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Radiofrequency Management of Trigeminal Neuralgia

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ABSTRACT

Background: Trigeminal neuralgia (TN) is a unique disease. The first line of management in TN is medical treatment using antiepileptic drugs, when drugs failed to control the pain or when there is intolerability to them, surgical interventions are then indicated. Percutaneous Trigeminal rhizotomy (PTR) is recommended for elderly patients with higher operative risk factors. **Objective:** The aim of this work is to review the literature regarding the pathology, methods of investigations, operative techniques, complications of management of trigeminal neuralgia and eventually prognosis, also evaluation of the effectiveness of the radiofrequency percutaneous radiofrequency rhizotomy - for management of trigeminal neuralgia**. Patients and Methods**: This study included a total of 15 patients with trigeminal neuralgia presented predominantly in females. Female: male 1.7:1 and the mean age was 53 years. They were admitted and managed at the Neurosurgical Department of at Al-Azhar University Hospitals and other private centers between June 2017 and October 2018. Clinical follow-up was obtained in 15 (100%) patients. **Results:** follow up revealed that 11 patient (73.4 %) had favorable outcome and 4 patient (26.6%) had unfavorable outcome. The mean preoperative visual analogue scale(VAS) was 7.83 (range 7-10). It dropped immediately postoperative to 2.33 (range 1- 4).), intraoperative complication was noted in 3 cases (18%).**Conclusion:** Radiofrequency rhizotomy is the procedure of choice for most patients undergoing first surgical treatments and patients at high risk from general anesthesia (although not necessarily the elderly).

Keywords: Trigeminal neuralgia, radiofrequency, percutaneous trigeminal rhizotomy.

INTRODUCTION

Trigeminal Neuralgia (TN): is defined as neuropathic pain syndrome characterized by sudden and usually unilateral severe brief stabbing recurrent pain in the distribution of one or more branches of the fifth cranial nerve. It is an excruciating, short-lasting (<2 minutes), unilateral facial pain that may be spontaneous or triggered by gentle, innocuous stimuli and separated by pain free intervals of varying durations [(1)]. The patient usually describes it as the worst pain in his life[(2)]. It is a very peculiar disease, which is also known as "tic douloureux". It is limited to the facial distribution of the trigeminal nerve and precipitated by stimuli to sensory endings in the trigeminal receptive area. The pathophysiology is unclear. Based on clinical observations, compression of the trigeminal nerve near the origin from the brain stem (root entry zone) by blood vessels or tumor, may cause trigeminal neuralgia. Local pressure causes demyelination that leads to abnormal depolarization resulting in ectopic impulses[(3)].

In the latest classification of the International Headache Society, 2 main types were defined:

CLASSIFICATION

Primary: or idiopathic including those with potential vascular compression of the trigeminal nerve

Secondary: which may be due to intrinsic brainstem pathology e.g. multiple sclerosis or lacunar infarction) extrinsic cerebellopontine angle pathology (e.g., neoplasms or vascular lesions) [(4)].

Since the first scientific publication on TN a variety of treatments have been advocated and practiced by surgeons throughout the world. Some controversy still exists regarding which surgical modality is the one of choice [(5)].In this study, we evaluated the percutaneous radiofrequency rhizotomy for management of cases of trigeminal neuralgia as regard advantages and disadvantages. Percutaneous radiofrequency rhizotomy is considered a minimally invasive procedures and performed as outpatient surgery with minimal anesthetic risk. In the 11th century an Arab physician, Jurjani, described a type of facial pain believed to be TN.

