ACTA SCIENTIFIC NEUROLOGY (ISSN: 2582-1121)

Volume 7 Issue 11 November 2024

Research Article

Peripheral Neurectomy for Trigeminal Neuralgia Followed by a Choice of Two Different Means of Obturating the Nerve Foramina

Vipul Garg, Ankit Aggarwal, Anik Sarkar*, Vanshikha Sharma, Marvi Bhopal, Megha Dhadwal, Shruti and Dakshanya Chatterjee

Department of Oral and Maxillofacial Surgery, Himachal Institute of Dental Sciences, India

***Corresponding Author:** Anik Sarkar, Department of Oral and Maxillofacial Surgery, Himachal Institute of Dental Sciences, India.

DOI: 10.31080/ASNE.2024.07.0778

Received: July 15, 2024

Published: October 17, 2024

Abstract

Introduction: Carbamazepine is usually the preferred first line of treatment for Trigeminal neuralgia, followed by some choice of drugs like Lamotrigine and Baclofen and anti-epileptics like Phenytoin, Gabapentin, Topiramate, Tocainide and Valproate. If there is a decrease in efficacy or development of tolerance to the drugs, some surgical modality needs to be considered. Factors such as pain relief, recurrence rate, morbidity, and mortality rates should be kept in mind while going through the treatment plan. A minimally invasive procedure for the treatment of Trigeminal Neuralgia is Peripheral neurectomy, a safe and efficient procedure for elderly patients, in rural and remote centers where neurosurgical facilities and the choice of drugs are not readily available. It is also effective in those patients who are reluctant to wait long enough for the pharmacotherapeutics to be efficient and also elect for any elaborate and extravagant neurosurgical procedures. Although loss of sensation along the branches of the trigeminal nerve and recurrence rate are associated trade-offs with peripheral neurectomy, all in all, it is considered a fairly safe and logical procedure in rural practice, which can be done even under local anesthesia. The purpose of this study is to evaluate the difference in recurrence outcomes of obturating the exposed nerve foramina using a titanium screw vs bone wax vs leaving the foramen open.

Materials and methods: 3 patients reporting to the Department of Oral and Maxillofacial Surgery, Himachal Institute of Dental Sciences, Paonta Sahib with complaints of sharp, stabbing paroxysmal pain responding to certain trigger points on whom previous medication of Carbamazepine was ineffective were prepared for peripheral neurectomy. On one patient, a titanium screw and on another, bone wax was used to obturate the exposed foramen post-operatively. In the third patient, the foramen was left as it is.

Results: The method of using a Titanium screw to obturate the foramen showed promising results when compared with both bone wax and leaving the foramen open.

Conclusion: Peripheral neurectomy is an efficient and cheap way to provide relief to patients living in rural areas with little healthcare facilities for trigeminal neuralgia. The decision to obturate the foramen with a titanium screw is still a viable option when compared with other methods of obturation.

Keywords: Neurovascular Compression; Multiple Sclerosis; Ganglionic Local Opioid Analgesia; Repetitive Transcranial Magnetic Stimulation; Microvascular Decompression; Gamma Knife

Introduction

Trigeminal neuralgia, aka "Fothergill's disease" or *tic douloureux*, is a type of chronic pain disorder that involves sudden attacks of severe facial pain, often described as a struck 'lightning bolt' or a stabbing sensation on the face. Indeed, such short-lasting paroxysms of pain occur multiple times throughout the day, debilitating the patient. This condition is almost always unilateral and can involve one or more divisions of the trigeminal nerve [1].

Affecting typically women more often than men and is more likely in people above 50 years [2]. These are recurrent, unilateral, brief (≤ 1 sec–2 mins), extremely painful electric shock-like episodes of pain in the trigeminal nerve distribution to various regions in the face that impacts basic human functioning such as talking, eating, drinking, and touching the face, thereby resulting in regressive quality of life. Epidemiological studies show increased anxiety and depression in affected individuals and even increased risk of suicide [3].

