8.9%)
Co-Morbid Psychiatric Condition	3 (3.3%)
Etiology	
Idiopathic	75 (83.3%)
Vascular	7 (7.8%)
Tumor	8 (8.9%)
Baseline Numerical Rating Scale Pain Score (mean, SD)	7.9 (1.8)
Pain Characteristics	
Provoked Paroxysmal Pain (ex. Electric shock-like)	49 (54.4%)
Constant Pain (ex. Dull and Aching)	5 (6.7%)
Mixed	35 (38.9%)
Onset (mean in years, SD)	2.7 (2.7)
History of Previous Thermocoagulation	42 (46.7)
Location (V2 / V3 / V2+V3)	42 (46.7%) / 43 (47.8%) / 5 (5.6%)
Laterality (Unilateral / Bilateral[1])	85 (94.4%) / 5 (5.6%)
History of Previous GKS	17 (18.9%)

Data are expressed as means (SD) or number of patients (%).
[1]Five patients reported bilateral symptom of TN, however they underwent RFT unilaterally in the more symptomatic side.

ing 6-months follow up data and 3 for lacking either pain description or NRS pain score on the electronic medical records. Ultimately, 90 patients were included in the study; among them, 75 patients (83.3%) reported a successful outcome (> 50% pain relief at 6 months after RFT procedure).

The demographic and clinical characteristics are shown in Table 1. The mean age of the patients was 60.2 years (SD 14.9). There were more women (73.3%) than men (26.7%). Regarding co-morbidity, 26 patients (28.9%) had hypertension, 8 patients (8.9%) had DM, and 3 patients (3.3%) had a psychiatric condition such as depressive disorder (n = 2) or anxiety disorder (n = 1). The average duration of the symptoms was 2.7 years (SD 2.7). Regarding the etiology, a substantial majority (n = 75, 83.3%) were idiopathic. Vascular reasons confirmed on MRI and MRA were 7.8% (n = 7). Eight patients (8.9%) were diagnosed as TN caused by brain tumor such as meningioma or Schwannoma. Baseline NRS pain score was 7.9 (SD 1.8), indicating severe pain. Among the 90 patients who underwent RFT, 49 patients (54.4%) presented with only provoked paroxysmal pain and 5 patients (6.7%) had only constant dull and aching pain. Both provoked and constant pain were present in 35 patients (38.9%) as mixed type. For pain location, a single V2 area was prevalent in 42 patients (46.7%) and a single V3 in 43 patients (47.8%), whereas 5 patients (5.6%) reported pain at the V2+V3 distribution. Almost all patients (n = 85, 94.4%) showed unilateral pain except for 5 patients (5.6%) who reported bilateral pain and had undergone RFT unilaterally in the more symptomatic side. Almost half of the patients (n = 42, 46.7%) had undergone RFT previously, and 17 patients (18.9%) had a history of GKS.

Complications of RFT included 3 cases of hypesthesia in a concordant division that lasted one month or longer; and four cases that had transient paresthesias or dysethesias without anesthesia dolorosa. However, no patients reported corneal numbness or diplopia.

Factors Associated with Treatment Outcome in Univariate Analysis (Table 2)

Overall, 75 patients (83.3%) in the entire cohort experienced a successful outcome (see Table 2). In univariate analysis, the most prominent factor associated with treatment results was pain characteristic. Higher success rates were noted in patients with provoked paroxysmal pain (OR = 76.667, 95% CI: 6.766 – 883.235, P = 0.001) and patients with mixed pain (OR = 20.000, 95% CI: 2.003 – 199.732, P = 0.011) compared to having only constant dull and aching pain. An existence of bilateral pain was associated with low success rates (OR = 0.110,

