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Trigeminal Nerve - Anatomy, Testing & Diseases: A Review

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Abstract

Trigeminal nerve (Cranial Nerve V) is one of the largest cranial nerves which is of mixed type i.e. it acts both as a motor and sensory nerve. It primarily supplies muscles of mastication and this function is motor there and it transmits sensory information to the brain from the face, most of the scalp, nasal and oral cavity. Main function of the trigeminal nerve is the sensory innervation from face, sinuses and facial bones e.g. perception of touch or pain. The most important and common syndrome caused by a disorder of trigeminal nerve (Cranial Nerve V) is Trigeminal neuralgia or loss of motor and sensory function throughout the course of this nerve. Trigeminal neuralgia is a condition of neuropathic facial pain and its manifestations can be caused by major neurologic diseases, such as tumors or multiple sclerosis. Pathology regarding trigeminal nerve can be subdivided according to its anatomical location i.e. nucleus, prepontine cistern, Meckel's cave/ cavernous sinus and extracranial as per site involvement in course of nerve. The functional, as well as the physical status of this nerve and its relationship with the ongoing pain, is difficult to obtain. To diagnose the peripheral nerve damage along with the associated neuropathic pain is challenging. Visual analog scales and diaries for pain can be maintained to keep a check over the intensity and frequency of the pain. The diagnostic procedure not only includes the laboratory tests e.g. blood tests, tissue biopsy, and imaging techniques (Radiography, Computed tomography or CT, Magnetic Resonance Imaging or MRI) but also the detailed history, physical examination, and some complementary tests. This can be very useful for the oral and dental professionals as the trigeminal nerve is one of the dominating nerve supplies to the maxilla and mandible along with the surrounding tissue.

Keywords: ***Trigeminal nerve; Trigeminal neuralgia; Neuropathic pain; MRI; CT; Testing; Pathology***

1. Cranial Nerve V (CN V): Trigeminal Nerve

1.1 Anatomy

Trigeminal nerve is the fifth and one of the largest cranial nerves in distribution in head and neck region having an extensive anatomic course. The trigeminal nerve gives three-terminal branches by trifurcating into Ophthalmic, maxillary and mandibular nerve lying distal to the trigeminal ganglion (FIG.1) [1].

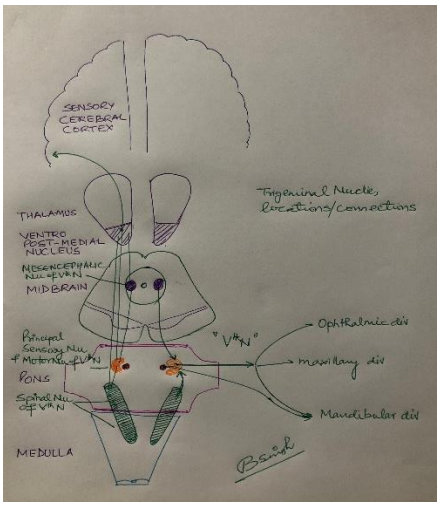

FIG. 1. **Schematic diagram about nuclear components, connections, locations and distribution of trigeminal nerve.**

1.1.1 Ophthalmic division V1

It is the smallest of the three divisions and purely afferent or sensory in function. In the lateral wall of the cavernous sinus, the ophthalmic nerve passes forward and reaches into the orbit via superior orbital fissure. Its divisions supply the lacrimal glands, conjunctiva, ciliary body, cornea, iris, eyeball, eyelid, part of the nasal mucosa, skin of the nose and forehead, sphenoidal sinus, frontal sinus, dura mater of anterior cranial fossa and posterior area of falx cerebri [2].

1.1.2 Maxillary nerve V2

The anterior convexity of trigeminal ganglion gives rise to the maxillary nerve which lies between the ophthalmic and mandibular divisions of the trigeminal nerve. It leaves the base of the skull through foramen rotundum lying inferolateral to cavernous sinus.

It is a medium-sized branch sensory in function, relatively larger to the ophthalmic nerve and smaller to the mandibular nerve. It lies embedded in the lateral wall of the cavernous sinus and passes forward along with the oculomotor nerve, trochlear nerve and ophthalmic division of the trigeminal nerve. It runs inferior and lateral to the ophthalmic nerve. The maxillary nerve communicates with the parasympathetic pterygopalatine ganglion in a bilateral cone-shaped space called the pterygopalatine fossa which lies posterior to the maxilla and gives off most of its branches for distribution. The nerve then leaves the fossa and enters the floor of the orbit through inferior orbital fissure as the infraorbital nerve which is the terminal branch of the maxillary nerve. The infraorbital nerve courses forward, first through the infraorbital groove and then through the infraorbital canal on the floor of the orbit. The infraorbital nerve innervates the upper or maxillary teeth and middle third of the face [3].