One, two, or all three of the branches, namely the ophthalmic nerve (V1), the maxillary nerve (V2), and the mandibular nerve (V3) (Figure 1) are affected, the maxillary or mandibular branches being most common. 'Paroxysmal attacks of pain, lasting from a fraction of a second to 2 minutes, affecting one or more divisions of the trigeminal nerve' is the definition for the disorder according to the Headache Classification Subcommittee, 2004 [4].

Trigeminal Neuralgia is classified into idiopathic Trigeminal Neuralgia, Classic Trigeminal Neuralgia, and secondary Trigeminal Neuralgia. The first is characterized by unknown causes, and in approximately 10% of patients, even after surgical procedures or magnetic resonance imaging, the disease seems to be spontaneous without a diagnosed cause. Classic Trigeminal Neuralgia is associated with neurovascular compression (NVC) in the trigeminal root entry zone, which leads to nerve root atrophy or displacement. Secondary Trigeminal Neuralgia may be caused by an underlying disease such as tumors or artery malformations and has been associated with multiple sclerosis (multiple sclerosis patients show a 20-fold high prevalence of Trigeminal Neuralgia) [5].

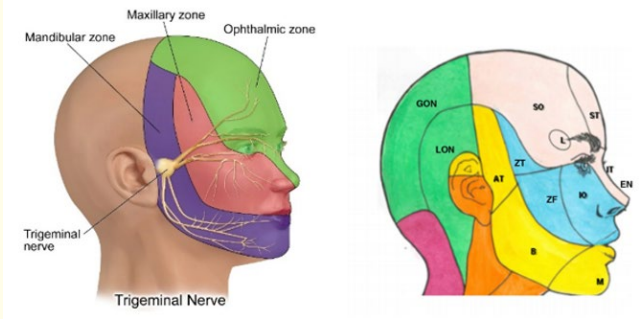


Figure 1: Areas of the face supplied by various branches of Trigeminal Nerve and a few C1-C3 nerves.

GON: Greater Occipital Nerve; LON: Lesser Occipital Nerve; SO: Supraorbital Nerve; ST: Supratrochlear Nerve; L: Lacrimal Nerve; IT: Infratrochlear Nerve; EN: External Nasal Nerve; ZT: Zygomaticotemporal Nerve; ZF: Zygomaticofacial Nerve; IO: Infraorbital Nerve; AT: Auriculotemporal Nerve; B: Buccal Nerve; M: Mental Nerve

Treatment for Trigeminal Neuralgia is initially pharmacological in the form of monotherapy; however, combined therapy with different drugs may be used when the efficacy of monotherapy is low. Patients not responsive to pharmacological treatment or those who present with severe side effects are candidates for more invasive strategies such as nerve block or surgery.

First-line therapy includes anticonvulsants like Carbamazepine (200-1200 mg/day) and oxcarbazepine (600-1800 mg/day) according to current evidence-based treatment guidelines (Table 1).

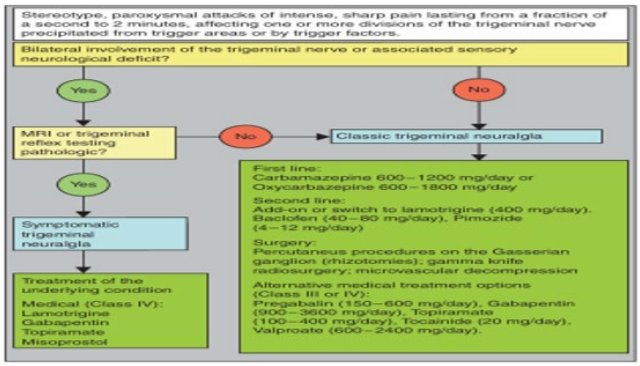
Drug	Mechanisms of action	Metabolism	Half-life	Therapeutic indication
Carbamazepine	VGSC blocker, L-type VGCC blocker	Cytochrome P450	0.5h	Epilepsy, trigeminal neuralgia
Oxcarbazepine	VGSC blocker, N-P- and R-type VGCC blocker	Cytosolic enzymes	9h	Epilepsy

Table 1: Anticonvulsants and how they help patients with Trigeminal Neuralgia.

