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Cranial Nerve V: The Trigeminal Nerve

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Definition

Sensory

The sensory portion of the trigeminal supplies touch–pain–temperature to the face. The nerve has three divisions: the ophthalmic, maxillary, and mandibular nerves (Figure 61.1). The innervation includes the cornea and conjunctiva of the eye; mucosa of the sinuses, nasal and oral cavities; and dura of the middle, anterior, and part of the posterior cranial fossae. The mandibular division carries the motor portion. The motor portion conveys proprioceptive impulses from the temporomandibular joint.

A lesion of the sensory fibers produces hypesthesia or anesthesia of the area supplied. The corneal reflex is absent when the area of supply is the eye. Proprioception for the temporomandibular joint is absent when there is a lesion of the mandibular division.

Motor

The motor division of the nerve supplies the muscles of mastication: masseter, temporal, pterygoid, mylohyoid, and digastric. These muscles produce elevation, depression, protrusion, retraction, and the side-to-side movements of the mandible. The motor division also supplies the tensor tympani and tensor palati muscles.

The mandible upon opening deviates toward the paralyzed side when there is unilateral paralysis of the masticatory muscles. This direction of the mandible is due to the action of normal pterygoids on the opposite side. The mandible droops, and no jaw movement is possible with bilateral paralysis. The involved muscles atrophy in nuclear or infranuclear lesions.

The jaw jerk is one of the deep tendon or stretch reflexes. When it is normal, tapping the mandible produces a brisk

contraction. When abnormal, with upper motor neuron lesions, there is a hyperactive or repeating reflex (clonus). With nuclear or infranuclear lesions, the reflex is absent.

Technique

Sensory

Tell the patient you are going to test the ability to feel touch or pain on the face. The eyes should be shut. Take a piece of cotton or the ball of your finger. Lightly touch either one or both sides of each of the three divisions of the trigeminal. Ask the patient to show or say whether you touched one or both sides of the face.

Next, take a safety pin and gently prick first one side of each division and then the other, asking the patient if there is any difference in the sensation on one side compared to the other. With the patient's eyes closed, touch sometimes with the sharp point of the pin and at other times with the dull guard. Ask the patient to describe the sensation.

Test the corneal reflex. Begin by telling the patient you are going to touch the eye gently in order to check the reflex. Take a wisp of cotton and twist it into a point. Ask the patient to look in the other direction, so you will not be testing the blink reflex. Then gently but firmly touch the cornea at its junction with the sclera. Sensitivity to pain increases medially from this point and decreases laterally. The junction of the cornea and sclera is a good compromise between causing pain to the patient and obtaining the reflex. There is a rapid blink of the eye being tested and a consensual blink of the other eye. If there is seventh nerve weakness on the side being tested, then observe the consensual reflex.

Motor

Test for motor abnormalities as follows:

1. Observe the skin over the temporal masseter muscles. Concavity or asymmetry suggests atrophy. The tip of the mandible should be in the midline.
2. Ask the patient to clench his or her jaws. Palpate the masseter and temporal muscles for asymmetry of volume and for tone.
3. Observe for deviation of the tip of the mandible as the jaws are opened. Line up a tongue blade with the tip of the nose and the center of the mouth if there is seventh nerve weakness. This maneuver makes it easier to perceive deviation. Deviation is to 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.

For the stretch reflex, demonstrate to the patient what you are going to do. Have the jaws half open and relaxed.

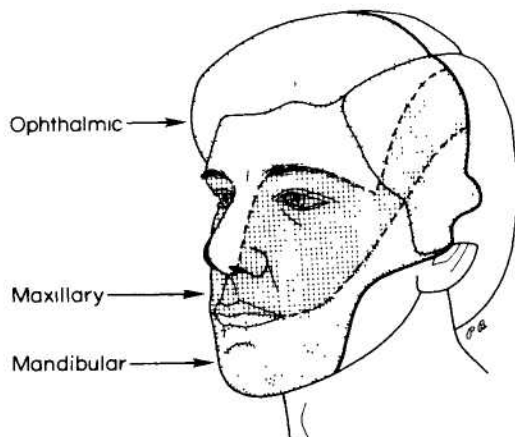


Figure 61.1
Areas supplied by the three sensory divisions of the trigeminal nerve.

Then place your index finger on the tip of the mandible and tap your finger gently but briskly with a reflex hammer.

The trigeminal nerve is the afferent portion of a number of valuable reflexes involving the facial nerve (see Chapter 62 and Table 61.1).

