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CLINICAL ARTICLE

Management of bilateral trigeminal neuralgia with trigeminal radiofrequency rhizotomy: a treatment strategy for the life-long disease

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Abstract
Background The objective of this study was to evaluate the effectiveness of percutaneous controlled radiofrequency trigeminal rhizotomy (RF-TR) in patients with bilateral trigeminal neuralgia (BTN). Patients were analyzed after RF-TR in terms of outcome, safety and complications.
Methods Eighty-nine BTN patients underwent 186 RF-TR procedures. Eighty-seven patients had idiopathic trigeminal neuralgia (ITN) and two patients had multiple sclerosis (2.2%). Fifty-six (62.9%) were women and 33 (37.1%) were men. Ages ranged from 29 to 85 years. Anesthesia was administered at a determined optimal level, allowing patient cooperation for controlled and selective lesioning.
Results The mean follow-up period was 101.71±77.7 months. Familial occurrence was seen in two (2.2%) patients. Synchronized pain was observed in 25 (28.2%) patients. Pain occurrence on the contralateral side was observed with an average duration of 124.7±87.13 months. Fifty-four of the 89 patients underwent 146 RF-TR procedures for both sides and 35 underwent 40 RF-TR procedures for one side. Complete pain relief or partial satisfactory pain relief was achieved on the medically treated side in 35 patients. During follow-up, 36 patients required the second procedure and 7 required the third procedure. Acute pain relief was reported in 86 (96.6%) patients. Early (<6 months) pain recurrence was observed in 11 (12.3%) and late (>6 months) recurrence in 25 (28.0%) patients. Complications included diminished corneal reflex in four (2.1%) patients, keratitis in two (1.1%), masseter dysfunction in four (2.1%), dysesthesia in two (1.1%), and anesthesia dolorosa in one (0.5%).
Conclusions RF-TR is an effective, selective, well-controlled, and effortlessly repeatable procedure for treating BTN, especially in the elderly, in terms of low morbidity and mortality rates and high rate of satisfactory pain relief.

Keywords Bilateral trigeminal neuralgia · Radiofrequency trigeminal rhizotomy · Pain · Percutaneous procedures

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Introduction

Following the initial knowledge-based description of idiopathic trigeminal neuralgia (ITN) by Locke in 1677 [34, 55], various standardized management strategies have been emphasized [1, 6, 20, 25]. Bilateral trigeminal neuralgia (BTN) is an uncommon disease, and published reports cite an incidence ranging between 1–6% [12, 16, 52]. Before referred to neurosurgery, medical treatment constitutes the first line treatment for ITN. Different favorable outcomes have been achieved with varying procedures, which include percutaneous radiofrequency coagulation, glycerol injection, balloon microcompression, trigeminal tractotomy, and microvascular decompression (MVD) [6, 9, 12, 16, 23, 25, 36, 40]. This condition is difficult to manage in terms of destructive procedures because of the troublesome consequences of bilateral denervation [14, 36]. MVD provides a successful treatment for ITN. It is well known that the incidence of the ITN increases with age; accordingly, BTN occurrence will increase in more advanced ages. Bilateral decompression of the trigeminal nerve through a retrosigmoid approach may challenge the patient in terms of safety. Although the literature includes elaborate and valuable reports concerning the effectiveness and safety of MVD, a comprehensive evaluation of the effectiveness of percutaneous, controlled radiofrequency trigeminal rhizotomy (RF-TR) in BTN patients has not been done previously [40, 49]. Our group, which has been involved in the treatment of BTN for more than 35 years, used a single treatment method (RF-TR) for the first 10 years of our practice. For the last 25 years, however, we have been using all current and accepted surgical techniques to manage patients with BTN. Our group does not recommend a single treatment method for this challenging disease, since the treatment strategy should be planned individually and the most appropriate treatment performed. In this study, we retrospectively analyzed the data of 89 patients with BTN who underwent percutaneous controlled RF-TR from 1976 to 2011.

Methods and materials

Between 1976 and 2011, 89 BTN patients underwent 186 RF-TR procedures in the Department of Neurosurgery, Ankara University. During this time period, the total number of TN cases was 3,014 and BTN cases were 89. A total of 87 ITN cases constituted the majority of patients, whereas 2 patients had multiple sclerosis (MS) (2.2%). Of the patients with BTN, 56 (62.9%) were women and 33 (37.1%) were men. The patients ranged in age from 29 to 85 years (average 51.65 ± 12.54).