This entity was "a type of pain which affects the teeth on one side and the whole of the jaw on the side which is painful. The first clear description of TN was provided in 1671. The patient was a well-known physician, Johannes Laurentis Bausch of Germany (1605–1665), founder and first president of the Imperial Leopoldian Academy of Natural Sciences, who suffered from severe TN for 4 years. The pain prevented him from eating any solid food and he was almost unable to speak. Emaciation gradually occurred and led to death from a stroke in 1665.Bausch's illness was detailed in his eulogy published in the Academy volume covering the year 1671 [(6)]. The well-known philosopher and physician John Locke (1632–1704) provided the first full description of TN and its treatment performed by a physician. While in Paris in 1677, Locke was called to see the wife of the English Ambassador, the countess of Northumberland, who was suffering an excruciating pain in the face and lower jaw. Two teeth had been removed without relief. Locke has applied sulphuric acid to the face of the Duchess of Northumberland in an attempt to treat her facial pain. In letters to his friend Mapletoft, he described her suffering in detail and outlined his treatment, which included a thorough purging of the lady [(7)]. In the 1930s, while performing partial sectioning of the trigeminal root for typical TN

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by way of a posterior fossa approach, the neurological surgeon Walter Dandy (1886–1946) noted that, "The sensory root is frequently indented, lifted up or bent at an angle by the artery" (Dandy WE,1934). "This I believe is the cause of tic douloureux". By this time, with accumulated surgical knowledge, it was also appreciated that an occasional tumor in the cerebellopontine angle could impinge upon the trigeminal nerve and causes a similar or atypical TN[8].Percutaneous procedures for treatment of trigeminal neuralgia were first introduced in 1853 by Patruban, who divided the maxillary nerve behind the orbit by passing a tenotome along the floor of the orbit and cutting the nerve as far back as possible.[9].In 1910,Harris applied a lateral approach to reach the foramen ovale and inject alcohol. In 1914, Härtel modified the approach to an anterior one similar to that currently practiced and in 1930, Irger used an inferior approach (both approaches used alcohol injection)[10].

PATIENTS AND METHODS

Patient population: A prospective and retrospective study was done on a series of 15 consecutive patients having Trigeminal Neuralgia managed by percutaneous trigeminal rhizotomy. This study was conducted on patient with variant ages at the time of diagnosis, presenting with trigeminal neuralgia, admitted and managed at the neurosurgical department at Sayed Galal Hospital, Al-Azhar University and other private hospitals between June 2017 and October 2018. During the period of the study, data were collected and saved in summary sheets case by case. Hospital records and radiology films of the patients were electronically saved. The study was approved by the Ethics Board of Al-Azhar University.

All patients in this study were submitted to the following neurosurgical procedures:

History taking: (Personal History, complaint, the chief complaint uses the patient's own words to state why he or she has presented for an evaluation; in other words, history of present illness: Severe pain in the distribution of the trigeminal nerve or one of its branches, represents the chronological sequence of events that led up to the pain onset and everything the patient has undergone since the onset: when it was initiated, who was consulted, what imaging and blood work has been carried out, what diagnosis was made, and what treatments were rendered. The results, positive or negative, of each of these events are extremely important. Proper analysis of pain regarding site, character, severity (according to visual analogue scale "VAS"), interval in between attacks, duration, and response to any medication given before past history of surgical procedures, history of major illness…etc., family history.)

Examination (General health, Mental Status. Vital Signs: Pulse, B.P, Temp., Neurological Examination: Level of consciousness, Cranial Nerves Examination: With special attention to fifth cranial nerve, Motor System Examination: Muscle power, muscle tone, reflexes. Sensory System Examination: Superficial sensations: Pain, temperature and light touch. Deep sensation: Joint position and vibration. Other systems Examinations)

Investigations: Routine laboratory investigations. Radiological investigations: Magnetic Resonance Imaging (MRI) and MRA. MRI may show a blood vessel impinging on the trigeminal nerve at the 'root entry zone' as it exits the brainstem. MRI brain with thin cuts (1-2 mm in thickness). The most used MRI protocols were 3D-FIESTA and 3DCISS to detect vascular compression of the trigeminal roots in the prepontine cistern and to exclude cases with secondary TN due to space occupying lesions or MS Other causes of trigeminal neuralgia include tumours, cysts, and vascular malformations, and for this reason an MRI is mandatory in the early stages of management

