Review Article

The Nervus Intermedius of Wrisberg: Anatomy and Functions

Abstract

Often regarded as a root of the facial nerve, the nervus intermedius of Wrisberg (NIW) contains both sensory and parasympathetic fibers. It receives taste information from the anterior two-thirds of the tongue, floor of the mouth, and palate, as well as sensory information from the skin of the external auditory and the mucous membranes of the nasopharynx and nose. It also innervates the sublingual, submandibular, and lacrimal glands. This paper aims to review NIW's origins, path, and functions.

Keywords: Wrisberg; intermedius; nerve; general visceral efferent fibers; special visceral afferent fibers; general somatic afferent fibers; general visceral afferent fibers

Introduction

"The nervus intermedius of Wrisberg (NIW), also referred to as nervus intermedius or Wrisberg nerve, was firstly identified by Italian physician Bartolomeo Eustachi in 1563 and described in detail in 1777 by German anatomist Heinrich August Wrisberg" [1, 2]. "NIW is commonly considered a root of the facial nerve having sensory and parasympathetic fibers" [3-5], taking its name from its intermediate location between the facial nerve and superior portion of the vestibular nerves [5, 6]. It is in charge of the sense of taste in the anterior two-thirds of the tongue, floor of the mouth, and palate, as well as of the sensory information from the skin of the external auditory and the mucous membranes of the nasopharynx and nose. It also innervates the sublingual, submandibular, and lacrimal glands [1, 7].

The aim of this paper is to review NIW anatomy and functions.

Origin of NIW

NIW consists of fibers derived from three different nuclei: 1) the superior salivatory nucleus located within the dorsal aspect of the pons, just superior to the pontomedullary junction. It provides preganglionic parasympathetic autonomic fibers (general visceral efferent-GVE fibers); 2) the solitary nucleus, also known as the nucleus of the solitary tract located in the medulla oblongata and lower pons. It receives sensory inputs (special visceral afferent-SVA fibers), including taste information; 3) the main trigeminal sensory nucleus receives cutaneous sensation (general somatic afferent-GSA fibers) [5, 7, 8].

Path of NIW

NIW emerge from the brainstem at the pontomedullary sulcus along with the motor root of the facial nerve and travel towards the internal auditory meatus, from where they enter the facial canal into the temporal bone, and merge at the geniculate ganglion, thus forming a single structure [9, 10]; the geniculate ganglion being a mass of cell bodies of pseudounipolar neurons located at the proximal portion of the facial canal [11-13].

Branches and functions of NIW

1. **The greater petrosal nerve**

   Also known as the greater superficial petrosal nerve, it carries parasympathetic, taste, and general sensory fibers. This nerve passes through the geniculate ganglion without synapsing and exits through the facial hiatus (greater petrosal nerve hiatus or hiatus fallopii) of the petrous bone. Along with the deep petrosal nerve, the greater petrosal nerve forms the Vidian nerve, which will carry preganglionic parasympathetic, sensory, and taste fibers from the greater petrosal nerve and postganglionic sympathetic fibers from the internal carotid plexus through the deep petrosal nerve. The vidian nerve courses anteriorly within the pterygoid canal to the pterygopalatine ganglion (sphenopalatine ganglion) located in the pterygopalatine fossa; the sympathetic fibers of the deep petrosal nerve cross the pterygopalatine ganglion without synapsing and provide all branches of the maxillary nerve V2 (second division of the trigeminal nerve) with sympathetic innervation. The preganglionic parasympathetic fibers synapse at the pterygopalatine ganglion, and postganglionic fibers provide secretomotor innervation to the

nasopharyngeal and palatine glands and supply the lacrimal gland by giving branches to the zygomatic branch of the maxillary nerve, which gives off a communicating branch to the lacrimal nerve branch of the ophthalmic nerve and conveys secretomotor fibers to the lacrimal gland [7, 14-16].

The greater petrosal nerve also transmits soft palate taste afferents to synapse in the geniculate ganglion after being relayed to the pterygopalatine ganglion by the lesser palatine nerves [17].

