# Neural Blockade for Trigeminal Neuralgia

11

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**Key Points**

- Review the history and epidemiology of trigeminal neuralgia.
- Highlight the clinical manifestations of trigeminal neuralgia.
- Review relevant anatomy of the trigeminal nerve and ganglion.
- Summarize the current treatment modalities and their effectiveness.
- Discuss neural blockade of the trigeminal nerve and ganglion and its application.
- Review potential complications of different invasive modalities.

## Historical Background

The first case report of trigeminal neuralgia (TN) dates back to 1671, where it proved fatal to the unfortunate Johannes Laurentius Bausch, a physician. Later works by Nicolaus Andre, John Fothergill, and Charles Bell established "tic douloureux" as a disorder of the trigeminal nerve [1, 2]. In ancient times, facial pain was described by the Arabic physician Ibn Sina (980–1073). The description of interventional therapy dates back to 1677 when Locke applied sulfuric acid to the face of the Duchess of Northumberland to treat her facial pain [3].

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The incidence of trigeminal neuralgia is estimated at 4–5 in 100,000 [4] with more prevalence in women (ratio of 1:1.5) [5]. It is the most common form of facial pain in people older than 50 years of age, and its highest incidence occurs in the ages between 50 and 70 years [3]. Described by Peter Jannetta as "the worst pain in the world," its presentation and management continues to present a challenge to modern-day medicine. In this chapter, the authors will review the current nonsurgical invasive modalities used to treat trigeminal neuralgia, placing an emphasis on proper diagnosis which is key for success.

## The Clinical Syndrome

### Clinical Manifestations

Trigeminal neuralgia pain is a neuropathic pain located in the distribution of the trigeminal nerve or cranial nerve V. It is classically described as sharp, stabbing, lancinating, electric shock-like, short lasting, intermittent and variable, and almost always unilateral. It is often so intense as to interfere with daily routines, speaking, or even eating. Pain can occur spontaneously, or can be triggered by movement or touching of the face or mouth. Therefore, patients typically avoid touching that area of their face, shaving, and chewing. Eating habits are affected, and often patients report weight loss. The fore mentioned avoidance is a valuable clue to diagnosis. In other facial pain syndromes, the opposite occurs: Patients tend to rub or massage the painful area of their face [6].

A typical attack lasts for seconds and is followed by a refractory period, a period of relief that lasts for seconds, minutes, or even hours. Any of the three branches of the trigeminal nerve may be affected. Typically, the neurologic examination is either normal or demonstrates a subtle decrease in sensation in the affected distribution, perhaps including suppression of the ipsilateral corneal reflex.

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**Table 11.1** Differential diagnosis of trigeminal neuralgia

| Differential diagnosis of trigeminal neuralgia | | |
|---|---|---|
| | Primary clinical characteristics | Mimicking characteristics |
| Glossopharyngeal neuralgia | Severe transient, stabbing or burning pain in the ear, base of the tongue, jaw, and tonsillar fossa | Pain in facial area; triggers can be chewing, swallowing, talking, or coughing |
| Geniculate neuralgia | Impairment of CN-VII sensory part; related to herpes zoster; pain is usually in the different ear structures | Pain may radiate from the ear to the face; has a burning dysesthetic quality |
| Herpetic and postherpetic neuralgia of the trigeminal nerve | Pain is steady and sustained, burning and aching. Often regresses in 2–3 weeks, months in patients older than 70 years of age | The steady pain is accompanied by shooting and sharp pain that radiates and is provoked by mechanical stimuli |
| Herpetic and postherpetic neuralgia of the cervical dorsal root ganglia | Steady pain in face, ear, and occiput | Facial pain, unilateral |
| Occipital neuralgia | Pain radiates following the greater occipital nerve distribution to the frontal region | Burning, unilateral pain that can radiate to the forehead, mimicking ophthalmic distribution of the trigeminal nerve |
| Atypical facial pain | Continuous aching or burning pain; unilateral or bilateral | Burning facial pain; may follow the nerve branches distribution; infrequently exacerbated by eating/talking |
| Rare disorders, that is, Raeder syndrome, trigeminal nerve neuritis from tumors, and other diseases | Usually Horner syndrome without anhidrosis | Sudden onset severe frontotemporal burning; often in periorbital or trigeminal distribution |
| Others: dental pathology, ear, nose, and throat; cluster or migraine headaches; temporomandibular joint syndrome | Variable presentations and patterns | Can mimic trigeminal neuralgia |

## Differential Diagnosis

The etiology of trigeminal neuralgia is not fully understood. Abnormality of the trigeminal nerve myelin sheet has been described but not agreed upon [7]. Trigeminal neuralgia is divided into primary or idiopathic and secondary where a compressive etiology is identified such as a vascular structure or tumors, or a disease etiology such as multiple sclerosis. Establishing a diagnosis of trigeminal neuralgia is instrumental to a successful management strategy especially if surgical or invasive interventions are being considered. Pathognomonic criteria for diagnosis include paroxysmal pain that lasts from a fraction of a second to 2 min and pain characterized as intense, sharp, stabbing, and precipitated by trigger factors. Table 11.1 lists facial pain syndromes that could share some of the clinical manifestations of trigeminal neuralgia. The authors cannot stress enough the importance of establishing a firm diagnosis prior to proceeding to management, especially invasive modalities. A false-positive diagnosis will not only lead to failure of treatment but to possible non-indicated invasive treatments that carries potential morbidity and mortality (Table 11.1).

## The Gasserian Ganglion

### Anatomy

Studying the gross and neuroanatomy of the trigeminal nerve is an essential task prior to neural blockade. The trigeminal nerve has both sensory and motor fibers. Visceral efferent fibers contribute to innervate some muscles of mastication and facial expression. Through its somatic afferent fibers, the trigeminal nerve transmits nociception, light touch, and temperature sensation from the skin of the face, teeth, anterior two thirds of the tongue, the nose, and oral cavity mucosa. Figure 11.1 shows the three branches of the trigeminal nerve (ophthalmic, maxillary, and mandibular).