VGSC: Voltage-Gated Sodium Channel; VGCC: Voltage Gated Calcium Channel

Second-line treatment includes add-on therapy with Lamotrigine (400 mg/day), or a switch to Lamotrigine, Baclofen (40-80 mg/day), or Pimozide (4-12 mg/day), antiepileptic drugs (AEDs) like Phenytoin, Clonazepam, Gabapentin, Pregabalin, Topiramate, Levetiracetam, Valproate, Tocainide (12 mg/day), newer AEDs like Tizanidine, Botulinum neurotoxin type A (BoNT-A), intranasal administered Lidocaine (8%), ganglionic local opioid analgesia (GLOA) at the superior cervical ganglion, Repetitive transcranial magnetic stimulation (rTMS) to the motor cortex at 20Hz daily for 5 days, etc.

In Multiple Sclerosis, Microvascular decompression is associated with a favorable response in approximately 50% of patients [6]. The Treatment modality of Trigeminal Neuralgia is briefly covered in flow chart 1.



Flow Chart 1: Pharmacotherapeutic and surgical modality for Trigeminal nerve.

Conservative treatments include Peripheral alcohol treatment (repeated alcohol injections can cause local tissue toxicity, inflammation and fibrosis, temporary weakness of the muscles of mastication, and burning alcohol neuritis), botulinum toxin, which eventually needs to be controlled with peripheral neurectomy. Peripheral neurectomy is a simple, low-risk procedure that can be done for all terminal branches of the 3 divisions of the trigeminal nerve [7].

The procedure involves the avulsion of the distal nerve supply of both the partial segment inside the foramina and the soft tissue extensions. Since some peripheral nerves have the potential for self-repair albeit a slow process that may take 3-4 months or even longer and the fact that minor and superficial nerve injuries almost always heal themselves, the need for obliterating the nerve foramina is not to be disregarded. Obliteration of the nerve foramina following peripheral neurectomy is sometimes achieved using placing stainless-steel/Titanium screws or some bone wax in the foramina where the distal sensory nerve endings exit.

This study aims to assess the necessity of obturating the nerve foramina following a peripheral neurectomy procedure and the long-term implications of said elective decision, based on patient quality of life and recurrence rate.

Materials and Methods

This study aims to determine the importance of obturating the nerve foramina after peripheral neurectomy is performed versus if the nerve foramina is left as, it is based on patient quality of life and recurrence rate.

A hospital based clinical study was conducted on patients reporting to the department of Oral and Maxillofacial surgery in Himachal Institute of Dental Sciences in Paonta Sahib with complaint of paroxysmal sharp shooting pain in any region of the face. The study recruited 3 patients, all of whom underwent peripheral neurectomy of affected sensory branches, one patient having his nerve foramina obliterated with Titanium screws, one where the opening of the nerve foramina was left intact.

Study Design

Hospital based clinical study.

Study setting

Department of Oral and Maxillofacial Surgery, Himachal Institute of Dental Sciences, Paonta Sahib.

Study subjects

Age group: 57-65 years of age

Inclusion criteria

Patients with paroxysmal, sharp, shooting pain in infraorbital region or mandible or during palpation of trigger zones. Patients of ASA Type I and Type II category.

Exclusion criteria

Patients with clinical or radiographically detectable lesions, pain attributable to recent trauma, surgery, metabolic disorders,

vascular abnormalities, neoplastic lesions, psychiatric conditions, heart disorders, patients with pacemakers or stents, pregnancy, bleeding disorders, neurological disorders like Bell's palsy, dental pain or patients of ASA Category III, IV or above, individuals with deleterious habits such as alcoholism and tobacco consumption were not part of the study.

Parameters considered

Visual Analogue Scale of between 1-10 (VAS) was used to measure immediate post operative pain, pain after a week of surgery, after 1 month and after 6 months following surgery. Loss of sensation (paresthesia) in the ipsilateral side if any, was noted.