Operative Procedure: Radiofrequency trigeminal (retrogasserian) rhizotomy: These procedures are performed under fluoroscopic guidance with IV sedation. RF ablation is the most commonly performed procedure A 22 gauge, 10 cm RF cannula is introduced at a point 2–3 cm lateral to, and 1 cm inferior to, the commissura labialis. It is directed toward the pupil at a point 3 cm anterior to the external auditory meatus. A submentovertex, or oblique submental fluoroscopic view, can be used to visualize the foramen ovale. Once within the foramen, a straight lateral view is used to confirm location within Meckel's cave. The cannula is advanced such that the tip of the electrode is located at the junction of the petrous ridge and the clivus (picture3). Stimulation at 50 Hz and a 1 millisecond pulse width should produce paresthesias at 0.1–0.5 V within the desired distribution of the nerve. Needle repositioning is necessary. When location is confirmed, thermoablation at 50, 60, 70° for 90 seconds is performed with the patient sedated. Adequate lessening is confirmed by loss of pinprick discrimination in the target distribution, and the needle is withdrawn.

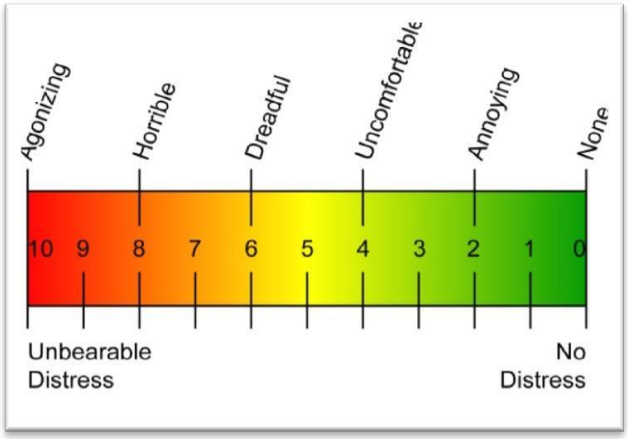
Follow up: All patients were followed up after surgery in the outpatient clinic for 6 months using the Ten-cm visual analog scale (VAS). There will be gradual withdrawal of the preoperative drugs. The presence of residual pain and postoperative complications were documented and compared with the preoperative symptoms.

Any unexpected complications appeared during the course of the research were cleared to participants and the ethical committee on time. We analyzed the clinical and operative data of 15 patients diagnosed with trigeminal neuralgia, refractory to medical treatment during the period from 2017 to 2018. The study included both prospective and retrospective cases to assess the outcome after radiofrequency trigeminal rhizotomy. The patients was selected according to the following inclusion and exclusion criteria.

Inclusion criteria: The patients age between 21 - 70 years. Either genders. All adult patients presenting with the features of trigeminal radicular pain and along distribution of its branches, especially those having persistent pain even after conservative treatment. The absence of a chronic or progressive neurological deficit.

Exclusion criteria: The patients above 70 years. Previous skull base surgery. Presence of causative pathology that requires surgical intervention. TMJ Pain that resembles TN. Superficial skin lesion at site of needle application. Coagulopathy or bleeding tendency. Breast feeding or pregnancy. Active psychiatric or mental conditions. Other uncontrolled general medical condition as unstable cardiac conditions, significant respiratory problems, poorly managed diabetes. Previous head trauma with fracture base of the skull. Presence of evident motor deficit on the agonizing side. Patients with secondary trigeminal neuralgia have been excluded from the whole study.

We have used the Visual Analogue Scale (VAS) for evaluation of the severity of facial pain. Each patient was asked to give his pain severity a grade from 0 to 10, while 0 means no pain at all and 10 the severest pain level (11)



Visual Analogue Scale (VAS) for assessment of pain severity in patients with trigeminal neuralgia.

Statistical Method

The collected data were organized, tabulated and statistically analyzed using SPSS software (Statistical Package for the Social Sciences, version 16, SPSS Inc. Chicago, IL, USA). For quantitative data, the range, mean and standard deviation were calculated. For qualitative data, which describe a categorical set of data by frequency, percentage or proportion of each category. Level of significance was set as P-value less than 0.05.