The gasserian ganglion, also known as the trigeminal ganglion or the semilunar ganglion, sits in an invagination of the dura mater of the posterior cranial fossa, known as Meckel's cave (Fig. 11.1). Injection of local anesthetic in Meckel's cave, which contains cerebrospinal fluid, can potentially lead to total spinal anesthesia or spread to other cranial nerves. Its three sensory divisions, the ophthalmic (V1), maxillary (V2), and mandibular (V3), divide and exit anteriorly as shown in

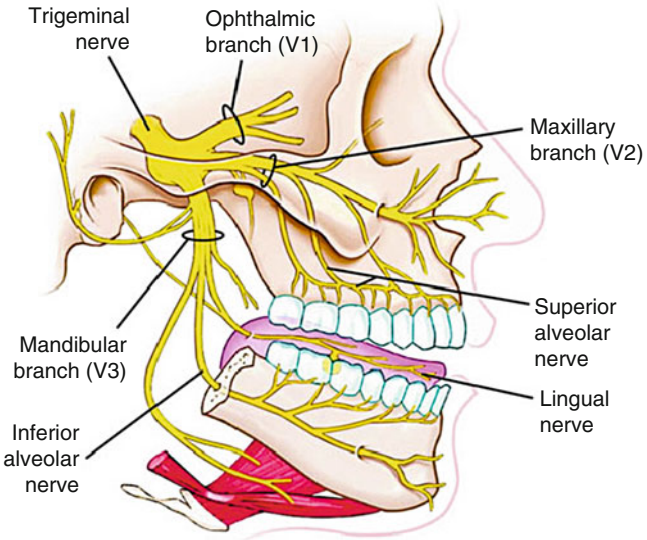


**Fig. 11.1** The division of the three branches of the trigeminal nerve after exiting the middle cranial fossa (Copyright Elsevier)

Fig. 11.1. The mandibular branch exiting through the foramen ovale has clinical applications as the reader will see in this chapter.

Blockade of the gasserian ganglion has been applied as surgical anesthetic for procedures of the head and neck in very limited instances. More commonly, it is used as a treatment for trigeminal neuralgia after failure of conservative therapy and also for cancer pain involving the face. Trigeminal ganglion neurolysis has been effective when oral therapy fails. The palliation of cancer-related pain arising from direct nerve involvement or surgical trauma has successfully been accomplished through blockade of the trigeminal ganglion or its divisions. Neurolysis of the trigeminal ganglion relieves cluster headaches refractory to oral therapy [8–12] and intractable atypical facial pain [13, 14].

## Techniques for Gasserian Ganglion Blockade

To decrease the chances of adverse events, the use of radiological guidance such as computed tomography [15], fluoroscopy [16], or ultrasonography [17] along with a blunt-tipped curved needle is highly recommended. The blockade of the trigeminal ganglion has been performed without radiological guidance in the past but is not advisable. Those measures not only increase patient's safety but also improve the access to the main anatomical landmark, the foramen ovale.

The patient is placed in a supine position with the head slightly extended. Facial skin is sterilely prepped. It is recommended that conscious sedation be administered for patient comfort with blood pressure, pulse oximetry, and electrocardiogram monitoring. Fluoroscopic x-ray guidance is used. The skin entry site is usually located approximately 2–3 cm lateral to the commissural labialis (the corner of the mouth) in a mid-pupillary line. Localization of the foramen ovale is critical to the success of this block. The anteroposterior fluoroscopic view usually shows the petrous ridge through the orbit, and 1 cm medially, it also shows a dip in the petrous ridge. Rotation of the C-arm head obliquely away from the nose approximately 20–30° and approximately 30–35° in the caudo-cranial direction will bring the foramen into view just medial to the mandible and at the top of the petrous "pyramid." Lidocaine 1 % is applied to the skin and subcutaneous tissue over the shadow of the foramen ovale. For a diagnostic local anesthetic block, a 22-g B-bevel needle, 8–10 long, is used (for radiofrequency lesioning, an RFA 10-cm needle with a 2–5-mm active RFA tip is used). The needle is advanced through the entry point toward the foramen ovale, rotating the needle tip as needed to keep it on course initially downward and laterally, then medially aiming for the foramen ovale. To prevent intraoral entry, placement of one finger in the mouth could be done. When bone is encountered, the needle could be walked posteriorly along the skull into the foramen. A lateral view should be obtained, revealing the needle through the foramen ovale in a trajectory superior and toward the medial aspect of the external auditory meatus. A mandibular nerve paresthesia is commonly elicited. It is mandatory to test negative aspiration of cerebrospinal fluid (CSF) confirming that the needle did not penetrate the dura matter. The needle position is confirmed with injection of nonionic water-soluble contrast and negative aspiration of blood and CSF. For diagnostic local anesthetic blockade, small increments of local anesthetic (lidocaine 2 %, bupivacaine 0.5 %, or ropivacaine 0.5 %) are injected for a total of 1 ml. Monitoring the patient is essential to confirm that local anesthetic did not reach the CSF, putting the patient at risk of inadvertent spinal anesthetic and potential respiratory arrest. Figure 11.2 illustrates the trajectory of the needle in correct placement for the gasserian block.

### Chemical Neurolysis

Currently, the most common agent used for neurolysis of the trigeminal ganglion is glycerol [18–24], knowing that phenol [25] and alcohol [26–28] have also been used in the past. A neurolytic solution up to 0.5 ml should be injected in small increments preferably of 0.1 ml to avoid inadvertent spread to structures of the brain stem. For the technique using glycerol, the needle is advanced into the trigeminal cistern and free CSF flow is confirmed. When using a hyperbaric neurolytic agent, the patient should sit with the head tipped forward for 2 h [29]. This maneuver ensures spread of the injectate to the maxillary and mandibular branches, sparing the ophthalmic branch. Acute unilateral total visual loss after gasserian phenol injection has been reported [30].