Maxillary nerve is purely sensory in function and is responsible to carry pain, temperature and tactile information from the areas above the mouth and below the orbit i.e. lower eyelid, skin covering side of the nose, cheek, maxillary sinus, nasopharynx, nasal cavity, palate, upper teeth, upper lip and dura mater of the middle cranial fossa.

1.1.3 Mandibular Nerve V3

The mandibular nerve is mixed that is both sensory and motor in nature. It arises from three nuclei namely Mesencephalic, principle sensory, and spinal nucleus of trigeminal nerve, and is responsible for giving rise to the larger lateral sensory root of this nerve. The motor root of the nerve arises from one motor nucleus. Before leaving the base of the cranium, the larger sensory root and motor root which runs along the trigeminal cave joins each other. Mandibular nerve enters the infratemporal fossa by exiting through Foramen ovale in the sphenoid bone.

The main trunk gives rise to a meningeal branch which is sensory in function, supplies duramater of middle cranial fossa and a motor branch to the medial pterygoid, which supplies tensor tympani and tensor veli palatini near the base of the skull along with a branch to Otic ganglion related directly to nerve to medial pterygoid.

Then, trunk divides into smaller anterior and larger posterior division. The anterior division is mainly motor and carries efferent fibers supplying muscles of mastication e.g. masseter, temporalis, lateral pterygoid.
The larger posterior trunk is mainly sensory and gives off auriculotemporal nerve wrapping around the medial meningeal artery. This supplies the tissue surrounding auricular and the temporal region along with parotid gland.

The posterior trunk further divides into lingual nerve which supplies sensory innervation to the anterior of the tongue excluding taste perception and inferior alveolar nerve which supplies the motor innervation to the mylohyoid and anterior belly of digastric muscles and sensory innervation to teeth, mucoperiosteum of the teeth as well as to the lower lip [1,4].

1.2 Testing

The diagnosis of damage or testing the function of a nerve is not only a difficult but challenging procedure. Recent advancements in the methodologies for evaluating nerve function has become really helpful.

Quantitative Sensory Testing or QST provides a graded assessment of the pain threshold and sensory detection. Common modalities to test the nerve for any neuropathy includes proprioception for thickly myelinated Aß fibers, cold detection for thinly myelinated Að, and heat detection for unmyelinated fibers [5].

1.3 Sensory

The patient should be made aware of the procedure to test the ability to feel touch or pain on the face. Ask the patient to shut the eyes and then take a piece of cotton or the ball of your finger. The three divisions of the nerve are then touched on either one or both sides.

Using a safety pin, gently prick one side of each division first and then the other. Keep on asking the patient about the change in sensation on one side compared to the other. Both the dull guard and sharp point of the pin is to be used with closed eyes of the patient. Then the patient is asked to describe the sensation.

To test the corneal reflex, the patient is made aware first about the procedure. Take a wisp of cotton and twist it into a point. The patient is asked to look in the opposite direction in order to avoid the blink reflex. At the junction of the cornea with the sclera, touch gently and firmly. It is used to detect the pain as well as to obtain a reflex. Sensitivity to pain increases medially from this point and decreases laterally. The rapid blink of the eye is tested along with a consensual blink of the other eye. If the seventh nerve is weak on the side being tested, you will get a consensual blink [6].

1.4 Motor

The Motor abnormalities are tested as follows

1. The skin over the temporal & masseter muscles is observed. If there is any concavity or asymmetry, if yes this is suggestive of atrophy.
2. Ask the patient to clench his or her jaws by keeping the tip of the mandible in the midline. Palpate the masseter and temporal muscles for asymmetry of volume and for tone.
3. Ask the patient to open the jaws and observe if there is any deviation on the tip of the mandible. If there is any deviation, it suggests the weak side.
4. Ask the patient to move the jaw from side to side against the resistance of your palm. The paralyzed side will not move laterally [6].

For the stretch reflex, ask the patient to keep their jaws half open and relaxed. Then place your index finger on the tip of the mandible and tap your finger gently but briskly with a reflex hammer. Normally this reflex is absent or very week but Reflex closing of mouth is positive and indicates upper motor neuron lesion.