In this study, carbamazepine was the principal medication used for medical treatment before surgery. All of the 89 patients reported that carbamazepine was inadequate for pain control, although their pain had responded well at earlier stages of their disease.

Most of the patients had been evaluated by cranial magnetic resonance imaging (MRI) preoperatively to exclude any lesion or tumor in the pontocerebellar angle, petrous apex, cavernous sinus, or cranial base. Electrocardiograms and chest X-rays were routinely obtained and evaluated by an anesthesiologist before surgery. The procedure was repeated if complete pain relief was not achieved or if pain recurred. Subsequent procedures in pain recurrence are especially indicated in patients with early pain recurrence (within 1 week after undergoing RF-TR).

We reviewed the surgical records retrospectively. The data were matched with the data acquired from a questionnaire that provided information about the degree and duration of pain relief, the need for further treatment, the presence of surgical sequelae, and a subjective assessment of the patients' overall degree of improvement—that is, complete pain relief, partial satisfactory pain relief, partial unsatisfactory pain relief, no change, and worsening of pain. Partial satisfactory pain relief was considered as: recurrent pain less severe than reported preoperatively; pain controlled with medication; no need for a subsequent RF-TR procedure. Partial unsatisfactory pain relief indicated that recurrent pain was as severe as the preoperative level, but could be controlled partially with medication. Complete pain relief indicated the patient took no medication and experienced no pain, and this condition was accepted as real success in our patients [22]. The profile of pain-free survival after undergoing the first RF-TR during the follow-up time was calculated according to the Kaplan-Meier method.

Prophylactic antibiotic treatment with a first generation of cephalosporin (cefazoline, 1 g, i.m.) was administered at 30 min prior to the procedure for every patient. During the RF-TR procedure, blood pressure recordings of patients were made at 1-min intervals; we routinely and continuously assessed blood oxygen saturation and cardiac function. RF-TR was performed while the patient was sedated, and analgesia was administered by a neuroanesthesiologist. Intravenous slow injection of a combination of alfentanil and midazolam usually brought about the desired level of analgesia and sedation throughout the procedure. The dose of anesthetic medication was gradually increased to provide a considerable level of anesthesia so that patients experienced minimal pain. The anesthesia was administered at a level that gave comfort to both the patient and surgeon during the electrical test stimulation and lesioning procedure, allowing patient cooperation as the surgeon performed controlled and selective lesioning. Because of the vagal reflex, atropine was the primary drug used for bradycardia, especially during penetration of the foramen ovale; nifedipine provided sublingually was the most frequently used antihypertensive agent in patients with chronic hypertension. Nitroglycerine dermal patches were applied to patients who were predisposed to cardiac ischemia and acute hypertension. General anesthesia was never used and is not recommended, because patient cooperation is essential to this procedure.

The RF-TR needle (TIC kit or TEW kit; Cosman, Burlington, MA, USA) was inserted toward the temporal fossa as described elsewhere [38, 47, 50, 51]. At the beginning of the procedure, X-rays of the patient in the submentovertical position provided information that allowed us to place the needle in the vicinity of the foramen ovale; the needle was then inserted through the foramen. Lateral X-rays were obtained to ensure that the tip of the needle was in the proper position. Obtaining X-ray images facilitates examination of the other foramen ovale and the whole skull base for better orientation and avoids additional radiation exposure. The desired target area was the preganglionic (retrogasserian) fibers of the gasserian ganglion, which is described as the junction of the lines joining the clivus and petrous apex radiologically; however, the mainstay of precise localization is the careful stimulation process [45].