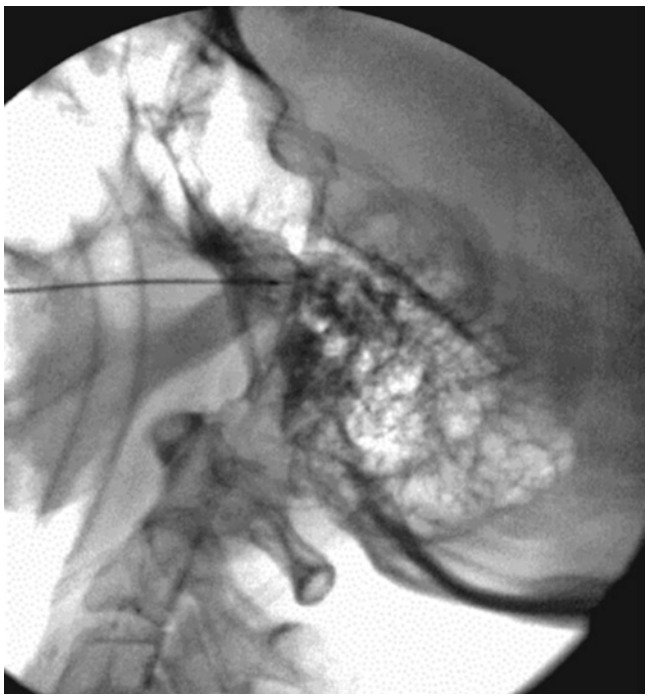

**Fig. 11.2** Lateral fluoroscopic view showing trans-foramen ovale gasserian ganglion block: needle is in position and radio-opaque dye classic spread is shown

### Radiofrequency Ablation

Conventional radiofrequency (RF) neurolysis is performed at temperatures ranging from 60° to 90° centigrade, for duration of 60–90 s. Knowing that the mandibular branch is the only branch carrying motor fibers, motor stimulation at 2 Hz within a range of 0.1–1.5 V will reproduce muscle contraction of the lower mandible. While performing lesioning for V1 or V2, motor stimulation at 2 Hz is not expected to show any muscular contraction. For confirmation of needle position, sensory stimulation at 50 Hz preferably below 0.6 V should precede any treatment. A correct needle position should reproduce a tingling-like sensation or paresthesia in the distribution of the targeted nerve branch. Adjustment of the needle position is performed to optimize desirable sensory patterns prior to any lesioning. Patient alertness and cooperation is of paramount importance: Patient feedback on where the sensation is elicited will help the physician complete the desired block successfully (Fig. 11.2). Understanding the anatomy and how the rootlets of the trigeminal ganglion lay in a superomedial to inferolateral plane is very important: In case of a non-desirable motor response, the practitioner will adjust the needle from a lateral position to a more medial one. Confirmation of negative blood flow should be documented. Up to 0.5 ml of 0.5 % bupivacaine or 0.2 % ropivacaine should be injected prior to RF lesioning to alleviate procedure-related discomfort. If RF lesioning is performed on the 1st branch of the trigeminal nerve (V1), temperature should be limited to 60° to preserve the corneal reflex.

Pulsed radiofrequency [31–34] is another option for neurolysis usually done at 42 °C for 120 s. Even though Erdine et al. [35] could not confirm its effectiveness in this study, it is still being performed with variable results.

## The Trigeminal Nerve Branches: Opthalmic, Maxillary, and Mandibular

### Anatomy

The ophthalmic branch (V1) of the trigeminal branch is a purely sensory branch [36]. It enters the orbit via the superior orbital fissure. In turn, it divides into three branches, the frontal, nasociliary, and lacrimal nerves. The latter two provide innervations to nasal structures and the lacrimal gland, respectively. The supraorbital and the supratrochlear are terminal branches of the frontal nerve: They exit the orbit anteriorly and provide innervations to upper eyelid, forehead, and anterior scalp. As illustrated in the next paragraph, they are clinically most significant of the V1 branches.

The maxillary branch (V2) is also a pure sensory branch [37]. It exits the middle cranial fossa into the pterygopalatine fossa in a horizontal fashion through the foramen rotundum. Then, it passes through the inferior orbital fissure to the orbit before exiting to the face via the infraorbital foramen. That passage through the four facial compartments lead to the division of the many branches of V2 to four regional groups of branches. Understanding the exit of V2 from the middle cranial fossa to the face simplifies the understanding of its innervations of facial structures (Fig. 11.1). Table 11.2 summarizes the four groups and the facial areas they innervate.

The mandibular nerve is formed by the joining of the large sensory mandibular division of the trigeminal nerve and a small motor nerve root. They both cross the foramen ovale leaving the middle cranial fossa and forming the mandibular nerve [37]. This combined trunk then divides into a small anterior and larger posterior trunk (Fig. 11.1). Prior to this division, it gives off the nervus spinosus, innervating the dura matter and mucosal lining of the mastoid sinus, and the internal pterygoid, innervating the internal pterygoid and sending branches to the otic ganglion.

From the anterior trunk comes the buccinator nerve to innervate the skin and mucous membrane overlying the buccinator muscle. The anterior trunk also gives off three motor branches: the masseteric, deep temporal nerves, and the external pterygoid nerve. They provide motor innervations to the masseter muscle, temporalis muscle, and external pterygoid muscle, respectively.

**Table 11.2** The four regional groups of V2

| The four regional groups of V2 | V2 nerve branches | Facial areas innervated |
|---|---|---|
| 1. Intracranial group | Middle meningeal nerve | The dura matter of the middle cranial fossa |
| 2. Pterygopalatine group | Zygomatic nerve | The temporal and zygomatic region |
| | The sphenopalatine branches | The mucosa of the maxillary sinus, upper molars, upper gums, and the mucous membrane of the cheek |
| 3. Infraorbital canal group | Anterosuperior alveolar branch | Incisors, canines, anterior wall of the maxillary antrum, floor of nasal cavity |
| | Middle superior branch | Premolars |
| 4. Infraorbital facial group | Inferior palpebral branch | Conjunctiva and skin of lower eyelid |
| | External nasal branch | Side of the nose |
| | Superior labial branch | Skin of the upper lip and part of the oral mucosa |

The posterior trunk contains mostly sensory fibers. The following branches come off the posterior trunk: The auriculotemporal nerve provides sensory innervations to the following structures – the tympanic membrane, the lining of the acoustic meatus, the posterior temporomandibular joint, the parotid gland, the skin overlying the temporal region, and the skin anterior to the tragus and helix. The lingual nerve innervates the dorsum and lateral aspects of the anterior 2/3 of the tongue, the lateral mucous membrane, and the sublingual gland. The inferior alveolar nerve innervates the lower teeth and the mandible. Its terminal branch, the mental nerve, innervates the chin and the skin and mucous membrane of the lower lip.