RESULTS

Our patients collected into single group, which includes 15 patients undergoing percutaneous radiofrequency (retrogasserian) rhizotomy.

The following data were recorded in the research protocol:

Demographic data, clinical presentation, pain grading before and after surgery, previous surgical treatment, pain characteristics, pre-operative radiological findings, postoperative complications, and postoperative pain relief.

All the patients had TN, not sufficiently relieved by medical treatment. Regarding the sex distribution among 15 cases in this study, female number was 8 and male was 7 by percentage 53.3% to 46.7 % female: male

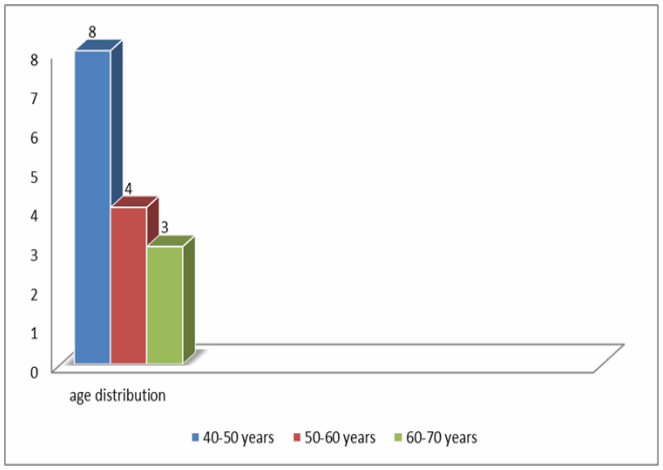


Figure (1): Age distribution in the studied patients.

Regarding the age distribution among 15 cases in this study, 8 patients among age range 40-50 years old by percentage 53.3% and 4 patients among age range 50-60 years old by percentage of 26.6 % and 3 patients 60-70 years old by percentage 20%. In our patients the pain syndrome was characterized by unilateral pain. 9 patients had right side pain (60%) and 6 patients had left side pain (40%). The symptoms duration was in 11 patients (73.3%) less than 5 years and 4 patients (26.4%) more than 5 years up to 10 years suffering. The symptoms often triggered by non-painful stimulation, and with pain-free periods. TN could be provoked by movement (e. g., flexion or rotation of the head, or by stamping the foot on the floor), whereas the pain disappeared when the patient rested in the supine position. Which is known as typical trigeminal neuralgia. Typical pain was in 13 patients (86.7%) and 2 patients (13.3%) had atypical pain which is characterized by heavy, aching, stabbing and burning pain, which is often continuous and periods of remission is rare. In our patients the pain distribution was, in most of the cases, related to the lower division of the trigeminal nerve 2nd and 3rd in 13 patients (86.7%). Only 2 patients (13.4 %) had 1st nerve division. Pre-operative evaluation for pain in our study used verbal description of pain to evaluate the pain before any intervention. In Patients underwent percutaneous radiofrequency; 13 patients 86.7% revealed horrible pain 10\10 and 2 patients 13.3% revealed excruciating pain 9\10. In our study, pain evaluation immediate after surgery showed 8 patients were completely free of pain after percutaneous radiofrequency 53.3%. 4 patient had satisfactory pain relief 26.67 %. In percutaneous radiofrequency. 2

patient had partial relief 6.7% after percutaneous radiofrequency.

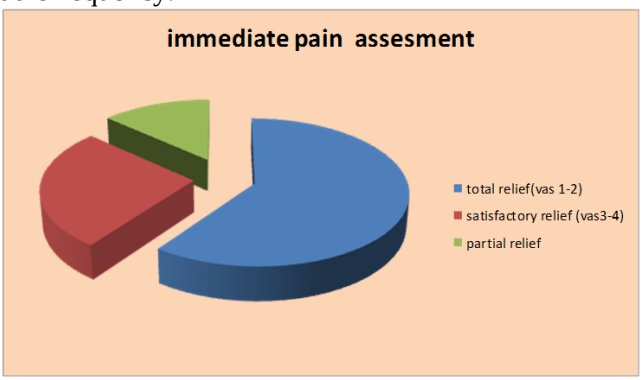


Figure (): Pain evaluation (immediate after surgery) distribution in the studied patients.