We used thermistor electrodes (TIC kit or TEW kit). In principle, straight electrodes were preferred for third-branch neuralgia and curved electrodes for the first-branch or second-branch neuralgia. Because selective RF-TR of the desired branch of the trigeminal nerve is essential, we confirmed localization within the nerve by electrical stimulation at 0.2–1 V (50 Hz, 0.2 ms). Lesions were made at a temperature of 55–70°C [33]; however, we now usually prefer a temperature below 70°C, especially for the first-branch, but with more than 60 s duration [24]. The preferred temperature for the initial or test lesion was 55°C; the temperature never exceeded 70°C during the procedure. The corneal reflex and masseter function were continuously and cautiously monitored during stimulation and lesioning by touching lightly a sterile piece of cotton to the cornea and examining the ipsilateral lower jaw movements. The procedure was completed if adequate hypoalgesia was achieved in the targeted branch and if pain could not be triggered as it had been preoperatively. The average number of lesions per procedure was four. It was preferred to perform the first lesion at 50°C for 60 s, for the purpose of controlling the lesion. Treatment strategy for the patients that had simultaneous pain is different. First, the intervention was performed on the side associated with more pain. Usually this pain was described as longer lasting in time. After pain relief and possible complication observations were made for a month, the second intervention was performed on the opposing side.

The patients were typically discharged on the day of surgery and evaluated in terms of pain scores the day after the surgery. Overnight hospitalization was recommended in patients with poor medical status to observe pain alleviation and vital functions after the procedure was completed. All medications previously provided for pain control were discontinued after the patient had undergone RF-TR.

Mean, standard deviation, minimum, maximum, and percentage were used as descriptive statistics. Nominal variables were evaluated by Fisher's exact test. The pain-free survival estimations were performed using Kaplan-Meier analysis. SPSS 11.5 was used for statistical analysis. A p value less than 0.05 was considered significant.

Results

The mean follow-up period was 101.71±77.7 months (range, 1–312 months). Of the patients with BTN, 56 (62.9%) were women and 33 (37.1%) were men. Localization of the pain on admission was on the right in 36 (40.4%), on the left side in 28 (31.4%) and bilateral in 25 (28.2%) (Fig. 1). Familial occurrence was seen in two (2.2%) patients. No additional cranial dysfunction was observed in our patients. In 22 patients, hypertension was observed (24.7%), and 2 (2.2%) patients had MS. Isolated involvement of the maxillary division of the trigeminal nerve was on the right in 20 (22.9%) and on the left in 13 (15.7%). Isolated involvement of the mandibular division was on the right in 8 (9.2%) and on the left in 21 (25.3%). Isolated involvement of the ophthalmic division was not observed in our patients. Pain occurrence on the contralateral side of the face accompanying the initial unilateral complaints was observed at an average of 124.7±87.13 months.

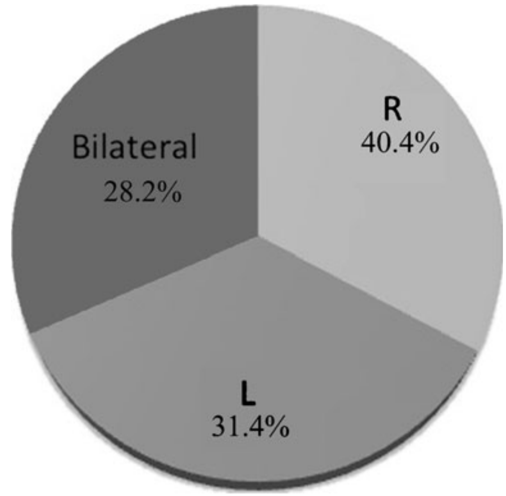

Fig. 1 Distribution (percentage) of localizations on admission

All of the 89 patients were under treatment with carbamazepine before admission, and 22 patients underwent 30 interventions for the same side before referring to us. These previous interventions were MVD in 8, retrogasserian alcohol injection in 12, subtemporal rhizotomy in 5, and suboccipital rhizotomy in 5 (Table 1). Other treatment modalities were discussed with every patient individually. A total of 186 RF-TR procedures were performed in 89 BTN patients. Fifty-four of the 89 patients underwent 146 RF-TR procedures for both side and 35 underwent 40 RF-TR procedures for one side. Complete pain relief or partial satisfactory pain relief was achieved on the medically treated side in 35 patients. During follow-up, 36 patients required the second and 7 required the

Table 1 Interventions performed before radiofrequency trigeminal rhizotomy procedures in 89 bilateral trigeminal neuralgia patients

Procedures	Number of patients	Number of procedures
Microvascular decompression	6	8
Peripheral alcohol injection	6	12
Subtemporal rhizotomy	5	5
Suboccipital rhizotomy	5	5
Total	22	30

third procedure. According to the side of the affected trigeminal nerve, pain recurrence was observed once in 17 (19.1%) patients on the right side and in 19 (21.3%) patients on the left side and twice in 6 (6.7%) patients on the right side and in 1 (1.1%) patient on the left side. The differences were not statistically significant (p=0.100). Bilateral recurrence was not observed.