## Blockade of the Ophthalmic Branch

The most commonly blocked branches of V1 are the supraorbital and supratrochlear branches. To block the supraorbital nerve, the patient is placed in a supine position. The landmark for this block, the supraorbital foramen, is palpated along the upper border of the orbit. After skin prepping, with precautions not to spill any disinfecting solution in the eye, a 25-gauge, 1.5-in.-long needle is introduced into the skin through the identified supraorbital foramen in a perpendicular plane to the skin. Some paresthesia is usually elicited; then, 3–4 ml of local anesthetic solution (lidocaine 1–2 %, bupivacaine 0.5 %, or ropivacaine 0.2 %) is injected in a fanlike fashion. Radiofrequency lesioning for the supraorbital nerve as a treatment for postherpetic neuralgia has been described. The technique for radiofrequency lesioning is similar to the local anesthetic block with the exception of using a RFA needle and confirmation of positive sensory response at 2-Hz stimulation in the somatic nerve distribution. To achieve a blockade of the supratrochlear branch of the ophthalmic division, simply direct the needle medially at the level of the supraorbital foramen and repeat similar steps as described above.

## Blockade of the Maxillary and Mandibular Branches

The preferred approach for blockade of the maxillary (V2) and the mandibular (V3) branches of the trigeminal nerve is through the mandibular notch, also known as the coronoid notch. These blocks could be done without radiologic guidance. However, fluoroscopic guidance is highly recommended. Patient is placed in supine position, and the x-ray C arm is placed in a lateral view. The patient is asked to open and close his/her mouth few times if possible to facilitate palpation of the mandibular notch which could be marked. After skin sterilization, the skin is anesthetized with lidocaine 1 %. A 22-g B-bevel needle, 8–10 cm long is used (for radiofrequency lesioning, an RFA needle, 10 cm long, with a 2–5-mm active RFA tip is used). The needle is introduced under fluoroscopic guidance at the site already marked and advanced in a horizontal plane. Fluoroscopic guidance is used to direct the needle tip through the infratemporal fossa (Fig. 11.3). A small-angulation cephalad and slightly posterior will allow the needle to be in proximity to the lateral nasal mucosa taking extreme care not to pierce through it. The end point of the advancement of the needle is the lateral pterygoid plate. If the maxillary nerve is the final target, a slight superior and posterior angulation will elicit paresthesia into this nerve distribution (nose ridge, upper lip, gum, and face). If the mandibular nerve is targeted, a slight caudad and anterior angulation usually elicits paresthesia in its somatic distribution (lower mandible, lower lip, lower jaw, and tongue). If radiofrequency lesioning is planned, sensory testing at 50 Hz should be achieved preferably below 0.6 V in the nerve distribution prior to any treatment. Negative aspiration of blood and CSF should be demonstrated prior to any treatment. Figure 11.4 shows the advancement and final position of the needle. Figure 11.5 shows RF needle in position.