Table 2. *Univariate clinical characteristics stratified by outcome.*

Variable	Negative Outcome (N = 15)	Positive Outcome[1] (N = 75)	Odds Ratio (95% CI)	*P*-value
Age (mean in years, SD)	59.7 (12.9)	60.3 (15.4)	1.003 (0.966 – 1.040)	0.891
Gender (N)				
Male	5 (20.8%)	19 (79.2%)	-	0.524
Female	10 (15.2%)	56 (84.8%)	1.474 (0.447 – 4.859)	
Co-morbidity				
Hypertension	3 (11.5%)	23 (88.5%)	1.769 (0.455 – 6.873)	0.410
Diabetes Mellitus	2 (25.0%)	6 (75.0%)	0.565 (0.103 – 3.114)	0.512
Co-Morbid Psychiatric Condition	2 (66.7%)	1 (33.3%)	0.88 (0.007 – 1.040)	0.054
Location of Pain				0.978
V2	7 (16.3%)	35 (83.3%)	1.250 (0.121 – 12.934)	0.852
V3	7 (16.3%)	36 (83.7%)	1.286 (0.124 – 13.295)	0.833
Mixed	1 (20.0%)	4 (80.0%)	-	-
Disease duration (mean in years, SD)	2.4 (2.9)	2.7 (2.7)	1.046 (0.842 – 1.300)	0.682
Laterality				
Unilateral	12 (14.1%)	73 (85.9%)	-	0.022
Bilateral	3 (60.0%)	2 (40.0%)	0.110 (0.017 – 0.726)	
Baseline NRS Pain Score (mean, SD)	8.4 (1.0)	7.7 (1.9)	0.779 (0.544 – 1.117)	0.175
Etiology				0.668
Idiopathic	12 (16.0%)	63 (84.0%)	-	-
Vascular	2 (28.6%)	5 (71.4%)	0.476 (0.083 – 2.746)	0.407
Tumor	1 (12.5%)	7 (87.5%)	1.333 (0.150 – 11.846)	0.796
Pain Characteristics				0.002
Provoked Paroxysmal Pain	3 (6.1%)	46 (93.9%)	76.667 (6.766–883.235)	0.001
Constant Dull and Aching Pain	5 (83.3%)	1 (16.7%)	-	-
Mixed	7 (20.0%)	28 (80.0%)	20.000 (2.003–199.732)	0.011
Previous Thermocoagulation	9 (21.4%)	33 (78.6%)	2.778 (0.535 – 14.429)	0.224
Previous Gamma Knife Surgery	1 (5.9%)	16 (94.1%)	3.797 (0.464 – 31.085)	0.214

Data are expressed as means (SD) or number of patients (%).
[1]Defined as > 50% pain relief lasting more than 6 months.
CI = confidence interval and NRS = numerical rating scale

95% CI: 0.017 – 0.726, $P = 0.022$). Co-morbid psychiatric condition was also related to a lower success rate (OR = 0.88, 95% CI: 0.008 – 0.866, $P = 0.054$). Baseline NRS pain score showed a slight trend towards significance ($P = 0.132$). No significant differences in treatment outcomes were observed on factors such as age, gender, hypertension, DM, pain location, disease duration, etiology, previous RFT, or previous GKS.

Factors Associated with Treatment Outcome in Multivariate Logistic Regression (Table 3)

Multivariate logistic regression was performed to assess independent predictors of successful RFT outcomes from covariates showing a trend towards statistical significance ($P < 0.2$) using univariate analysis. Our multivariate model accounted for 43.9% of the variability in the dependent variable (outcome). In the multivariate analysis, patients who suffered provoked paroxysmal pain were most likely to experience a successful outcome (OR = 131.516, 95% CI: 6.094 – 2838.284; $P = 0.002$) than those who suffered constant dull and aching pain. Mixed type pain (provoked + constant pain) was also presented as a positive predictor of a successful outcome of RFT (OR = 20.602, 95% CI; 1.194 – 355.335, $P = 0.037$). On the other hand, a high NRS pain score showed a trend towards a lower success rate (OR = 0.596, 95% CI; 0.349 – 1.018) from RFT; however, it was not statistically significant ($P = 0.058$). Although bilateral TN and co-morbid psychiatric conditions were associated with negative outcomes in univariate analysis, they failed to exhibit significant difference in multivariate analysis ($P = 0.165$ and $P = 0.239$, respectively).

Discussion

Careful selection of patients in the management of TN with RFT can decrease morbidity and improve treat-

Table 3. Multivariate logistic regression of the factors associated with positive outcomes for trigeminal ganglion radiofrequency denervation (r2 = 43.9%).

Variable	Odds Ratio	95% CI	*P* value
Pain Characteristics			0.005
Provoked Paroxysmal Pain	131.516	6.094 – 2838.284	0.002
Constant Dull and Aching Pain	-	-	-
Mixed	20.602	1.194 – 355.335	0.037
Baseline NRS Pain Score	0.596	0.349 – 1.018	0.058
Laterality			0.165
Unilateral	-	-	
Bilateral	0.165	0.012 – 2.237	0.175
Co-Morbid Psychiatric Condition	0.176	0.010 – 3.173	0.239

CI = confidence interval
Baseline reference characteristics: constant dull and aching pain; unilateral pain; and no co-morbid psychiatric condition.

ment efficacy and patients' satisfaction. The main goal of this study was to determine those clinical and demographic variables related to the treatment outcome in patients with TN undergoing RFT. Overall, 83.3% of patients reported a successful treatment result as defined by the parameters of this study. Pain characteristics was the most significant predictor associated with a successful outcome of RFT in both univariate and multivariate logistic analysis. In accordance with our multivariate model, existence of provoked paroxysmal pain or mixed type of pain can predict a successful outcome of RFT, which resulted in ORs of 131.5 and 20.6, respectively. Although a high NRS pain score, co-morbid psychiatric condition, and bilateral TN were suggested as negative predictors related to the outcome of RFT in univariate analysis, they were not statistically significant in the multivariate analysis.