Acute pain relief was reported in 86 (96.6%) patients after the first RF-TR procedure, and this finding was accepted as the initial success rate of RF-TR. Early (<6 months) pain recurrence was observed in 11 (12.3%) patients, whereas late (>6 months) recurrence was reported in 25 (28.0%) patients during an average follow-up period of 101.71±77.7 months (range, 1–312 months).

Cumulative proportion pain-free survival on the right side was determined as 0.91 at 1 year, 0.88 at 2 years, 0.78 at 5 years, 0.67 at 10 years, and 0.56 at 20 years after the first RF-TR. These values were calculated as 0.97 at 1 year, 0.83 at 2 years, 0.68 at 5 years, 0.57 at 10 years, and 0.26 at 20 years on the left side. Kaplan-Meier curve for pain-free survival after the first procedure, in which bilateral RF-TR procedures were performed, on the right and left sides are illustrated in Figs. 2 and 3, respectively [26].

After undergoing the first RF-TR procedure, 61 (68.5%) patients experienced selective pain control, i.e., pain relief with hypalgesia obtained in the same division or divisions of the trigeminal nerve experiencing neuralgia, and 25 (28.1%) patients experienced nonselective pain control, i.e., hypalgesia in the other branches as well. A second RF-TR procedure resulted in 24 (66.7%) patients reporting selective pain control and 12 (33.3%) nonselective pain control. Overall, 69.1% selective and 30.9% nonselective pain control was observed in 186 procedures.

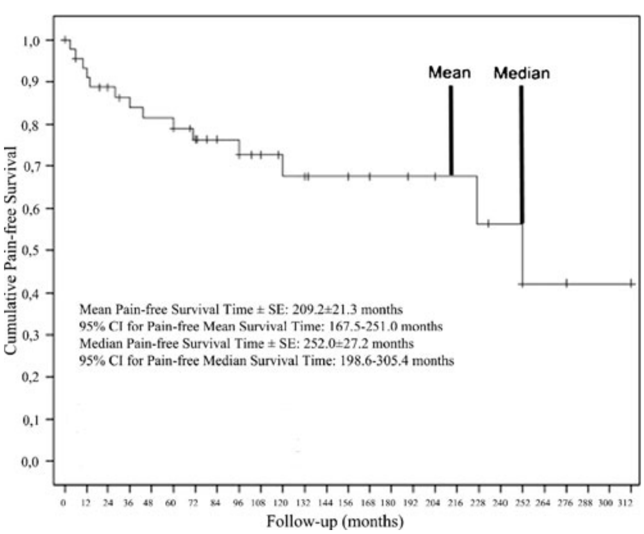

Fig. 2 Kaplan-Meier curve for pain-free survivals after the first procedure on the right side (*SE* standard error, *CI* confidence interval)

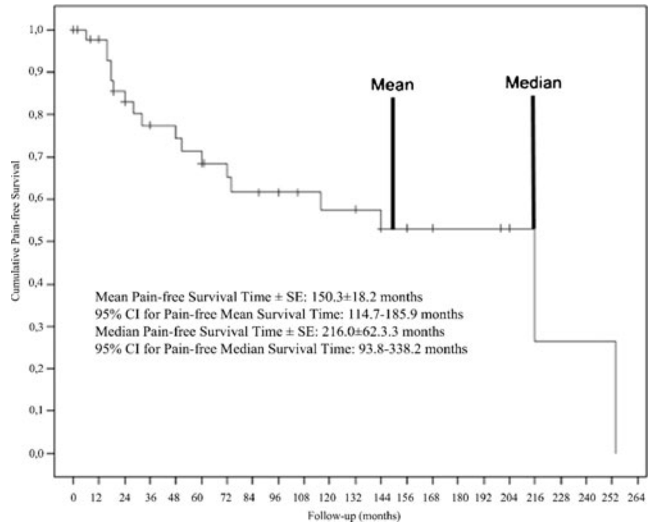

Fig. 3 Kaplan-Meier curve for pain-free survivals after the first procedure on the left side (*SE* standard error, *CI* confidence interval)