Methodology

Preoperatively routine tests like blood pressure, $SpO_{2,}$ CBC, PT-INR, ESR, HB1Ac and viral load of HIV, HBsAg and HCV was assessed and only those patients with acceptable reports were selected for surgery. During surgery, patients were scrubbed extra orally with Isopropyl alcohol followed by Povidone-Iodine solution, draped. intraorally asepsis performed with Povidone-Iodine scrub and local anesthesia of affected inferior alveolar, the mental nerve and the infraorbital nerve was achieved by 2% Lignocaine solution in 1:80,000 or 1:2,000,00 Adrenaline. Local vasoconstriction and hemostasis were achieved with local infiltrations of anesthetic solution.

For exposure of the Inferior Alveolar nerve and the mental nerve

Incision in the shape of an inverted Y (Ginwala incision) on the anterior border of ramus with external oblique ridge as landmark was given though the mucosa to the level of the periosteum. Medial dissection on the medial border of ramus was carried out by reflecting the periosteum, releasing the temporalis fibers on the posterosuperior aspect with blunt dissection with curved hemostat and the neurovascular bundle entering the mandibular foramen were identified. The inferior alveolar nerve was then isolated and clamped with two curved hemostats and a 3-0 Vicryl suture was used to tag the nerve trunk in between the hemostats. Next, a vestibular incision is made in the premolar region and bluntly dissected through the periosteum to expose the mental foramen when the IAN exits the mandibular canal to supply the soft tissue. The distal segment attached to the flap is detached from the soft tissue and the nerve trunk was then severed near the mandibular foramen using a scalpel, and then the distal hemostat is continuously twisted on its long axis to avulse the IAN segment inside the mandibular canal [8].

The proximal segment is freed and layered suturing is carried out for closure of the flaps. Irrigation was done in the operative site using saline and Povidone-Iodine solution and pressure pack was given.

For exposure of the infraorbital nerve

A vestibular incision is given between the canine and the first premolar and blunt dissection is carried out underneath the muscles and periosteum in the canine fossa to approach the infraorbital foramen where the infraorbital nerve exits the infraorbital canal to supply the soft tissues. Two curved hemostats are clamped in the nerve trunk and the nerve is severed in between the two hemostats and the distal segment is detached from the soft tissues and the proximal segment inside the infraorbital canal is avulsed by twisting the hemostat. Layered closure is done using sutures and the operative site is irrigated and a pressure pack is given.

General patient considerations

Intravenous injection of Dexamethasone and Intramuscular Diclofenac was given postoperatively in all the patients for pain and to reduce the inflammatory response. Patients were recalled after 7 days for suture removal and to record patient response to VAS in respect to post operative pain and paresthesia. They were also recalled after a month and then again 6 months later for follow-up.

In case the foramina are to be obturated

When the nerve segments inside their respective bony canals have been successfully avulsed, a decision to obturate the foramina might be undertaken which the foramina are either obturated using bone wax or are first enlarged using mechanical drilling and covered with titanium bone screws placed.

Case history 1

A 65-year-old male patient, reported to the dept. of Oral and Maxillofacial surgery in Himachal Institute of Dental Sciences in Paonta Sahib 2 years ago with a complaint of sharp, recurring lancinating pain in his left side of lower jaw, extending from the chin to the angle of mandible since around 8-9 months. Trigeminal

neuralgia of left inferior alveolar nerve along with the mental branch was suspected based on verbal description of the symptoms and palpating for trigger zones. He was put on a therapeutic dose of Carbamazepine. His condition did not improve even after gradual increase in drug dosage. Medication was discontinued abruptly and peripheral neurectomy of left inferior alveolar nerve and the mental nerve under local anesthesia was planned.

Figure 2: Extra-oral and intra-oral photographs of patient 1.

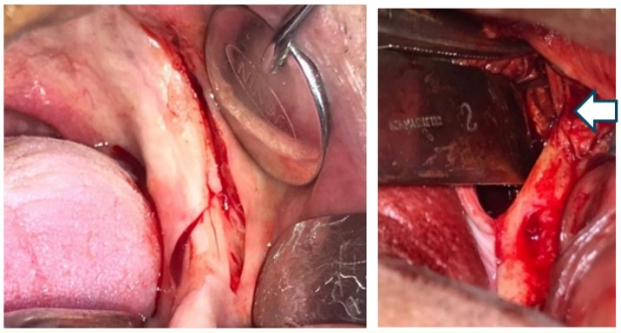


Figure 3: Ginwala Incision placed over the anterior border of ramus of the mandible and dissection to expose the inferior alveolar neurovascular bundle (white arrow).