One week follow up: were 5 patients were completely free of pain after percutaneous radiofrequency 33.33%. 9 patient had satisfactory pain relief 60% in percutaneous radiofrequency. 1 patient had no pain relief after percutaneous radiofrequency 6.6%. 6 months follow up results were: 7 patients were completely free of pain after percutaneous radiofrequency 46.7%. 3 patients had satisfactory pain relief 20% in percutaneous radiofrequency. 3 patient had partial relief 20% after percutaneous radiofrequency. 2 patients had recurrent severe trigeminal pain that was not responding to medical treatment. The relation between pain evaluation data and outcome of patients in our study was statistically insignificant P> 0.05.

DISCUSSION

Our survey was undertaken to study the clinical features of trigeminal neuralgia.

As regard demographic data: The mean age of these patients was 52.9 years. Female gender was slightly more affected (8 cases, 53.08%).

According to ***Sletteb and Eide et al.*** a prospective study of 25 patients with trigeminal neuralgia (TN), examined 13 female and 12 male. Female: male was 1.08:1. Affected side (right/left) was 18/7 by percentage 72% and the mean age was 53 years old[(11)].

While in ***Katusic et al.*** the overall crude incidence rate of trigeminal neuralgia per 100,000 populations in Rochester, Minnesota, for 1945 through 1984 was 4.3 for both sexes combined. The age-adjusted (to total 1980 US population) rate for women (5.9) was significantly higher than that for men (3.4). Data based on evidence in the medical records suggest that trigeminal neuralgia is a rather rare and unpredictable disease[(12)].

In ***Loh et al.*** the survey was undertaken to study the clinical features of trigeminal neuralgia in an Asian population. Demographic data of 44 patients treated at the Dental Faculty of the National University of Singapore and at the University of Malaya were reviewed. The results of the survey were analyzed and comparisons made with those of Caucasian patients as reported in other studies where there was a general similarity in the clinical findings. Trigeminal neuralgia presented predominantly in females. Right-sided involvement occurred at a greater frequency, and the peak age at onset was between the sixth and seventh decades of life[(13)]. and this is in agreement with Dahle et al., (1989). Fifty-seven patients, 34 women and 23 men, Female: male 1.8:1 underwent intervention for trigeminal neuralgia between 1980 and 1987 in two different centers in Sweden. The diagnosis was based on severe paroxysms of pain restricted to the trigeminal nerve distribution. Between these attacks, the patients were free from pain (tic douloureux). The age range was from 37-77 years, with an average age of 59 years. Right side 38 patients Left side 16 and bilateral 3 patients[(14).]

As regards clinical presentations:

In this study, Clinical diagnosis of TN was confirmed by history and examination. A detailed description of the neuralgia was obtained to define its typical (i.e. only paroxystic) or atypical (i.e. association with a background of continuous pain). This description corresponds to the International Classification of Headache Disorders definition. Patients with typical pain were 86.7 % and who with atypical were13.3 %. The mean duration of pain compliant prior to surgery was 3.22 years (range 1-8).

While in ***Dahle et al.*** duration of symptoms (years) <5 was in 16 patients and from 5-10 years was in 18 patients and from 11-20 years in 20 patients and >20 3 inpatients and all the 57 patient had typical pain[(14)].

And in ***Sletteb et al.*** Duration of symptoms (years) was from 5 to 10 years with median 7 and all the patients had typical TN[(11)].

In this study the combination of V2 and V3 divisions represented 40 % of cases, followed by isolated v3 division (33.3%), and lastly with equal percent for both combinations of V1, 2 and isolated V2 division affection (13.3% for each).