After undergoing RF-TR, absent corneal reflex was observed in four (2.1%) patients and diminished corneal reflex in four (2.1%). No bilateral diminished or absent corneal reflex was observed. Keratitis was observed in two (1.1%) patients. Masseter dysfunction was observed in four (2.1%), whereas only two (1.1%) had initial difficulty with chewing, and all improved during follow-up. Bilateral masseter dysfunction was not observed. Painful dysesthesia occurred in two (1.1%) patients, resulting in anesthesia dolorosa in one (0.5%) (Table 2). There were no additional cranial nerve deficits after the procedure. Transient mean arterial blood pressure elevation to a level 50% greater than baseline measurements was observed in 14% of patients just after penetration of the foramen ovale. However, bradycardia and hypertension were manageable with drugs intraoperatively.

Table 2 Complications related to 186 radiofrequency trigeminal rhizotomy procedures in 89 patients

Complications	Patients	
	No.	%
Diminished corneal reflex	4	2.1
Absent corneal reflex	4	2.1
Bilateral diminished corneal reflex	0	0
Bilateral absent corneal reflex	0	0
Corneal keratitis	2	1.1
Masseter paresis	4	2.1
Masseter paralysis	0	0
Transient cranial nerve paralysis	0	0
Permanent cranial nerve paralysis	0	0
Painful dysesthesia	2	1.1
Anesthesia dolorosa	1	0.5

No mortality was observed in 186 procedures on 89 patients in our total of 3,014 TN patients.

Discussion

The initial small number of patients afflicted by BTN was described more than two centuries ago subsequent to the first illustration of TGN by Locke in 1677 [31, 34, 41, 56]. In various comprehensive series, BTN has accounted for 0.6–5.9% of the ITN patients [8, 17, 54]. In the present study, BTN was present in 89 of our 3,014 TN patients, for an incidence of 2.95%.

From an extensive perspective about the epidemiological features, BTN exhibits relatively varying characteristics when compared with unilateral ITN. Pollack et al. [40] compared cases in their comprehensive analysis and reported a higher proportion of females, a higher percentage of familial cases and additional cranial nerve dysfunction. Harris [17] also demonstrated the partiality for females in his series. In the present study, the distribution of the patients in terms of gender showed a correspondence, but history of familial cases was observed in only two (2.2%) patients, and there was no additional cranial dysfunction prior to the admission.

Harris [15] initially described the relationship between MS and TN in terms of bilateralism in 1926. In his subsequent series in 1940, he reported 7 BTN patients (14%) of 50 TN patients suffering from MS [17]. Henderson [18] reported BTN in 7 (30%) of 23 patients with MS experiencing TN. In order to demonstrate the relationship between BTN and MS, almost identical results were reported by various authors [21, 43]. In contrast to the previous series, BTN was observed in 2 (0.5%) of 25 patients with MS experiencing TN and 2.2% of the patients in the BTN group had MS. The differences between the series remain to be explained. The length of the symptomatology period of MS may influence the incidence of bilateralism. Long-lasting MS may trigger contralateral symptoms. In view of the fact that bilateralism and demyelinization combine in one pathology, occurrence of systemic hypertension as a concomitant illness was observed in 24 (27.2%) patients in the present study.

