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Facial nerve: embryology and anatomy of its nucleus

Abstract

Introduction: The facial nerve is one of the twelve cranial nerves, specifically the seventh cranial nerve. Although its function is primarily motor it also has sensory and parasympathetic functions.

Embryology of the facial nerve: The development of the facial nerve begins in the third week, it becomes the nerve of the second branchial arch. By the fifth week, the intermediate nerve appears. In the seventh week, the other branches of the facial nerve appear. The facial muscles that have been formed, must be innervated by the different branches of the facial nerve in week 12, otherwise a fatty involution will appear. Later the growth of nearby structures will mark the definitive path of the facial nerve.

Facial nerve nuclei anatomy: The facial nerve has different nuclei that are located in the pons. These nuclei give rise to: the facial nerve itself, the intermediate nerve, which has a different nucleus for each of its functions: general sensory, special sensory and visceral motor.

Keywords: facial nerve, embryology, brain stem anatomy, review of the literature

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Introduction

The VII cranial nerve (also known as the facial nerve) is one of the twelve cranial nerves, a group of nerves that arise from the brain and brainstem, the cranial nerves has functions like special senses (vision, smell, taste, audition), communication with the environment, balance, eye movements, control of thoracoabdominal viscera and sensitive and motor function of the cervical and facial region.[1]

The facial nerve is predominantly a motor nerve. However, sensory and vegetative (parasympathetic) functions are also involved in its complex role.[2,3] Facial expressions as the result of activity of craniofacial muscles, contraction of the muscles derived from the second pharyngeal arch such as stapedius, platysma, stylohyoid and posterior belly of the digastric, and secretory participation through general visceral efferent fibers (salivary, lacrimal, nasal and palatal glands) are some examples that illustrate the physiologic importance of the VII nerve.

Additionally, exteroceptive fibers (special visceral afferent fibers) are responsible for the transport of gustatory stimuli of the anterior two thirds of the tongue, somatic sensations of the auricle and the internal auditory canal.[1,2]

Facial nerve embryology

In the third week of intrauterine development appears the facio-acoustic primordium, this structure originates from the rhombencephalon and develops in the rostral sense to the otic placode. The facial nerve becomes the nerve of the second branchial arch, and for this reason it will supply all the elements that derive from it:[4] the stapes, the styloid process of the temporal bone, the stylohyoid ligament, the minor horn and the upper portion from the body of the hyoid, also to the muscles of the stapes, stylohyoid, posterior belly of the digastric, auricular, and facial expression.[5]

The origin of the second pharyngeal arch is found in the rhombomere R4 in the rhombencephalon because of the neural crest cells, which have originated thanks to the signaling of BMP (bone morphogenetic protein) and its control in the expression of WNT1, they are transformed from epithelial cells to mesenchymal cells.[6]

In the fourth week of embryogenesis the first branch of the facial nerve appears in the rostral aspect of the embryo. By the fifth week, the intermediate nerve becomes evident and two weeks later will be recognized as an independent nerve.

Towards the seventh week the tympanic cord will be derived from the first branch of the facial nerve, joining elements of the first branchial arch and the lingual nerve (branch of the V par). By the middle of this week, the trunk of the facial nerve, which is already formed, bifurcates into the temporofacial and cervicofacial branches. Around the end of this week different fascicles that originate from these branches are recognized clearly. The temporal, zygomatic, oral, mandibular and cervical regions will give origin to the five main (terminal branches) of the facial nerve.[4]

In the eighth week of pregnancy the cartilaginous capsule from the previously formed ear vesicle forms a groove around the facial nerve, the stapedial artery and the stapes muscle. This groove will become the facial canal. By week 12 all the muscles of the face are formed, and all are innervated by one of the branches of the facial nerve, if the innervation is not present, the affected muscle fibers will sustain an adipose involution, a finding described in the Moebius syndrome, in which there is agenesis or destruction of the nuclei of cranial nerves VI and VII.[7]

In the twenty-first week the ossification of the facial canal begins, which will only end when the collateral branches of the facial nerve are found in their definitive location and when the artery has been reversed,[4] in many cases, the ossification ends in the early childhood.

With respect to the trajectory of the facial nerve during intrauterine life, literature reports that initially the nerve presents itself as a rectilinear structure. However, by the sixth week, due to the mesencephalic growth, there is a change of direction in acute angle,

which will become the knee of the facial nerve. Towards the fourth month of formation, a second change of direction appears, secondary to the development of the tympanic cavity, which originates from the first branchial pouch; this second tier will be the elbow of the seventh pair.[4]

Towards the end of pregnancy, the tympanic bone and the mastoid process are not fully developed, so the petrous portion of the facial nerve does not exist and will not be formed until between 2 and 4 years of age.[4]

Facial nerve nuclei anatomy

The cranial nerves from III to XII have their origin in the brainstem. These nerves, which include the VII, share some anatomical features. For example, the presence of one or more nuclei in the depth of the brainstem (mesencephalon, pons or medulla oblongata) in which the neuronal somas are found, and whose axons join to form the nerve itself. This structure becomes visible through its apparent origin, and from this point each of the nerves makes a particular path inside the skull, and leaves it through a specific foramen, to finally reach the organs of interest. This general anatomy is presented for motor portions, the sensorial and vegetative portions send afferent impulses to the nuclei into the brainstem.[8]