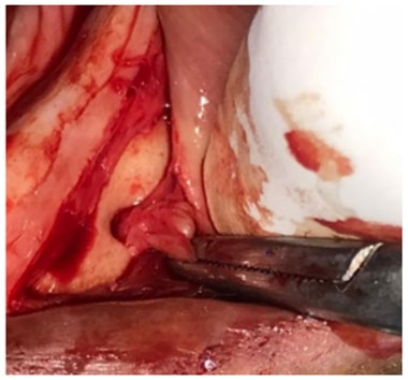


Figure 4: Premolar Vestibular approach for the mental nerve. Mental nerve extraosseous ending clamped for maneuvering the nerve bundle.

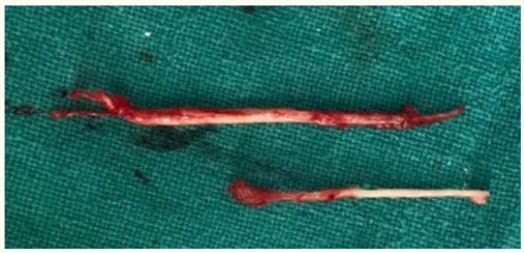


Figure 5: The avulsed nerve in the mandibular canal and the mental nerve respectively.

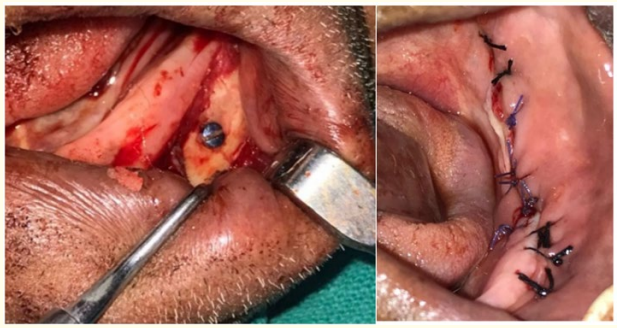


Figure 6: The mental foramen obturated using Titanium screw and the mandibular incision closed in layers.

Case history 2

A 57-year-old male patient named arrived at the department of Oral and Maxillofacial Surgery in Himachal Institute of Dental Sciences, Paonta Sahib with chief complaint of stabbing, lancinating pain in the upper right face below the eye from the past 1 year.

Patient had been previously treated conservatively in the form of nonsteroidal analgesics and eventually carbamazepine since around 6 months earlier. The patient did find some relief initially for about a month before noticing little effect of medicines for his pain. Manual examination revealed a suspicion of affected right infraorbital nerve. Peripheral neurectomy was eventually planned.

Figure 7: Vestibular incision to expose the right infraorbital nerve. Dissection carried out to expose the infraorbital nerve.

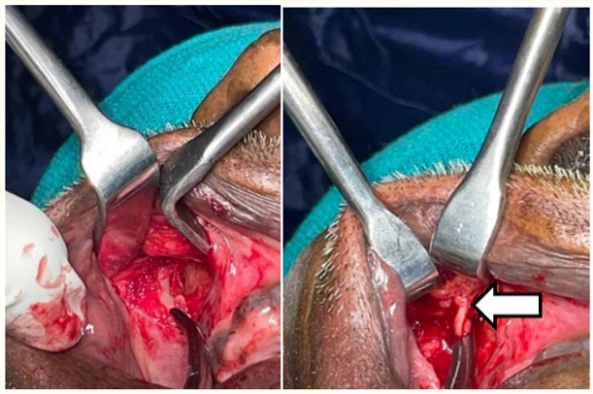


Figure 8: Infraorbital nerve exposed and clamped. Infraorbital nerve being avulsed using a curved hemostat.

Figure 9: The infraorbital canal left open after the nerve has been avulsed.