The best possible modality for the treatment of BTN should be: less invasive; have the capacity to alleviate the painful attacks, the lowest complication rates and side effects, and the lowest failure and recurrence rates; terminate the requirement for medical therapy; be cost-effective [35]. Following the report of Jannetta [19], MVD was accepted as an effective treatment option for TN [46]. In view of the fact that the occurrence rate of TN increases with age, the safety of MVD in the elderly [27, 30] is still controversial. Several authors separately concluded that older patients who undergo MVD do not have increased risk of in-hospital complication and mortality [10, 13, 39]. Burchiel et al. [7] underlined that previous small series may not have adequate statistical power to capture the safety of MVD in the elderly. Rughani et al. [42] reviewed 3,273 patients who underwent MVD as the primary procedure for a diagnosis of ITN and discussed the safety of MVD for ITN in the elderly in terms of in-hospital complications and mortality. These complications include cardiac, pulmonary, thromboembolic, cerebrovascular, and wound problems and central nervous system (CNS) infection. They reported 0.68% in-hospital mortality and 7.36% overall in-hospital complication rates for patients ≥65 years and 1.16% in-hospital mortality and 10.0% overall in-hospital complication rates for patients ≥75 years, and suggested a relationship between age and in-hospital morbidity and mortality [42]. Our study presents 89 BTN cases; 28 (31.8%) of the patients were ≥65 years, and no in-hospital morbidity or mortality was observed. As the previous publications mentioned the safety of MVD in unilateral cases, the risk of a high rate of occurrence of major complications and mortality for bilateral MVD operations in the elderly should be expected.

Treating BTN patients with MS is more challenging. Spontaneous polycentric demyelination of the root entry zone of the trigeminal nerve is irrelevant to compression and for this reason, MVD may fail [5, 22]. In our opinion, although glycerol or balloon compression may be considered alternatively, RF-TR at relatively low tempratures should be the choice for this condition with the advantage of the possibility for controlled lesioning. Two bilateral cases in our own series were managed with two separate RF lesions for each side.

After the initial application of stereotactic radiosurgery (SRS) for ITN by Leksell in 1951, the likely least invasive technique for the treatment of ITN began to be used by various centers [3, 28, 32]. Kondziolka et al. [29] reported 89% initial pain relief in 503 patients following gamma knife radiosurgery (GKRS) for ITN at a median latency of a 1-month period. The late pain relief rates were 80% at 1 year, 71% at 3 years, 46% at 5 years, and 29% at 10 years, and 29% of the patients required an additional procedure. Villavicencio et al. [53] reported the results of CyberKnife radiosurgery. The initial pain relief rate was 67%, and 50% maintained complete pain relief among 95 patients with ITN. On the other hand, they reported 18% with masticator weakness, diplopia and decreased hearing. Immediate pain relief after the procedure is limited, and the median time to complete pain relief was 5 months [29]. The results of these studies indicate that in terms of early and late pain relief, RF-TR is superior to GKRS and CyberKnife radiosurgery.

Troublesome consequences of bilateral denervation in destructive procedures include keratitis, severe difficulty in chewing, eating and swallowing due to masseter paralysis and loss of tactile sensation in the mouth. The complication rates of this study are summarized in Table 2. In the previous series of RF-TR, keratitis was published with an incidence between 0.4–3% [4, 11, 25, 37, 44, 51]. Patients should be particularly informed about the probability of keratitis. The corneal reflex should be checked steadily during the entire surgery. This can be done easily using a sterile piece of cotton, as we did during our practice. Natural tears should be prescribed to the patients that have diminished corneal reflex postoperatively [2].

The surgeon may address the motor deficit of the lower jaw while preforming the lesions, particularly at the mandibular branch. This may result in a paresis or paralysis of the masseter muscle that may affect chewing ability. In the previous series of RF-TR, masseter weakness was published with an incidence between 4.1–65% [4, 11, 25, 37, 44, 48, 51]. Sweet and Wepsic [48] reported that prominent bilateral anesthesia in the mandibular area would be sufficient for chewing difficulties as well. We did not observe this in our series, in neither the 3,014 patients with ITN nor the 89 patients with BTN. This complication could be prevented with controlled lesioning under moderate temperature and by examining the jaw movements of the lower jaw toward the ipsilateral side after each lesion.

Although each side of the face is treated separately, it must be kept in mind that a bilateral approach to such a patient, whatever the procedure, should not be considered the same as the approach to two different patients having unilateral complaints. Performing the procedure on one side does not affect the pain of the contralateral side, but may exacerbate the complication rate. From the point of view of BTN, patients need bilateral procedures and are exposed to a double risk of experiencing the above-mentioned complications. This probability highlights the importance of controlled and selective lesions to avoid these crucial complications.