Nucleus

the facial nerve has various functions, it is important to note that, of these functions, the facial nerve itself is responsible for carrying gill motor fibers, while the intermediary nerve carries general sensory fibers (pain, temperature, pressure, vibration and proprioception), special sensory fibers (taste) and visceral motor (sympathetic efferences).[9] Each of these components has its own nucleus with a unique location.[4]

Facial nerve itself

Motor nuclei of the facial nerve are in the posterior part of the protuberance, between the dorsal nucleus of the trapezoid body (anterior and lateral) and the nucleus of the sixth pair (medial and posterior). The superior motoneurons that come from the cerebral cortex advance in caudal direction through the knee of the internal capsule, and make the synapse with the second motor neuron in the nuclei of the facial nerve. After this synapse, the motor neurons are directed in the posterior direction towards the floor of the fourth ventricle, they surround the nucleus of the sixth pair (medial root branch) forming a small elevation that is called the facial colliculus. After forming this colliculus, the nerve is directed again in the anterior direction (lateral root branch) to finally emerge through the pontocerebellar angle between the abducent nerve (medial to facial nerve) and the vestibulocochlear nerve (lateral to facial nerve).

Intermediary nerve

Also known as nerve of Wrisberg, although it is described independently, it is considered a unit with the facial nerve. As previously mentioned, it carries fibers with distinct functions.[10]

a. **General sensory component:** formed by primary sensory fibers that come from the skin of the auricular concha, the wall of the external auditory canal and the tympanic membrane in its external portion. These fibers join and advance through the stylomastoid foramen where they join to branchial motor fibers, later, these fibers arriving at the geniculate ganglion. The postganglionic fibers enter the brainstem forming the intermediate nerve, which sends fibers through the spinal tract of the trigeminal nerve to make synapses in the spinal nucleus of this nerve.

b. **Special sensory component:** These fibers have the function of giving special sensory innervation (taste) to the anterior two thirds of the tongue, besides, innervate the hard and soft palate. These fibers pass through the stylomastoid foramen next to the lingual nerve, form the chorda tympani, which enters through the petrotympanic fissure and joins to the facial nerve in the petrosal region of the Temporal bone. Like the general sensory fibers, the neuronal somas are found in the geniculate ganglion, the postganglionic fibers that go in the direction of the brain stem enters through the intermediary nerve, enter the solitary tract and end in the gustatory nucleus; The upper portion of the solitary nucleus, this one, is located posteriorly and laterally with respect to the motor nucleus of the facial nerve.

c. **Visceral motor component (parasympathetic afferent fibers):** These fibers have the function of innervating the salivary, lacrimal, nasal and palatal glands. There are two nuclei that send vegetative fibers through the facial nerve, these are: the superior salivary nucleus and the lacrimal nucleus.

d. **Superior salivary nucleus:** located inferior to the motor nucleus of the facial nerve. It is responsible, under the influence of the hypothalamus, to mediate responses such as salivation to olfactory stimuli.

e. **Lacrimal nucleus:** it is located medially with respect to the motor nucleus of the facial nerve. From this nucleus come fibers that go to the pterygopalatine ganglion, which sends postganglionic fibers that innervate the lacrimal gland.

It is important to know the embryology, anatomy of the nucleus and the functions of the facial nerve, to recognize the primary role that plays in important activities of the facial region.

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Conflict of interest

The authors declare that they have no conflicts of interest regarding this paper.

References

1. Monkhouse S. *Nervios craneales anatomía funcional*. Chile: Editorial Universidad Santiago de Chile, Santiago de Chile; 2014.
2. Lee C, José Á, Cuenca Buele S, et al. Anatomía y fisiología del sistema nervioso. Machala, Ecuador: Universidad Técnica de Machala; 2015.
3. Toulgoat F, Sarrazin J, Benoudiba F, et al. Facial nerve: from anatomy to pathology. *Diagn Interv Imaging*. 2013;94(10):1033–1042.
4. Hitier M, Edy E, Salame E, et al. Anatomía del nervio facial. *EMC–Otorrinolaringol*. 2007;36(1):1–16.
5. Almela M, Iniesta J. Embriología, Anatomía Topográfica y Quirúrgica De Las Regiones Cérvico-Faciales. Libro Virtual de Formación en Otorrinolaringología. España: Sociedad Española de Otorrinolaringología y Patología Cervico-facial: cap; 2014;121:1–14.
6. Sadler TW. Langman. Embriología Médica. 13th ed. Barcelona, España: Wolters Kluwer; 2016:296–297.

7. Aytés A. Síndrome De Moebius. *Protoc diagn ter peadiatr*. 2010;1:80–84.

8. Standring S. Gray's anatomy. 41st ed. London, UK: Elsevier; 2016:231–233.

9. Patiño A. Revisión y actualización Revisión anatómica del nervio facial (VII Par Craneano). *Morfolia*. 2016;8(2):12–24.

10. Wilson-Paules L, Akesson E, Stewart P, et al. Nervios craneales eEn la salud y la enfermedad. 2nd ed. Buenos Aires, Argentina: Editorial Médica Panamericana; 2003.