Basic Science

Sensory

The three divisions of the nerve carry pain, temperature, and touch modalities from the skin of the face; the mucosa of sinuses, nose, and mouth; the teeth; and portions of the dura. They convey proprioceptive sensation from the teeth, hard palate, temporomandibular joint, and muscles of mastication. The three divisions are as follows:

1. *Ophthalmic*. Upper division. Innervates forehead, upper eyelid, cornea (thus the corneal reflex), conjunctiva, dorsum of the nose, and dura of some of the anterior cranial fossa. Leaves orbit through the superior orbital fissure. Proceeds through the lateral wall of the cavernous sinus in close relation to the third, fourth, and sixth cranial nerves. Joins other two divisions to form the trigeminal (semilunar, Gasserian) ganglion.
2. *Maxillary*. Supplies upper lip, lateral and posterior portions of nose, upper cheek, anterior temple, mucosa of nose, upper jaw, upper teeth, roof of mouth, and dura of part of the middle cranial fossa. The nerve leaves the pterygopalatine fossa, passes through the foramen rotundum, traverses the inferior part of the cavernous sinus, and enters the trigeminal ganglion.
3. *Mandibular*. Supplies lower lip, chin, posterior cheek, temple, external ear, mucosa of lower part of mouth, anterior two-thirds of the tongue, and portions of the dura of anterior and middle cranial fossae. Proprioceptive impulses are carried largely in the motor nerve, which is incorporated into the mandibular division. It enters the cranium through the foramen ovale and goes to the trigeminal ganglion.

Sympathetic and parasympathetic fibers join the three divisions and are distributed to the pupil, to the nasal mu-

Table 61.1
Location of Central Trigeminal Lesions

Functional loss	Location	Structure(s)
Pain, temperature, touch over entire body, including face ipsilaterally	Lateral rostral pons and above	Spinothalamic ventral trigeminal tracts contralaterally
Masticatory muscle paralysis and pain, temperature, touch over face ipsilaterally	Midpons	Main sensory nucleus, motor nucleus, and entering root fibers ipsilaterally
Pain, temperature over face ipsilaterally; pain, temperature over body (and occasionally face) contralaterally	Lateral inferior pons or lateral medulla	Spinal tract and spinal tract nucleus ipsilaterally; spinothalamic tract and occasionally ventral trigeminal tract contralaterally

cosa causing mucus secretion, to the lacrimal, submaxillary, and sublingual glands, and to the arterioles of the face.

The trigeminal ganglion rests in Meckel's cave, a cavity on the apex of the petrous bone. In this position the ganglion is lateral to the internal carotid artery and the posterior portion of the cavernous sinus. The trigeminal ganglion contains pseudounipolar ganglion cells whose internal branches pass into the pons. These internal branches form the sensory root of the trigeminal, which is analogous to the posterior root of a spinal nerve. The root enters the lateral portion of the middle third of the pons. The branches either bifurcate into ascending and descending arms or ascend or descend without bifurcating. The central processes are distributed to three sensory nuclei (Figure 61.2). Beginning with the lowest or most caudal they are (1) the spinal tract nucleus, (2) the main sensory nucleus, and (3) the mesencephalic nucleus. They are considered below in that order.

The *spinal tract nucleus* (homologous to the most dorsal laminae of the dorsal horn of the spinal cord): pain and temperature. The descending central processes of the sensory root are gathered as a bundle, the spinal tract of the trigeminal nerve. This tract descends to the caudal medulla where it begins to fuse with the dorsolateral tract of Lissauer in the spinal cord. The tract gives off fibers to its nucleus, which lies medial. The nucleus is continuous caudally with the substantia gelatinosa of the spinal cord and rostrally with the main trigeminal sensory nucleus (see below). There is probably a topographical localization of fibers in both the tract and in the nucleus.

The spinal tract and nucleus: pain and temperature. The important clinical principle is that lesions in any of the following locations will give ipsilateral loss of pain and temperature on the face (and of course other findings depending upon location of the lesion): peripheral, nuclear, and sensory root of the trigeminal; pontine or medullary locations that involve the spinal tract and nucleus. The spinothalamic tract from the contralateral half of the body is near the trigeminal tract and nucleus. Therefore it follows that at these levels there can be contralateral loss of body pain and temperature associated with an ipsilateral loss of facial pain and temperature if the lesion is sufficiently large. Vascular lesions of the lower medulla are a frequent cause of this clinical syndrome.

Secondary trigeminal fibers arise from the spinal tract nucleus and cross to the other side. They form the ventral trigeminal tract (VTT). The VTT ascends in close relationship with the contralateral medial lemniscus terminating in the ventral posteromedial (VPM) nucleus of the thalamus.