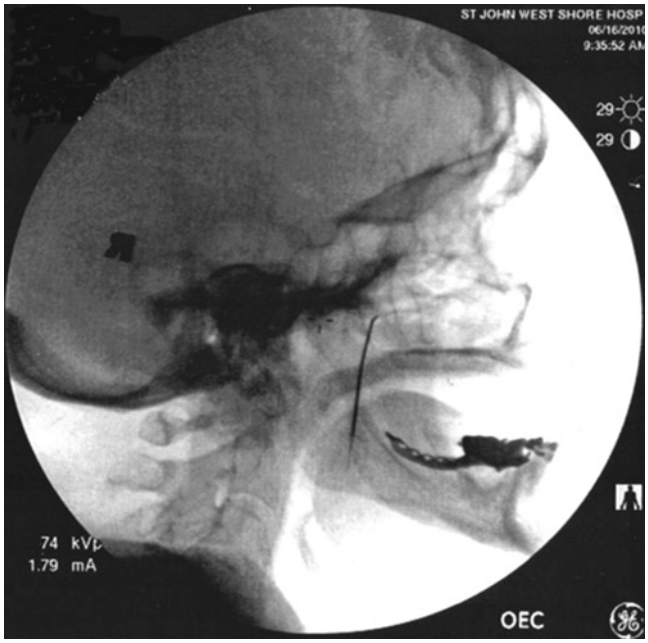


**Fig. 11.3** Lateral fluoroscopic view showing needle though the coronoid notch in position for advancement

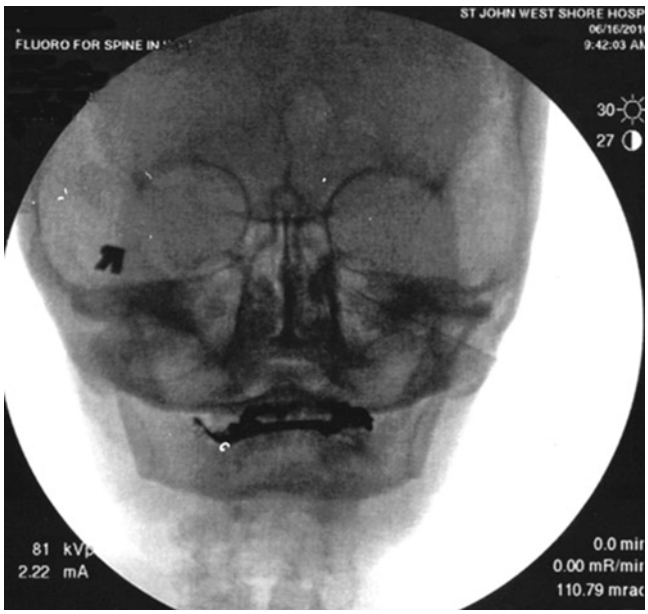


**Fig. 11.4** Anteroposterior fluoroscopic view showing needle advancement for maxillary nerve block

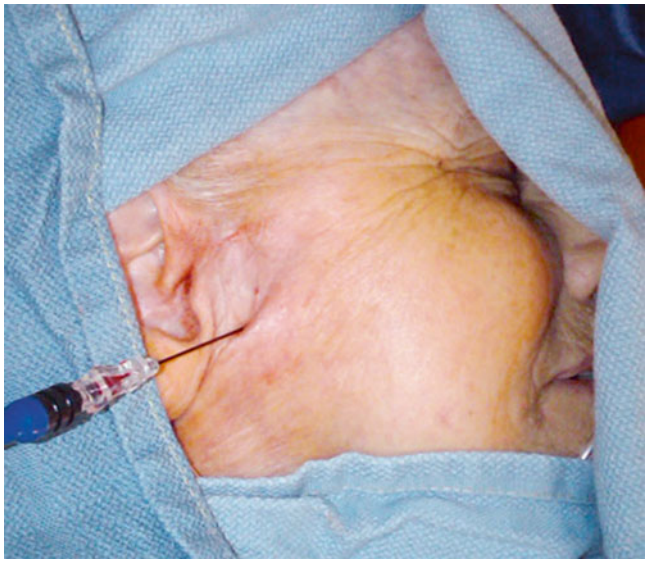

**Fig. 11.5** Final needle placement for radiofrequency lesioning of the maxillary nerve

## Efficacy and Safety

The efficacy and safety of radiofrequency (RF) lesioning for trigeminal neuralgia have been described in the literature. Review of current literature reveals one retrospective uncontrolled chart review [38] and four prospective uncontrolled clinical trials [39–42]. No randomized sham-controlled trials on the value of RF treatment of the trigeminal ganglion have been published. An initial complete pain relief was reported in 83–99 % of patients treated with RF ablation in some studies [39, 40, 43–49]. Repeating the procedure has increased the long-term efficacy in three studies [38, 40, 42]. Kanpolat et al. [38] reviewed the records of 1,600 patients that received percutaneous radiofrequency rhizotomy as a treatment for trigeminal neuralgia. Even though initially up to 97.6 % reported acute pain relief at 5-year follow-up, only 57.7 % reported complete pain relief with a single procedure. This figure reaches 94.2 % for patients receiving multiple procedures. At 10- and 20-year follow-up, the percentage for single procedure was 52.3 % and 41 %, respectively, and for multiple procedures was 94.2 % and 100 %, respectively. The authors concluded that this technique is safe and effective.

Long-term safety from prospective uncontrolled and retrospective clinical studies up to 20 years was demonstrated. Taha and Tew [50] conducted a 15-year prospective study following 154 patients with trigeminal neuralgia treated with percutaneous stereotactic radiofrequency rhizotomy. Initial success was reported at 99 % after a single treatment. Similar results were confirmed in a prospective study by Scrivani et al. following 215 patients with trigeminal neuralgia for 15 years following rhizotomy. They found that patients had pain relief in 92 %. Table 11.3 summarizes the efficacy of RF lesioning for facial pain, trigeminal neuralgia, and headache.

Other retrospective comparative studies examined the safety and efficacy of RF lesioning compared with other established treatment modalities, such as microvascular decompression (MVD), balloon microcompression, glycerol

**Table 11.3** Results of radiofrequency lesioning studies

| Study | Technique | Results (%) | Number of patients | Comments |
|---|---|---|---|---|
| Kanpolat et al. [38] | RF | 41–100 | 1,600 | TN, 20-year follow-up |
| Taha et al. [39] | RF | 99 | 154 | TN, 15-year follow-up |
| Zakrzewska et al. [41] | RF | 36–40 months pain-free | 48 | Chronic facial pain |
| Onofrio [43] | RF | 86 | 140 | Mainly TN |
| Tew et al. [44] | RF | 93 | >100 | TN elderly |
| Sengupta and Stunden [45] | RF | 92 | 39 | TN |
| Piquer et al. [46] | RF | 69 | 98 | TN, 4.5-year follow-up |
| Maxwell [54] | RF | 100 | 8 | Migrainous neuralgia |
| Spincemaille et al. [47] | RF | 85 | 53 | TN, 2-year follow-up |
| Grunert et al. [55] | RF | 92 | 250 | TN |
| Choudhury et al. [56] | RF | 78 | 40 | TN |
| Moraci et al. [48] | RF | 97 | 605 | TN |
| Taha and Tew [11] | RF | 100 | 7 | Cluster HA |
| Yoon et al. [49] | RF | 87 | 81 | TN |
| Scrivani et al. [40] | RF | 83–92 | 215 | TN, 5-year follow-up |

**Table 11.4** Results of studies on gasserian neurolysis with glycerol

| Study | Results (%) | Patient number | Comments |
|---|---|---|---|
| Dieckman et al. [57] | 92 | 55 | TN |
| Spaziante et al. [58] | 94 | 50 | TN |
| Saini [52] | 59–8 | 552 | Follow-up 2–6 years |
| Young [59] | 86 | 162 | TN |
| Burchiel [60] | 80 | 60 | TN |
| Waltz et al. [61] | 80 | 200 | TN |
| Van de Velde et al. [62] | 76 | 20 | TN |
| Ischia et al. [19] | 92 | 112 | TN |
| Borda et al. [63] | 64 | 120 | TN |
| Cappabianca et al. [53] | 93 | 191 | TN |
| Kondziolka et al. [64] | 59 | 53 | With MS 11-year follow-up |
| Linderoth and Hakanson [65] | 90 | 23 | Facial pain |
| Ekbom et al. [8] | 57 | 7 | Cluster HA |
| Pieper et al. [12] | 83 | 18 | Cluster HA |

rhizotomy, partial trigeminal rhizotomy, neurectomy, and alcohol block [50, 51]. Taha and Tew [50], in an extensive review, concluded that the highest rate of recurrence of pain is associated with glycerol rhizotomy. Trigeminal motor dysfunction is highest with balloon compression, while initial pain relief is best achieved with radiofrequency rhizotomy and MVD. Oturai et al. [51] sent questionnaires to 316 patients previously treated over 16 years for trigeminal neuralgia. They reported a success rate of 83 %, 51 %, and 42 %, respectively, after radiofrequency lesioning, neurectomy, and alcohol block. They concluded that radiofrequency lesioning has the highest success when compared to neurectomy and alcohol block. Table 11.4 summarizes studies conducted on the efficacy of glycerol neurolysis. The largest group of patients studied with glycerol neurolysis was reported by Saini [52]. After a single injection, 59 % and 8 % reported pain relief at 2 and 6 years, respectively. The best reported results with glycerol neurolysis were reported by Cappabianca, 93 % success within days of procedures [53].