Verbal description of pain is our test to evaluate the pain before any intervention: 8 patients 53.3% had horrible, excruciating pain 9-10\10 and 6 patients 40% had dreadful pain 7-8\10. 13 patients of them had no pain after a period of rest

According to ***Sletteb et al.*** the result was horrible in 4 patients and excruciating pain in 21 patients. and result at rest was no pain in 21 patients, 1 had discomforting, 1 had distressing, 1 had horrible and 1 had excruciating from 25 patients according to Verbal Description of Pain. The pain distribution was, in most of the cases, related to the lower division of the trigeminal nerve 2nd and 3 $^{rd.(11).}$

While in ***Dahle et al.*** affected nerve division was in 4 patients for 1st division and for 2nd in 15 patients and for 3rd in 15 and in 23 for 2nd, 3rd and the all cases was 10\10 according to Verbal Description of Pain[(14)].

In the study of ***Bendersky et al.*** a series of 55 patients (33 women, 22 men) with idiopathic trigeminal neuralgia treated from January 2006 to April 2011 were analyzed. Their mean age was 68.2 years. The divisions of the trigeminal nerve most often involved were V2 + V3 (52%) followed by V2 (29%). The right side was more commonly affected than the left (58% vs. 42%, respectively)[15].

In our study, the whole 15 patients 100% underwent medical therapy with carbamazepine for long time but the patients did not feel any improvement or there was partial, initial improvement otherwise they complained from drugs side effect.

In ***Dahle et al.*** all patients underwent medical therapy with carbamazepine or diphenylhydantoin before being considered for surgical treatment. In addition, many patients had been subjected to other treatments in the past, such as glycerol rhizotomy (9%), alcohol block (3%). The results were in these cases considered unacceptable due to recurrent pain or the side effects of the drugs given[14].

While in ***Steude et al.;***194 patients suffering from an idiopathic trigeminal neuralgia (tic douloureux) had been primarily successfully treated for a considerable time period with (Carbamazepine). 28 patients had already undergone several surgical treatments such as alcohol injections; most of them had undergone a treatment with acupuncture and the pain is also recurrent[16].

In ***Broggi et al.*** 43 patients had been previously treated with Tegretol (3 to 9 tablets per day) from 1 to 6 years. Only 36 had experienced remission of pain. However, side-effects (leucopenia, drowsiness, dizziness and unsteadiness, cutaneous rash etc.) had led to discontinue the medical treatment and to recommend surgery.[17]. According to ***Sletteb et al.*** all the patients had typical TN, were not sufficiently relieved by carbamazepine or phenytoin.[11].

As regard Clinical results:

In our study, we achieved an initial pain relief (either partial or complete) in 100% of cases with a mean immediate postoperative VAS of 2.33.

When comparing improvement in pain intensity during the immediate postoperative period to the preoperative one, we found that PTR resulted in 55.56 % reduction in pain intensity (measured by VAS). This reduction in pain intensity reached 44.9 % when comparing the VAS at the end of follow up period to the preoperative one.

The mean preoperative VAS was 7.83 (range 7-10). It dropped immediately postoperative to 2.33 (range 1- 4). There were 9 cases that showed initial partial improvement, 5 of them showed stationary course of partial improvement, and the remaining 4 cases showed delayed complete cure. At the end of follow up period, the mean VAS raised to 3.33 (range 0-8) because of recurrent cases.

When excluding the 5 patient who had partial initial pain relief with no further improvement, we had a recurrence rate of 26.6 % (4 cases). The mean VAS of the recurrent cases was 7 at the end of the follow up duration. Those recurrent cases were not controlled with medical treatment and needs further interventions.

While in ***Tronnier Volker et al.*** two hundred twenty-five patients who underwent MVD and 206 patients who underwent radiofrequency were analyzed retrospectively in detail. Overall, there was a 50% risk for recurrence of pain 2 years after percutaneous radiofrequency rhizotomy. Conversely, 64% of patients who underwent MVD remained completely pain free 20 years postoperatively. Patients without sensory impairment after MVD were pain free significantly longer than patients who experienced postoperative hypesthesia or partial rhizotomy[18].