Cortical projections from the VPM go to the somatosensory areas of the cortex, principally the postcentral gyrus. There is a somatotopical localization.

The *main sensory nucleus* (homologous to the dorsal funiculus of the spinal cord): tactile sensation. The ascending branches of the sensory root end in this nucleus, which lies in the pons adjacent to the entering root fibers. There is a somatotopical organization.

The large majority of ascending fibers from this nucleus cross the brainstem, travel in association with the contralateral medial lemniscus, and end upon the VPM of the thalamus. A smaller group of fibers does not cross but ascends near the periaqueductal gray as the dorsal trigeminal tract. This tract terminates on the ipsilateral VPM. The thalamocortical projections go to the somatosensory areas of the cortex.

The *mesencephalic nucleus*: proprioceptive sensibility. This nucleus is located in the lateral dorsal margin of the central

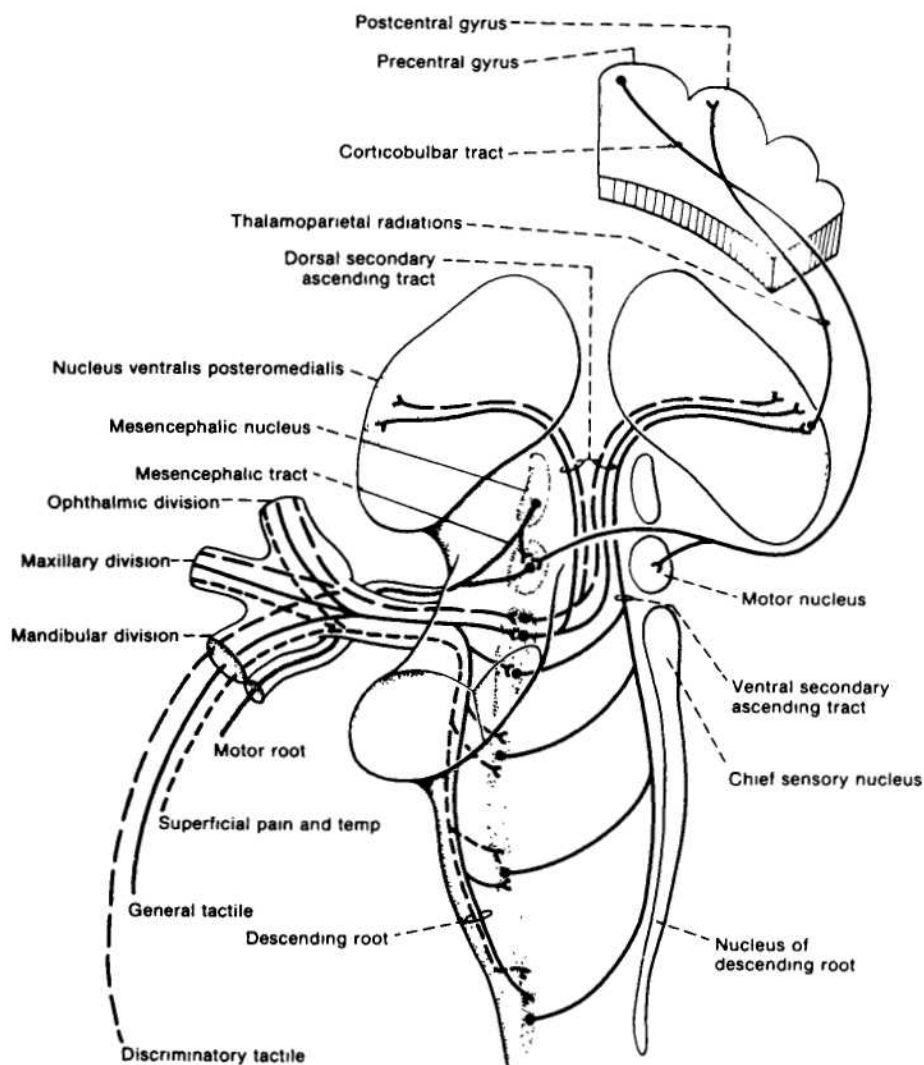


Figure 61.2
The trigeminal nerve and its connections. From DeJong RN. *The neurologic examination*. 4th ed. New York: Harper & Row, 1979. Used with permission.

gray matter lying next to the fourth ventricle. Afferent impulses arise in masticatory muscles, teeth, periodontium, hard palate, and the temporomandibular joint. Most afferent fibers destined for this nucleus appear to travel with the motor root, although some fibers may go with all three divisions of the nerve. The cells of origin of these fibers, unlike those described above, are not in the trigeminal ganglion; they are in the nucleus itself within the brain. This apparently represents an example of a dorsal root ganglion that exists within the substance of the central nervous system.