There are fewer studies that address pulsed radiofrequency lesioning. One randomized controlled study indicates the superiority of conventional RF lesioning over pulsed RF lesioning for the management of idiopathic trigeminal neuralgia [35]. In a trial of 40 patients with trigeminal neuralgia randomized to receive pulsed versus conventional RF lesioning of the trigeminal ganglia, Erdine et al. [35] confirmed the effectiveness of the conventional lesioning. Only 10 % of the pulsed RF group reported

improvement. The authors concluded that pulsed RF lesioning was not an effective treatment for trigeminal neuralgia (Tables 11.3 and 11.4).

## Complications and Side Effects

Complications are expected after neural blockade of the trigeminal nerve and the gasserian ganglion. Prior to any injection involving the trigeminal nerve, patient should be warned about potential common side effects including severe headache, dysesthesia, and significant facial or subscleral hematoma regardless of the technique used. Intravascular injection, more dangerously in the carotid artery, is a devastating complication. In an extensive review comparing results and complications of percutaneous techniques performed as a treatment for trigeminal neuralgia, Taha and Tew reviewed 6,205 cases of RF ablation, 1,217 cases of glycerol injection, and 759 cases of balloon compression [50]. Facial numbness was the most common side effect reported varying between 60 % with glycerol and 98 % with RF. Anesthesia dolorosa was reported in less than 4 % [50, 66, 67]. The incidence of loss of the corneal reflex, ulceration, keratitis, and hypesthesia has all been reported [20, 43, 47, 60–63]. Dysesthesia occurs at the same rate independent of the technique and procedure. Acute unilateral total visual loss after Gasserian ganglion phenol injection has been reported [30]. Rhinorrhea after percutaneous radiofrequency lesioning is reported [68]. Masticatory muscle weakness was reported in many studies and was found to be reversible over time [50, 69–71]. Infection is always a potential complication with any of the techniques used. Due to the proximity to brain stem structures, a potential risk of meningitis is possible and had been reported in 24 out of 7,000 cases reviewed by Sweet [72]. Reactivation of a dormant herpetic infection is reported with the use of different techniques especially after trigeminal balloon compression [73]. Total spinal anesthesia, respiratory arrest, and fracture of the pterygomaxillary fissure are possible. Having mentioned how frequent and intractable some of these complications can be, it is recommended that only providers with adequate training and expertise perform these facial invasive procedures.

## Neuro-Modulation for Trigeminal Neuralgia

With the emergence of neuro-modulation, we have witnessed a shift from neuro-destructive techniques to more neuro-modulatory ones. While deep brain and motor cortex stimulation have been used for treatment of trigeminal neuropathic pain and trigeminal neuralgia, the results are variable and the procedures are very invasive and complex. Attempts to place percutaneous neuro-modulatory electrodes at the gasserian ganglion using the trans-foramen ovale technique are being performed by trained neurosurgeons. However, technical limitations related to migration of electrodes have limited the success of such trials. While it is worthwhile mentioning because of its relatively less-invasive nature, the data on gasserian ganglion stimulation for trigeminal neuralgia is insufficient to recommend it use.

## References


1. Lewy FH. The first authentic case of major trigeminal neuralgia and some comments on the history of the disease. Ann Med Hist. 1938;10:247–50.
2. Stookey B. Differential dorsal root section in the treatment of bilateral trigeminal neuralgia. J Neurosurg. 1955;12(5):501–15.
3. van Kleef M, van Genderen WE, Narouze S, Nurmikko TJ, van Zundert J, Geurts JW, Mekhail N. 1. Trigeminal neuralgia. Pain Pract. 2009;9:252–9.
4. Katusic S, Williams DB, Beard CM, Bergstralh EJ, Kurland LT. Epidemiology and clinical features of idiopathic trigeminal neuralgia and glossopharyngeal neuralgia: similarities and differences, Rochester, Minnesota, 1945–1984. Neuroepidemiology. 1991;10:276–81.
5. Rozen TD. Trigeminal neuralgia and glossopharyngeal neuralgia. Neurol Clin. 2004;22:185–206.
6. Dalessio DJ. Trigeminal neuralgia. A practical approach to treatment. Drugs. 1982;24:248–55.
7. Fisher A, Zakrzewska JM, Patsalos PN. Trigeminal neuralgia: current treatments and future developments. Expert Opin Emerg Drugs. 2003;8:123–43.
8. Ekbom K, Lindgren L, Nilsson BY, Hardebo JE, Waldenlind E. Retro-Gasserian glycerol injection in the treatment of chronic cluster headache. Cephalalgia. 1987;7:21–7.
9. Mathew NT, Hurt W. Percutaneous radiofrequency trigeminal gangliorhizolysis in intractable cluster headache. Headache. 1988; 28:328–31.
10. Hassenbusch SJ, Kunkel RS, Kosmorsky GS, Covington EC, Pillay PK. Trigeminal cisternal injection of glycerol for treatment of chronic intractable cluster headaches. Neurosurgery. 1991;29:504–8.
11. Taha JM, Tew Jr JM. Long-term results of radiofrequency rhizotomy in the treatment of cluster headache. Headache. 1995;35:193–6.
12. Pieper DR, Dickerson J, Hassenbusch SJ. Percutaneous retrogasserian glycerol rhizolysis for treatment of chronic intractable cluster headaches: long-term results. Neurosurgery. 2000;46:363–8.
13. Stechison MT, Brogan M. Transfacial transpterygomaxillary access to foramen rotundum, sphenopalatine ganglion, and the maxillary nerve in the management of atypical facial pain. Skull Base Surg. 1994;4:15–20.
14. Sweet WH. Controlled thermocoagulation of trigeminal ganglion and rootlets for differential destruction of pain fibers: facial pain other than trigeminal neuralgia. Clin Neurosurg. 1976;23:96–102.
15. Koizuka S, Saito S, Sekimoto K, Tobe M, Obata H, Koyama Y. Percutaneous radio-frequency thermocoagulation of the Gasserian ganglion guided by high-speed real-time CT fluoroscopy. Neuroradiology. 2009;51:563–6.
16. Tator CH, Rowed DW. Fluoroscopy of foramen ovale as an aid to thermocoagulation of the Gasserian ganglion; technical note. J Neurosurg. 1976;44:254–7.
17. Tsui BC. Ultrasound imaging to localize foramina for superficial trigeminal nerve block. Can J Anaesth. 2009;56:704–6.
18. Elias M. Glycerol for trigeminal rhizolysis. Clin J Pain. 1997; 13:272.