Traditionally, TN, or "Tic Doloureux" is recognized by unilateral short-lived, strong, sharp, shooting pain in one or more branches of the fifth cranial nerve, which is a purely clinical diagnosis based on expert consensus (21). More recently, it has been clinically divided into TN1 that is typical TN with idiopathic, spontaneous facial pain that is predominantly episodic and TN2 that is atypical TN with idiopathic, spontaneous facial pain that is predominantly constant (1,22). In accordance with several studies comparing TN1 and TN2, the latter was suggested as a negative variable associated with early recurrence across all treatment modalities, including RFT, GKS, and glycerol rhizotomy (4,23,24). Similarly, in our study, an existence of provoked paroxysmal pain nature was a strong positive predictor related to a successful outcome of RFT. Furthermore, our results found that if patients diagnosed with TN have only constant dull and aching pain without provoked pain, it might be difficult to achieve a successful outcome after RFT even for a short duration. Only one patient with constant pain (16.7%) in the study showed a successful outcome, which was relatively low compared to the rate of successful outcome in patients with provoked pain (n = 46, 93.9%) or mixed pain (n = 28, 80.0%). Hence, the result might help to screen patients with medically intractable TN who are supposed to undergo RFT procedure.

Although empirical evidence indicates that vascular compression near the root entry zone of the trigeminal nerve root is associated with TN in about 95% of patients (21), the etiology of TN remains mainly idiopathic (n = 75, 83.3%) in this study, even after MRA and MRI evaluation. Some authors suggest that a history of inflammatory disorders of the ear, nose, and throat region, such as chronic maxillary sinusitis, periodontitis, and dental cysts can cause of TN (25-27). However, in reality, in a significant portion of patients with facial pain including TN, pain is assumed to have occurred after dental procedures such as local anesthetic injections, endodontic treatment, implant placement, and dentoalveolar surgery (28-30). In this case, it used to be classified not into TN, but into trigeminal neuropathic pain resulting from unintentional injury to the trigeminal nerve (1,2). Hence, we excluded patients who underwent RFT for managing "trigeminal neuropathy" in our analysis. Although there is a paucity of literature regarding the study of RFT for managing iatrogenic TN, RFT for managing neuropathic pain from nerve injury may not be recommended (31,32).

If the medical treatment is unsuccessful or has too many side effects (7,33), percutaneous treatment can be considered. Commonly performed percutaneous procedures for managing TN include balloon compression, glycerol rhizotomy, and RFT. All of these procedures generally show effective initial pain relief; however, RFT might have a higher initial success rate than

balloon compression (13,34,35) and a higher long-term success rate than glycerol rhizotomy (16). Although long-term efficacy of RFT is comparatively lower than that of MVD, it is less invasive with lower morbidity and mortality rates, and can be repeated in the same patient if required (18). Furthermore, RFT allows a degree of dermatomal mapping before lesioning, which may be able to promote more selective destruction of trigeminal divisions. Corneal complication was most likely to occur after RFT compared to other percutaneous procedures (14,18). Fortunately, however, there were no reported cases of corneal complication in our retrospective cohort; we assumed that using a short (2 mm) active tip and awakening patients before lesioning to make sure that the pain site is concordant with sensory stimulation may help to avoid the complication.

Our study had several limitations that warrant attention. Although all RFT procedures in this study were supervised by one pain physician in accordance with our consistent technical method, we did not include other procedure-related factors in our analysis, such as the cerebral spinal fluid (CSF) return, immediate pain relief, and postoperative sensory deficit, which might be clinically relevant to the procedure. Another limitation was the retrospective nature of the analysis and the inherent flaws including recall bias, post-hoc selection and classification of study variables, and the absence of a pre-determined sample size which likely precluded finding a significant effect for certain independent variables in our multivariate analysis (e.g., etiology and co-morbid psychiatric condition). Finally, it should be explained that an overall initial success rate of RFT for TN (77.5%) in this study was likely lower than those in previous reports that presented 84.6% and 97.6% initial success rate of RFT (13,16). Low success in this study may be explained by the inclusion of patients with TN2 such as atypical TN who had been excluded in former studies; in this study it is suggested that TN2 may be a negative predictor for successful RFT. In addition, the differences in the pre-defined "successful outcome" may be another cause of differences in success rates in each study.

Conclusion

In conclusion, we found that having a provoked paroxysmal pain or mixed condition was associated with a positive outcome in both univariate and multivariate analysis. In addition, we also found that bilateral pain, high baseline NRS pain score, or co-morbid psychiatric condition resulted in a negative outcome in univariate analysis. Pain clinicians should consider these findings when selecting patients for managing TN to increase the efficacy of RFT. Prospective studies are recommended to confirm our findings and ascertain which additional variables can be taken into account to improve the likelihood of a successful outcome for RFT in patients with TN.

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