Most central processes of the cells of this nucleus descend as the mesencephalic tract to the motor nucleus of the fifth nerve. There are, however, other and more complex connections. This nucleus may be concerned with the force of the bite when the source of these proprioceptive impulses and the distribution of the central processes to the motor nucleus are taken into consideration.

Motor

The supranuclear innervation originates in the lower precentral gyrus, with the contralateral contribution larger than the ipsilateral. These fibers, as part of the corticobulbar tract, descend in the genu of the internal capsule, course through the cerebral peduncles, and are distributed to the motor nuclei of the trigeminal nerve.

The motor nucleus lies in the middle of the pons medial to the main sensory nucleus. The fibers leave the pons ventral to the sensory fibers. The motor root lies against the trigeminal ganglion and is incorporated into the mandibular division of the sensory nerve.

When the jaw jerk is performed, muscle spindles are activated as the masticatory muscles are stretched suddenly by tapping on the mandible. These afferent proprioceptive impulses are carried largely in the motor portion of the nerve and end in the mesencephalic nucleus. Collaterals

from this nucleus terminate on the trigeminal motor nucleus thereby setting up a two-neuron reflex arc. (See Chapter 72, Deep Tendon Reflexes.)

Clinical Significance

Peripheral lesions involving the sensory portion of the trigeminal at any point distal to the pontine exit can produce ipsilateral pain and/or varying degrees of anesthesia. The distribution of the lesion will, of course, determine the symptoms and findings. Some of the etiologies are (from Selby, 1984):

1. Peripheral lesions: craniofacial trauma, basilar skull features, dental trauma, maxillary sinusitis, primary or metastatic tumors, aneurysm of the internal carotid artery, cavernous sinus thrombosis, stilbamidine, trichlorethylene, lupus, scleroderma, Sjögren's syndrome, sarcoidosis, probably amyloidosis, and a fairly common idiopathic benign sensory neuropathy. Horner's syndrome can be produced by lesions of the nasociliary nerve as it runs with the ophthalmic division.
2. Lesions of the ganglion: herpes zoster infection, primary and metastatic tumors.
3. Trigeminal root lesions: adjacent tumors and vascular malformations, especially acoustic neurinoma and cholesteatomas. These lesions are prone to produce facial pain that is often misdiagnosed as tic douloureux or tooth pain.

Vascular lesions, tumors, and congenital malformations (syringobulbia and syringomyelia) are the common causes of *central lesions*. Lesions of the sensory cortex will produce a raised threshold (but not anesthesia) to pain and temperature on the opposite side of the face. Thalamic lesions can produce contralateral hypesthesia and hyperpathia of the face. Midpontine lesions, when unilateral, produce ipsilateral decrease in tactile sensation of the face due to involvement of the main sensory nucleus, and ipsilateral paralysis of the masticatory muscles when the motor nucleus is involved. Anesthesia or hypesthesia ipsilaterally is seen if the pontine lesion involves entering sensory root fibers carrying pain and temperature modalities. Below the pons, ipsilateral pain and temperature is lost if the spinal tract and nucleus are involved. When the ventral trigeminal tract carrying crossed pain-temperature fibers is involved, loss of these modalities occurs on the opposite side of the face.

Some helpful generalizations about central trigeminal lesions are given in Table 61.1.

Tic douloureux, or trigeminal neuralgia, is a relatively frequent cause of facial pain. There is a paroxysmal pain of great intensity that involves any or all of the trigeminal division. The pain is more frequent in the maxillary or mandibular division. The pain lasts seconds to minutes and can be set off by a blast of cold or hot air, shaving, combing the hair, or similar stimulus. There are no objective findings such as anesthesia. The etiology is unknown. For years there was disagreement about whether the pain originated centrally or peripherally. Electron microscopic observations of pathologic changes in the trigeminal ganglion in recent years are suggestive of ganglionic origin. One current suggestion is that adjacent arteries compress the ganglion (Haines et al., 1980).

The motor nerve as it runs with the mandibular division can be damaged by the lesions listed above. Clinically there is atrophy and flaccid paralysis of the muscles of mastication. In unilateral paralysis, as the mandible opens it will swing to the paralyzed side due to the action of the normal opposite external pterygoid. Bilateral paralysis with dropping of the mandible is rare. Spasm of the masticatory muscles is seen with tetanus and strychnine poisoning.

References

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