19. Ischia S, Luzzani A, Polati E. Retrogasserian glycerol injection: a retrospective study of 112 patients. Clin J Pain. 1990;6:291–6.
20. Fujimaki T, Fukushima T, Miyazaki S. Percutaneous retrogasserian glycerol injection in the management of trigeminal neuralgia: long-term follow-up results. J Neurosurg. 1990;73:212–6.
21. Orlandini G. Treatment of trigeminal neuralgia with retrogasserian glycerol injection. Preliminary results. Minerva Anestesiol. 1988;54:525–6.
22. Maksymowicz W. Treatment of trigeminal neuralgia by glycerol gangliolysis of the trigeminal ganglion. Neurol Neurochir Pol. 1987;21:45–8.
23. Igarashi S, Suzuki F, Iwasaki K, Koyama T, Umeda S. Glycerol injection method for trigeminal neuralgia. No Shinkei Geka. 1985;13:267–73.
24. Sindou M, Tatli M. Treatment of trigeminal neuralgia with glycerol injection at the Gasserian ganglion. Neurochirurgie. 2009;55: 211–2.
25. Vasin NI. Methodology for and results of phenol blocks of the Gasserian ganglion in severe forms of facial pains. Vopr Neirokhir. 1973;37:16–22.
26. Longhi P, Graziussi G, Granata F. "Selective" percutaneous alcohol administration to the Gasserian ganglion in the treatment of trigeminal neuralgia. Riv Neurobiol. 1982;28:303–8.
27. Ecker A, Perl T. Selective Gasserian injection for tic douloureux. Technical advances and results. Acta Radiol Diagn (Stockh). 1969;9:38–48.
28. Fava E, Gentilli R. Taste sensitivity of the anterior two thirds of the tongue after alcohol block of the gasserian ganglion. Minerva Anestesiol. 1956;22:407–13.
29. Loar C. Peripheral nervous system pain. In: Raj P, editor. Pain medicine: a comprehensive review. 1st ed. St. Louis: Mosby; 1996. p. 453–60.
30. Aydemir O, Yilmaz T, Onal SA, Celiker U, Erol FS. Acute unilateral total visual loss after retrogasserian phenol injection for the treatment of trigeminal neuralgia: a case report. Orbit. 2006; 25:23–6.
31. van Boxem K, van Eerd M, Brinkhuizen T, Patijn J, van Kleef M, van Zundert J. Radiofrequency and pulsed radiofrequency treatment of chronic pain syndromes: the available evidence. Pain Pract. 2008;8:385–93.
32. Nguyen M, Wilkes D. Pulsed radiofrequency V2 treatment and intranasal sphenopalatine ganglion block: a combination therapy for atypical trigeminal neuralgia. Pain Pract. 2010;10:370–4.
33. Orlandini G. Pulsed percutaneous radiofrequency treatment of the Gasserian ganglion for therapy of trigeminal neuralgia: technical notes, validity of the method and selection of the patients. Pain. 2004;108:297–8.
34. van Zundert J, Brabant S, Van de Kleft E, Vercruyssen A, Van Buyten JP. Pulsed radiofrequency treatment of the Gasserian ganglion in patients with idiopathic trigeminal neuralgia. Pain. 2003;104:449–52.
35. Erdine S, Ozyalcin NS, Cimen A, Celik M, Talu GK, Disci R. Comparison of pulsed radiofrequency with conventional radiofrequency in the treatment of idiopathic trigeminal neuralgia. Eur J Pain. 2007;11:309–13.
36. Neill RS. Head, neck and airway. In: Wildsmith JAW, editor. Principles and practice of regional anesthesia. New York: Churchill Livingston; 1987.
37. Hahn MB, Hahn MB, McQuillan PM. Trigeminal nerve block. In: Regional anesthesia. St-Louis: CV Mosby; 1996.
38. Kanpolat Y, Savas A, Bekar A, Berk C. Percutaneous controlled radiofrequency trigeminal rhizotomy for the treatment of idiopathic trigeminal neuralgia: 25-year experience with 1,600 patients. Neurosurgery. 2001;48:524–32.
39. Taha JM, Tew Jr JM. Buncher CR: a prospective 15-year follow up of 154 consecutive patients with trigeminal neuralgia treated by percutaneous stereotactic radiofrequency thermal rhizotomy. J Neurosurg. 1995;83:989–93.
40. Scrivani SJ, Keith DA, Mathews ES, Kaban LB. Percutaneous stereotactic differential radiofrequency thermal rhizotomy for the treatment of trigeminal neuralgia. J Oral Maxillofac Surg. 1999;57:104–11.
41. Zakrzewska JM, Jassim S, Bulman JS. A prospective, longitudinal study on patients with trigeminal neuralgia who underwent radiofrequency thermocoagulation of the Gasserian ganglion. Pain. 1999;79:51–8.
42. Mathews ES, Scrivani SJ. Percutaneous stereotactic radiofrequency thermal rhizotomy for the treatment of trigeminal neuralgia. Mt Sinai J Med. 2000;67:288–99.
43. Onofrio BM. Radiofrequency percutaneous Gasserian ganglion lesions. Results in 140 patients with trigeminal pain. J Neurosurg. 1975;42:132–9.
44. Tew Jr JM. Lockwood P, Mayfield FH: treatment of trigeminal neuralgia in the aged by a simplified surgical approach (percutaneous electrocoagulation). J Am Geriatr Soc. 1975;23:426–30.
45. Sengupta RP, Stunden RJ. Radiofrequency thermocoagulation of Gasserian ganglion and its rootlets for trigeminal neuralgia. Br Med J. 1977;1:142–3.
46. Piquer J, Joanes V, Roldan P, Barcia-Salorio JL, Masbout G. Long-term results of percutaneous gasserian ganglion lesions. Acta Neurochir Suppl (Wien). 1987;39:139–41.
47. Spincemaille GH, Dingemans W, Lodder J. Percutaneous radiofrequency Gasserian ganglion coagulation in the treatment of trigeminal neuralgia. Clin Neurol Neurosurg. 1985;87:91–4.
48. Moraci A, Buonaiuto C, Punzo A, Parlato C, Amalfi R. Trigeminal neuralgia treated by percutaneous thermocoagulation. Comparative analysis of percutaneous thermocoagulation and other surgical procedures. Neurochirurgia (Stuttg). 1992;35:48–53.
49. Yoon KB, Wiles JR, Miles JB, Nurmikko TJ. Long-term outcome of percutaneous thermocoagulation for trigeminal neuralgia. Anaesthesia. 1999;54:803–8.
50. Taha JM, Tew Jr JM. Comparison of surgical treatments for trigeminal neuralgia: reevaluation of radiofrequency rhizotomy. Neurosurgery. 1996;38:865–71.
51. Oturai AB, Jensen K, Eriksen J, Madsen FF. Neurosurgical treatment of trigeminal neuralgia. A comparative study of alcohol block, neurectomy and electrocoagulation. Ugeskr Laeger. 1998;160: 3909–12.
52. Saini SS. Reterogasserian anhydrous glycerol injection therapy in trigeminal neuralgia: observations in 552 patients. J Neurol Neurosurg Psychiatry. 1987;50:1536–8.
53. Cappabianca P, Spaziante R, Graziussi G, Taglialatela G, Peca C, de Divitiis E. Percutaneous retrogasserian glycerol rhizolysis for treatment of trigeminal neuralgia Technique and results in 191 patients. J Neurosurg Sci. 1995;39:37–45.
54. Maxwell RE. Surgical control of chronic migrainous neuralgia by trigeminal ganglio-rhizolysis. J Neurosurg. 1982;57:459–66.
55. Grunert P, Pendl G, Ozturk E, Ungersbock K, Czech T. Results of electrocoagulation of Gasser's ganglion in 250 patients with idiopathic trigeminal neuralgia. Zentralbl Neurochir. 1988;49: 196–201.
56. Choudhury BK, Pahari S, Acharyya A, Goswami A, Bhattacharyya MK. Percutaneous retrogasserian radiofrequency thermal rhizotomy for trigeminal neuralgia. J Indian Med Assoc. 1991;89: 294–6.
57. Dieckmann G, Veras G, Sogabe K. Retrogasserian glycerol injection or percutaneous stimulation in the treatment of typical and atypical trigeminal pain. Neurol Res. 1987;9:48–9.