Case history 3

A 60-year-old female patient reported to the dept. of Oral and Maxillofacial Surgery, Himachal Institute of Dental Sciences, Paonta Sahib with complaint of stabbing and lancinating pain in the left side of lower jaw since a year. The pain was aggravated on eating, touching her face, while washing her face. On clinical examination, Trigeminal Neuralgia of left Inferior Alveolar Nerve was diagnosed. She was previously on medication such as carbamazepine but showed no improvement in her symptoms. Peripheral Neurectomy was suggested to her.

Figure 10: Extraoral and intraoral photographs of patient 3.

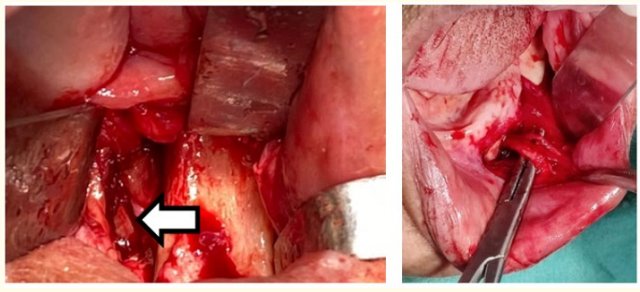


Figure 11: Exposure of Inferior Alveolar nerve (white arrow) and Mental Nerve.

Figure 12: Avulsed mental nerve and Inferior Alveolar and respectively (length compared side by side with a standard pair of tweezers).

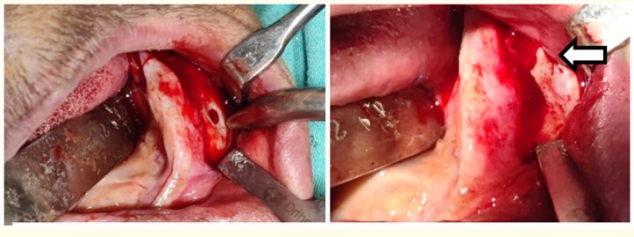


Figure 13: Exposed mental foramen. Mental foramen obturated with bone wax (white arrow).

Figure 14: Closure done using 3-0 Vicryl + silk sutures.

Results and Discussion

Results

All three patients were evaluated post-operatively after 7 days for suture removal, where healing as well as immediate post-operative expectations were verified like pain reduction (through VAS), loss of sensation, numbness and improved quality of life. The patients were recalled at intervals of 1 month and 6 months post-operatively.

Patient 1 reported after 7 days with immediate post operative complications and loss of trigger points that aggravated the pain. There was numbness in the areas supplied by the avulsed nerves but overall, he has satisfied that the debilitating pain was no more. His verdict was the same even after 1 and 6 months where recurrence was not noted. His VAS score was 6 after seven days, 8 after one a month and 9 after 6 months.

Patient 2 was satisfied with outcome of surgery after 7 days and had no post-operative complications, even after a period of 1 month. Although he started noticing some pain but only when his trigger points were aggravated after a period of 6 months. His VAS score was 7 after seven days, 7 after one month and 5 after 6 months.

Patient 3 was satisfied after 7 days post-operatively with no post-operative complications and she was doing well even after a month or two. 6 months ago, she started to complain of debilitating pain that was of comparable intensity to before the surgery. Her VAS score was 8 after one week, 8 after a month and 3 after 6 months.

Discussion

Trigeminal neuralgia is one of the most debilitating neurosensory diseases of the face, about 1,00,000 people reporting of the disease every year [9]. Carbamazepine, introduced in 1962 still remains one of the most prescribed drugs for the treatment of trigeminal neuralgia. Other drugs like Gabapentin, Pregabalins and Dilantin sodium are also considered effective alternates. No patient should be suggested a surgical solution unless conservative drug therapies have been implemented with little to no benefits first. Since long term therapy with carbamazepine can lead to serious side effects such as, (i) development of resistance and intolerance, ii) drowsiness, (iii) vertigo, (iv) nausea and serious consequences like (i) hemopoietic depression (ii) aplastic anemia (iii) abnormalities in liver functions [10], alternate and more radical procedures have surfaced throughout the years.