The trigeminal nerve is the afferent portion of a number of valuable reflexes involving the facial nerve [7].

2. Trigeminal Neuropathies

Trigeminal neuropathies (TNs) are disorders that often manifests as skin and mucosal numbness in the region supplied by the trigeminal nerve.

The trigeminal sensory alteration may cause facial numbness. They can be the result of trauma, tumors, or diseases of the connective tissue, infectious or demyelinating diseases. It may also be of some idiopathic origin. The first manifestation of tumor disease can also be reflected by trigeminal neuropathies. A condition where a patient feels decrease sensory perception but when sensation is perceived, it can cause considerable discomfort, is called Hyperesthesia [8].

3. Trigeminal Neuralgia

Trigeminal neuralgia also called **tic doulureux** is a clinical condition characterized by neuropathic pain which is paroxysmal in nature. This pain can have a sudden onset and can last for several minutes. It is throbbing and shock-like pain often affecting a trigger zone. Compression of the trigeminal nerve is supposed to be the most common cause of trigeminal neuralgia. The compression can be due to various reasons e.g. aneurysm, arteriovenous malformation, tumor, and trauma. Treatment of trigeminal neuralgia depends on the etiology. If there is a structure compressing the nerve, surgical resection is

a good option. But before any invasive intervention, pharmacological means need to be preferred due to associated risks of surgery.

The first-line treatment is carbamazepine, and second-line medications include lamotrigine, oxcarbazepine, phenytoin, gabapentin, pregabalin and baclofen [9].

4. Cluster Headache

Cluster headaches can be misinterpreted with trigeminal neuralgia because of a similar presentation. A severe headache affecting one side of the head near the distribution of the trigeminal nerve is a characteristic symptom of Cluster headache. These headaches can be accompanied by other symptoms such as the congested nose, swelling, and lacrimation on the affected side. This is triggered by some external stimulus that causes the onset of symptoms. Prophylactic treatment usually includes a combination of trigger avoidance and pharmacotherapy. Acute attacks can be treated with fast-acting triptans and oxygen [10].

5. Wallenberg Syndrome

Wallenberg syndrome also called Lateral Medullary Syndrome is a condition that occurs when the lateral portion of the medulla in the brainstem gets damaged, often due to stroke. This results in an ipsilateral sensory loss in the territory of the trigeminal nerve and contralateral sensory loss in the rest of the body.

6. Clinical Significance

The lesion associated with the trigeminal nerve can be centrally located as well as peripherally located.

6.1 Central lesions

It includes lesions of the sensory cortex, thalamic lesions, mid pontine lesions, etc. The causes of central lesions can be tumors, vascular lesions, and congenital malformations.

An elevated threshold to pain and temperature is observed on the side opposite the affected side of the sensory cortex. Contralateral hyperpathia and hypesthesia of the face are produced in the case of Thalamic lesions. The mid pontine lesions cause a decrease in tactile sensation of the face. If the lesion involves the spinal tract and nucleus, ipsilateral pain and temperature are lost below the pons.

6.2 Peripheral lesions

It involves the sensory part distal to the pontine of the cranial nerve V. It produces ipsilateral pain and numbness i.e. paraesthesia or anesthesia of varying degrees.

The causes of the peripheral lesions can be:

- **Root lesions of Trigeminal Nerve**: tumors and vascular pathology e.g. cholesteatomas, neurinomas, etc. This can produce facial pain which is often found similar to the signs and symptoms of dental pain or trigeminal neuralgia.
- **Ganglionic lesions**: metastasis of the tumor or infections like herpes zoster can cause these kinds of neuropathies.
- **Peripheral lesions:** can also be caused due to aneurysm of the internal carotid artery, dental trauma, infections of the maxillary sinus, the trauma of the craniofacial region, etc. Some other diseases and syndromes like Sjogren's syndrome, Horners syndrome, lupus, scleroderma, sarcoidosis can lead to sensory neuropathies of the trigeminal nerve [11].

7. Summary

Trigeminal nerve is one of the largest cranial nerves and it is subject to paroxysmal neuropathies. Trigeminal neuralgia, cluster headache, Wallenberg Syndrome are few of the disorders of the trigeminal nerve and are of different origin.

Proper diagnosis and testing for the nerve damage and prophylactic measures can help the recovery. The elaborate course of the nerve, clinical testing, significance and the lesions associated can be very useful for the oral and maxillofacial surgeons.

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