Kanpolat et al. presented the largest study that included 1600 patients with the longest follow-up (25 years). The average follow-up time was 68.1 months (range12–300). Initial pain relief was accomplished in 97.6% of patients, while at 5 years it reached 57.7%. Percent of patients with pain relief reached 52.3% at 10-year follow-up and 41 % at 20-year follow-up. Early pain recurrence (<6 months) was observed in 123 patients (7.7%) and late pain recurrence was observed in 278 patients (17.4%). They reported that in cases with recurrent pain, reoperation resulted in much longer pain relief[19].

According to ***Tatli et al.*** they reviewed 9 studies that included 4683 patients with a mean follow up period of 8.3 years. The average initial pain relief was 90.3 %, the average follow-up pain free rate 50.4 %, with a recurrence rate of 45.9% [20].

As Regard Complications:

We had reported transient facial hypoesthesia in 33.33 % and transient masticatory muscle weakness in 6.6% of patients. At the end of follow up durations, the percentage of tolerable facial numbness was 26.6%. We had reported no cases of anesthesia dolorosa, corneal hypoesthesia, other cranial nerve palsies, or mortalities.

Hypoesthesia should not be considered a complication but a side effect of this procedure, because successfully treated patients almost always experience mild or moderate hypolgesia or hypoesthesia[19].

In their review, ***Tatli et al.*** had reported 5-98% facial hypoesthesia, trigeminal motor weakness in 4-24%, corneal hypoesthesia in 5-18%, keratitis in 0.5-18%, and anesthesia dolorosa in 0.8-2% [20].

In ***Kanpolat et al.*** study, the reported complications were diminished corneal reflex in 5.7%, masseter weakness and paralysis in 4.1%, dysesthesia in 1%, anesthesia dolorosa in 0.8%, keratitis in 0.6%, and transient paralysis of oculomotor and abducens nerves in 0.8%. Permanent abducens nerve palsy was observed in two patients, CSF leakage in two, carotid-cavernous fistula in one, and aseptic meningitis in one [19].

While in ***Taha et al.*** in their study, reevaluate the results of radiofrequency rhizotomy and review the

effectiveness of other surgical procedures for the treatment of trigeminal neuralgia. Five hundred patients with trigeminal neuralgia underwent radiofrequency rhizotomy at the University of Cincinnati Medical Center, Cincinnati, OH, between 1981 and 1986. Their results are compared with those of patients reported in the literature who underwent radiofrequency rhizotomy (6205 patients), glycerol rhizotomy (1217 patients), balloon compression (759 patients), microvascular decompression (MVD) (1417 patients), and partial trigeminal rhizotomy (250 patients). Comparisons were based on the following outcome parameters: technical success, pain relief and recurrence, facial numbness, dysesthesia, corneal anesthesia, keratitis, trigeminal motor dysfunction, permanent cranial nerve deficit, intracranial hemorrhage or infarction, perioperative morbidity, and perioperative mortality. They found that MVD had the lowest rate of technical success. Radiofrequency rhizotomy and MVD had the highest rates of initial pain relief and the lowest rates of pain recurrence. MVD had the lowest rates of facial numbness and dysesthesia. All percutaneous procedures had similar rates of dysesthesia. Posterior fossa exploration had the highest rates of permanent cranial nerve deficit, intracranial hemorrhage or infarction, and perioperative morbidity and mortality[21].

We postulate that our rate of annoying side effects were relatively lower than that of other series because of careful selection of patients for RFA, limitations of patients with V1 symptoms, and, most importantly, the production of precise lesion at moderate temperature (50-60- 70°) producing hypoalgesia and not analgesia or anesthesia.

CONCLUSION

The diagnosis of TN is made on clinical history alone. There are no diagnostic tests. Percutaneous Radiofrequency rhizotomy techniques offer advantages and disadvantages. Radiofrequency rhizotomy is the procedure of choice for most patients undergoing first surgical treatments and patients at high risk from general anesthesia (although not necessarily the elderly) More and more advanced technology is increased; the diagnostic radiological investigation is giving us clear picture about the exact causes of trigeminal neuralgia.

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