Currently available surgical options are, (1) Non-invasive techniques like: (a) peripheral neurectomy, (b) alcohol injections, (c) cryotherapy, (d) selective radio frequency thermocoagulation or (2) Invasive techniques like: (i) open microvascular decompression, (ii) percutaneous: (a) radiofrequency rhizotomy, (b) retrogasserian glycerol rhizotomy, (c) balloon compression of trigeminal nerve, (d) stereo static radiosurgery-gamma knife.

Peripheral neurectomy was done for the first time in 18th century with limited success. By dividing or avulsing a peripheral branch of the trigeminal nerve, the maxillofacial surgeon can achieve an exact, complete and long-lasting effect. Peripheral neurectomy can be done on the supraorbital and supratrochlear/ Infratrochlear/ lacrimal nerves, the infraorbital nerve and the inferior alveolar, lingual and mental nerves. This surgery can be carried out as an outpatient procedure under local anesthesia in elderly and debilitated patients who are at an increased risk for undergoing invasive neurosurgical procedures. It is also useful in patients, reluctant for major neurosurgeries, and patients in rural places where facilities for advanced neurosurgical procedures are not available. As many patients and maxillofacial surgeons prefer this treatment owing to an advantage of minimum risk of morbidity, peripheral neurectomy has found its role in the treatment of trigeminal neuralgia.

Peripheral neurectomies are definitely a better choice over peripheral nerve blocks with alcohol or phenol because the latter poses greater disadvantages like local tissue toxicity, inflammation, fibrosis and burning alcohol neuritis. Partial pain relief was seen with botulinum toxin; however, the cost of botulinum toxin is prohibitive in rural practice. The diagnosis in our study was based on a detailed history, clinical examination and control of pain by carbamazepine. All our patients were taking carbamazepine average 600-1200 mg/day for at least 2 years and had become refractory to carbamazepine therapy. Magnetic resonance imaging was not done in our study as the study was done in rural set-up, which lacks the advanced diagnostic imaging services and cost affordability was a factor too. Magnetic resonance imaging (MRI) may be useful in discovering underlying pathosis, associated with trigeminal neuralgia if patients have failed to respond to an initial conservative treatment. The patients, most likely to exhibit significant magnetic imaging resonance findings, are young and with pain in more than one trigeminal branch [11]. Further Study by Darlow., *et al*. recommended the use of MRI only in patients in whom a trial of standard medications has been unsuccessful or in those who have atypical symptoms like (bilateral or uncommon distribution, longer than usual pain duration) to investigate whether demyelination, vascular compression or a tumor is the cause of the pain. Recent guidelines issued by the American Academy of Neurology (AAN) and European Federation of Neurological Societies (EFNS) have failed to find sufficient evidence to support or refute the fact that the presence of a neurocompression is the cause of Trigeminal Neuralgia [12]. Reviews on neurectomies and obturation of foramen with fat, titanium screws, gold foils, silicone are being published in oral and maxillofacial surgery literature since 60 yrs. Sung was one of the earliest authors who reported placing gold foil to obturate the foramina.

In our study, the mental foramen was sealed with titanium screw on one patient while the other with bone wax, all readily available and comparatively cheap alternatives, following peripheral neurectomy. In the case where peripheral neurectomies were done with the placement of stainless-steel screw in the foramen, no complaint was presented with the symptoms of pain till date (at the end of 12 months). The purpose of securing the foramen with a screw was to see whether there was change in the pain-free period. We are quite satisfied with the result of placement of stainless screw in the foramen. Hence, by preventing nerve regeneration, the chances of recurrence in terms of time period are reduced. A similar study, done by Mason in (1972), achieved a success rate of 64% at the end of 12 months and 26% at the end of 4th year. Hong-Sai, in (1999), reported a case series of 12 patients with peripheral neurectomies, of which in 4 cases, the infraorbital foramen and mental foramen was obturated with titanium screws with no incidence of recurrence in a period of 4 years.

In the patient where the mental foramen was obturated using bone wax, the relief period lasted about 6 years before the patient started noticing symptoms of pain again with little improvement.

In the other patient where after peripheral neurectomy of infraorbital nerve, the foramen was not obturated, there was some improvement in relieving pain symptoms initially but the symptoms returned after the 6-month follow-up in a less severe form.

