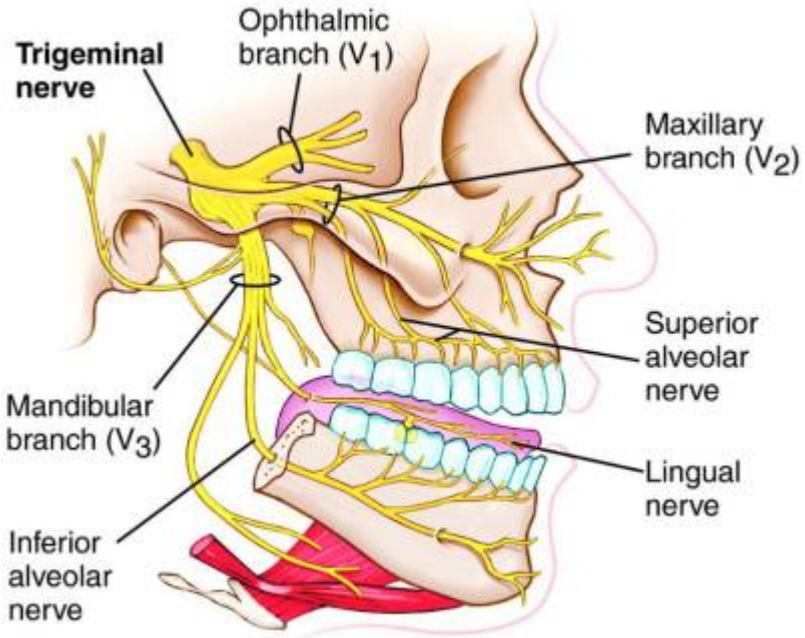
Trigeminal nerve



Johann Friedrich Meckel made the first description of the subarachnoid space investing the trigeminal nerve into the middle fossa.

Possible pathways for facial pain include: trigeminal nerve (portio major as well as portio minor (motor root).

Supratentorial sensory perception, including facial pain, is subserved by the trigeminal nerve, in particular, by the branches of its ophthalmic nerve, which provide an extensive innervation of the dura mater and of the major brain blood vessels. In addition, contrary to previous assumptions, studies on awake patients during surgery have demonstrated that the mechanical stimulation of the pia mater and small cerebral vessels can also produce pain. The trigeminovascular system, located at the interface between the nervous and vascular systems, is therefore perfectly positioned to detect sensory inputs and influence blood flow regulation. Despite the fact that it remains only partially understood, the trigeminovascular system is most probably involved in several pathologies, including very frequent ones such as migraine, or other severe conditions, such as subarachnoid hemorrhage. The incomplete knowledge about the exact roles of the trigeminal system in headache, blood flow regulation, Blood-brain Barrier Permeability, and trigemino-cardiac reflex warrants for an increased investigation of the anatomy and physiology of the trigeminal system [1].

Anatomy

The trigeminal nerve complex is a very important and somewhat unique component of the nervous system. It is responsible for the sensory signals that arise from the most part of the face, mouth, nose, meninges, and facial muscles, and also for the motor commands carried to the masticatory muscles. These signals travel through a very complex set of structures: dermal receptors, trigeminal

branches, Gasserian ganglion, central nuclei, and thalamus, finally reaching the cerebral cortex. Other neural structures participate, directly or indirectly, in the transmission and modulation of the signals, especially the nociceptive ones; these include vagus nerve, sphenopalatine ganglion, occipital nerves, cervical spinal cord, periaqueductal gray matter, hypothalamus, and motor cortex. But not all stimuli transmitted through the trigeminal system are perceivable. There is a constant selection and modulation of the signals, with either suppression or potentiation of the impulses. As a result, either normal sensory perceptions are elicited or erratic painful sensations are created [2)].

Originating in the posterior fossa of the brain stem, it follows a long and complex course towards its distribution territory, crossing several regions with a complex anatomy and establishing important relationships with several structures.

The nerve fibers originate in the brainstem and are part of several grey matter nuclei occupying all the brainstem and even the first spinal cervical segments.

Each of these sensitive and motor nuclei represents different processing centers, and there is a true systematization of the information this nervous tract is responsible for conducting.

The sensitive nucleus is the largest, comprising 3 true sub-nuclei, each responsible for each aspect of the general sensitivity. The highest is the mesencephalic nucleus, located in the tegmentum close to the midline and to the grey matter close to the Sylvian aqueduct. The neurons that form this nucleus are in charge of the propioceptive integration in the Vth nerve territory, high level information for correct mastication. The main nucleus is in the pons, it is also situated in the depth of the tegmentum, and is responsible for the tactile integration of the territory of this nerve. Finally, the inferior nucleus occupies the tegmentum of the medulla, extending caudally to the first segments of the cervical spine, and is in charge of thermal and pain information. Its location explains the possible appearance of symptoms in the facial territory in patients with a degenerative/inflammatory disorder of the upper cervical spine. There is one single motor nucleus, located in the pons tegmentum supplying mastication muscles, and is correspondingly called mastication nucleus. The fibers related with all these nuclei gather in the pons and emerge through the lateral sector of its anterior aspect, forming a thick nervous tract with two roots: a thicker and lateral sensitive root and a thinner more medial motor root.

The only intra-axial segment of the Vth ends there and initiates its long course to its distribution territory; it is formed by different sub-segments before dividing itself into its terminal branches (the cisternal and Gasserian or transdural segments).

The point where the roots emerge in the brainstem is called “REZ” (Root Entry Zone), an anatomical landmark of great functional hierarchy.

Trigeminal nerve cisternal portion

see Trigeminal nerve cisternal portion.

Branches

The trigeminal nerve as the name indicates is composed of three large branches. They are the

ophthalmic nerve (V1, sensory), maxillary nerve (V2, sensory), and mandibular nerve (V3, motor and sensory) branches. The large sensory root and smaller motor root leave the brainstem at the mid-lateral surface of the pons.

Anatomical variations can occasionally result in unexpected findings on physical examination. McDonough et al. reported two cases of seemingly unique connections between maxillary nerve (V2, sensory) and mandibular nerve (V3, motor and sensory) branches parts of the trigeminal nerve. In these two cadaveric specimens, at the foramen ovale, small neural connections, confirmed with histology, were identified joining V2 to specifically, the motor root of V3 [3)].

Function

The trigeminal nerve (the fifth cranial nerve, or simply CN V) is a nerve responsible for sensation in the face and certain motor functions such as biting and chewing. It is the largest of the cranial nerves. Its name (“trigeminal” = tri- or three, and -geminus or twin, or thrice twinned) derives from the fact that each trigeminal nerve, one on each side of the pons, has three major branches: the ophthalmic nerve (V1), the maxillary nerve (V2), and the mandibular nerve (V3). The ophthalmic and maxillary nerves are purely sensory. The mandibular nerve has both cutaneous and motor functions.

Sensory information from the face and body is processed by parallel pathways in the central nervous system. The motor division of the trigeminal nerve is derived from the basal plate of the embryonic pons, while the sensory division originates from the cranial neural crest.

Trigeminal nerve sensory pathways

see Trigeminal nerve sensory pathways.

Trigeminal nerve-related pathology

Trigeminal nerve-related pathology.

Imaging

see Trigeminal nerve imaging.

References

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3)
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