58. Spaziante R, Cappabianca P, Peca C, De Divitiis E. Percutaneous retrogasserian glycerol rhizolysis. Observations and results about 50 cases. J Neurosurg Sci. 1987;31:121–8.
59. Young RF. Glycerol rhizolysis for treatment of trigeminal neuralgia. J Neurosurg. 1988;69:39–45.
60. Burchiel KJ. Percutaneous retrogasserian glycerol rhizolysis in the management of trigeminal neuralgia. J Neurosurg. 1988;69: 361–6.
61. Waltz TA, Dalessio DJ, Copeland B, Abbott G. Percutaneous injection of glycerol for the treatment of trigeminal neuralgia. Clin J Pain. 1989;5:195–8.
62. Van de Velde V, Smeets P, Caemaert J, Van de Velde V. Transoval trigeminal cisternography and glycerol injection in trigeminal neuralgia. J Belge Radiol. 1989;72:83–7.
63. Borda L, Doczi T, Tarjanyi J. Treatment of trigeminal neuralgia with glycerin injected into Meckel's cavity. Orv Hetil. 1994;135: 181–4.
64. Kondziolka D, Lunsford LD, Bissonette DJ. Long-term results after glycerol rhizotomy for multiple sclerosis-related trigeminal neuralgia. Can J Neurol Sci. 1994;21:137–40.
65. Linderoth B, Hakanson S. Paroxysmal facial pain in disseminated sclerosis treated by retrogasserian glycerol injection. Acta Neurol Scand. 1989;80:341–6.
66. Burchiel KJ, Steege TD, Howe JF, Loeser JD. Comparison of percutaneous radiofrequency gangliolysis and microvascular decompression for the surgical management of tic douloureux. Neurosurgery. 1981;9:111–9.
67. Broggi G, Franzini A, Lasio G, Giorgi C, Servello D. Long-term results of percutaneous retrogasserian thermorhizotomy for "essential" trigeminal neuralgia: considerations in 1000 consecutive patients. Neurosurgery. 1990;26:783–6.
68. Ugur HC, Savas A, Elhan A, Kanpolat Y. Unanticipated complication of percutaneous radiofrequency trigeminal rhizotomy: rhinorrhea: report of three cases and a cadaver study. Neurosurgery. 2004;54:1522–4.
69. Natarajan M. Percutaneous trigeminal ganglion balloon compression: experience in 40 patients. Neurol India. 2000;48:330–2.
70. Abdennebi B, Bouatta F, Chitti M, Bougatene B. Percutaneous balloon compression of the Gasserian ganglion in trigeminal neuralgia Long-term results in 150 cases. Acta Neurochir (Wien). 1995;136:72–4.
71. Lichtor T, Mullan JF. A 10-year follow-up review of percutaneous microcompression of the trigeminal ganglion. J Neurosurg. 1990; 72:49–54.
72. Sweet WH. Complications of treating trigeminal neuralgia: an analysis of the literature and response to questionaire. In: Rovit RL, Murali R, Janetta PJ, editors. Trigeminal neuralgia. Baltimore: Williams & Wilkins; 1990. p. 251–79.
73. Simms HN, Dunn LT. Herpes zoster of the trigeminal nerve following microvascular decompression. Br J Neurosurg. 2006; 20:423–6.