There is still lack of knowledge about treating this challenging condition. Our groups' preferred perspective for BTN is, relieving pain with minimal lesioning. The evaluation of the patients that had simultaneous pain both side was different. First intervention was performed on the more severe side in terms of pain, which was usually the longer-lasted one. Surgeon must be more cautious for this circumstance. If possible, partial and less aggressive lesioning must be accomplished. After observation of the pain relief and possible complications for 1 month, the second intervention was performed on the other side. If anesthesia was observed after the first procedure for this cases, the temperature never exceeded 60°C during the procedure for the opposite side. Although the probability of recurrence after mild to moderate lesioning can increase, alleviating pain with medication in BTN cases can be considered as a favorable clinical outcome.

Conclusion

RF-TR is a safe, effective, selective, well–controlled, and effortlessly repeatable procedure for treating BTN, especially in the elderly, in terms of low morbidity and mortality rates and the high rate of satisfactory pain relief. Based on our 37-year experience, we believe that TN is a lifelong disease that requires expert strategies with life-long duration.

Conflicts of interest None.

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Comment

Although statistically a rare condition, representing 1–3% of all trigeminal neuralgias (TNs) according to the large published series, bilateral trigeminal neuralgias (BTNs) are difficult to deal with, even for the specialized neurosurgical centers to which these patients are referred. The Ankara series with 89 BTN operated patients is to our knowledge the largest reported series. Surprisingly, multiple sclerosis (MS) was the etiology in only 2.2% of the 89 cases. By comparison, in our group of 38 patients with BTN, which represented 0.9% of our overall series of 4,200 patients referred for TN over the same period of time, MS was the cause of the neuralgia in 32 patients.

In MS patients with TN, whether unilateral or bilateral, microvascular decompression (MVD) has been proposed by a few authors, with the rationale to free the root of an eventual vascular compression, avoiding the use of a lesioning procedure with its subsequent side-effects of numbness, corneal hypoesthesia and masticatory weakness. In our hands, MVD in MS patients has rarely been long-term effective, even when a vascular “conflict” (generally a simple contact) was found. We think, however, that MVD may be considered in some MS patients, but only if a clearcut and marked vascular compression can be suspected on high-resolution MRI sequences. For patients with BTN not related to MS or other inflammatory disease, we do advocate MVD as the first option when the three high-resolution MRI sequences: 3D T2, 3D TOF angiography and 3D T1 with Gd, in association, demonstrate a vascular compression [1, 2].

Conversely, in the absence of obvious vascular compression on high-resolution MRI, or for patients with poor general conditions, a percutaneous lesioning-procedure: a thermo-rhizotomy (Th-Rh) in our Department, is preferred even if to be done bilaterally.

To reduce risks of harmful side-effects, which would be particularly disabling when the Th-Rh is performed bilaterally, the thermolesion should be as selective as possible, as regard to topography and extent and also to the intensity of the hypoesthesia. We think it important to place the uninsulated tip of the electrode at the retrogasserian portion of the trigeminal root, precisely at the level of the triangular plexus. X-ray landmark on lateral view is at the upper ridge of the petrous apex and just behind the clival plane [3]. A complementary physiological testing (preferably at 5 Hz frequency) is necessary to adjust the final placement of the electrode. It consists in the awake patient of checking the location of the evoked paresthesias to be at the very place of the trigger zone. When the threshold of intensity is above 0.4 volts, which makes the electrode supposed to be outside the nerve, the electrode should be repositioned. Besides, stimulation produces masticatory responses; when the threshold is below 0.3 V, relocation of the electrode away from the trigeminal motor fibers should be attempted. At 5 Hz, stimulation also provokes fine muscle twitches in the facial nerve territory: in orbicularis oculi when the tip of the electrode is in V1/V2 radicular fibers, in Levator Labii when tip is in V2 fibers and orbicularis oris when the tip is in V3 fibers. These evoked motor responses (EMRs) are hypothesized to be owing to trigemino-facial reflexes (similar—in mechanism—to the blink-reflex) [4]. These EMRs have a good localizing value and may help in those patients not able to cooperate [5].

As pointed by the Ankara authors, we agree that—provided it be selective and well-controlled—RF-TR is a safe and effective procedure, especially for elderly patients, even those with BTN.

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