In our observation, the role of titanium screw to block the foramen following peripheral neurectomy was significantly

beneficial. Although, the choice of leaving the foramen open and choosing to block the foramen using bone wax should little to no difference in their respective outcomes. Definitely more studies need to be conducted on a larger number of subjects using different methods of obturating the foramen after surgery to slow down the process of nerve regeneration.

In a country like India, where 70% of the population still belongs to the rural areas, peripheral neurectomies is still playing an important role in managing trigeminal neuralgia after more than 100 years. We are of the view that peripheral neurectomies offer temporary benefit although neurosurgery definitely has a role in the treatment of trigeminal neuralgia. Every patient is not medically fit and may not be accessible to good neurosurgical facilities, either due to lack of infrastructure in rural places or due to financial affordability. We observed that many patients in rural areas lead a poor quality of life. Isolation and depression are common among them because of associated excruciating pain. It is common for people suffering from trigeminal neuralgia to have poor oral hygiene along with other concomitant oral diseases because of the avoidance of tooth brushing. It is commonly observed in rural practice that, indiscriminate tooth extractions are done on the affected side without any relief from pain. Many of the patients were taking analgesics before a proper diagnosis could be done. In many of the cases, trigeminal neuralgia had been misdiagnosed by the general dental practitioners as TMJ disorder or sinusitis. All our patients were from rural background where insurance coverage is practically non-existing. Patient follow-up is a herculean task in rural setup because, as the symptoms subside, patients do not come for follow-up. Constant counselling is required. Also, many of these patients are reluctant to undergo advanced major surgical procedures in urban areas, owing to their low standard of living, high costs involved and the distances needed to be travelled. Peripheral neurectomy is a day care procedure that requires minimum armamentarium.

Conclusion

Peripheral neurectomy is a safe and effective procedure for elderly patients, for those patients living in remote and rural places that cannot avail major neurosurgical facilities, and for those patients who are reluctant or systemically contra-indicated for major neurosurgical procedures and where first line of pharma therapeutic interventions has failed.

Bibliography

1. Nidhi Shankar Kikkeri and Shivaraj Nagalli. "Trigeminal Neuralgia". *National Library of Medicine (IHS)* (2022).

2. Elie M. Ferneini. "Trigeminal Neuralgia". *Journal of Oral and Maxillofacial Surgery* 79.11 (2021): 2370-2371.

3. Zakrzewska JM., *et al*. "Evaluating the impact of trigeminal neuralgia". *Pain* 158 (2017): 1166-1174.

4. Headache Classification Subcommittee: The international Classification of headache. Disorders. Cephalalgia. (2nd edition) 24 (2004): 16-21.

5. Eder Gambeta., *et al*. "Trigeminal neuralgia: An overview from pathophysiology to pharmacological treatments". *Molecular Pain* 16 (2020): 1-18.

6. Obermann M. "Treatment options in trigeminal neuralgia". *Therapeutic Advances in Neurological Disorders* 3 (2010): 107-115.

7. Ali., *et al*. "Peripheral neurectomies: A treatment option for trigeminal neuralgia in rural practice". *Journal of Neurosciences in Rural Practice* 3.2 (2012): 152.

8. Malik N. "Textbook of Oral and Maxillofacial Surgery". New Delhi, India: JP Brother Medical Publishers (2008): 685-697.

9. MacDonald BK., *et al*. "The incidence and lifetime prevalence of neurological disorders in a prospective community-based study in the UK". *Brain* 123.Pt 4 (2000): 665-676.

10. Loh HS., *et al*. "Trigeminal neuralgia- a retrospective survey of a sample of patients in Singapore and Malaysia". *Australian Dental Journal* 43 (1998): 188-191.

11. Yang J., *et al*. "Magnetic resonance imaging used to assess patients with trigeminal neuralgia". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 81 (1996): 343-350.

12. Gronseth G., *et al*. "Practice Parameter: The diagnostic evaluation and treatment of trigeminal neuralgia (an evidence-based review): Report of the quality Standards Subcommittee of the American Academy of Neurology and the European federation of Neurological Societies". *Neurology* 71 (2008): 1183-1190.