"As for the general sensory fibers (general visceral afferent-GVA fibers), their primary neurons are in the geniculate ganglion and gather sensory information through the greater petrosal nerve from the nasal cavity, part of the soft palate, and the sinus cavities. Fibers enter the brainstem with NIW and synapse in the solitary nucleus" [18].

2. **The chorda tympani**

The chorda tympani branches off of the facial nerve, just above the stylomastoid foramen, and pierces the tympanic cavity to go into the posterior canaliculus. It then enters via the petrotympanic fissure into the infratemporal fossa, where it merges with the lingual nerve.

The chorda tympani carries SVA fibers that relay taste sensations from the anterior two-thirds of the tongue; these fibers travel to the geniculate ganglion and enter the brain via NIW to terminate at the solitary nucleus [19].

The chorda tympani also carries GVE fibers, originating from the superior salivatory nucleus, to the submandibular ganglion, where they synapse and later travel with the lingual nerve to the sublingual and submandibular glands, stimulating their secretion [18, 20].

Finally, GSA fibers gather sensory information from the auricle (pinna) and the external auditory meatus; these fibers travel via the auricular branch of the vagus nerve. After the geniculate ganglion, the fibers arrive at the brainstem via NIW and terminate in the main trigeminal sensory nucleus [21, 22].

Origins, functions, and branches of NIW are summarized in Figure 1.

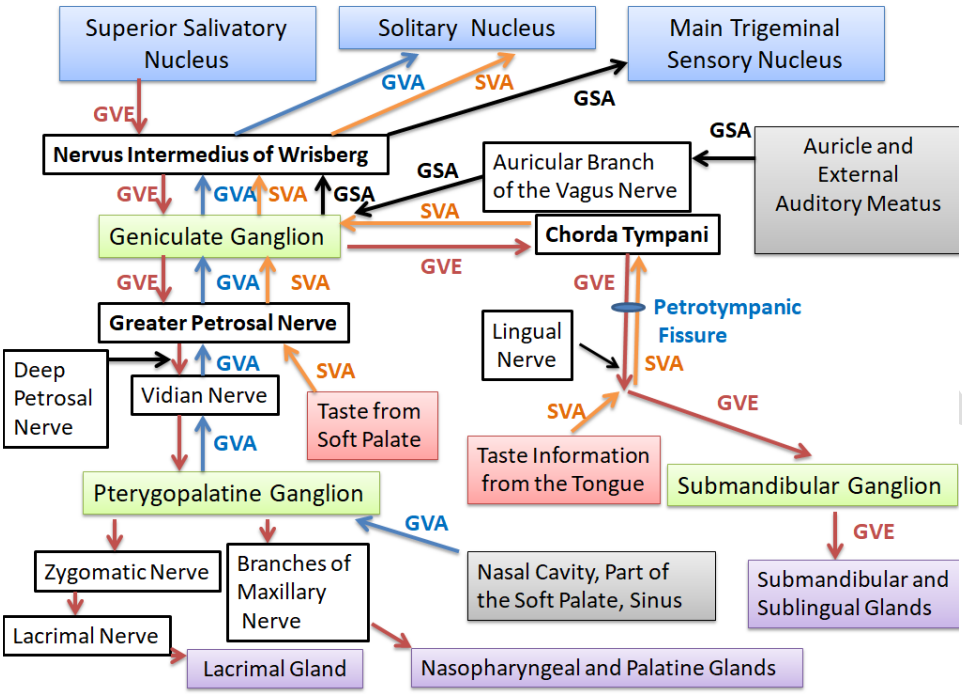

Figure 1: Origins, functions, and branches of the nervus intermedius of Wrisberg

GVE: general visceral efferent; GVA: general visceral afferent; SVA: special visceral afferent; GSA: general somatic afferent

Conclusion

NIW is a complex nerve made up of various fiber types (parasympathetic GVE fibers from the superior salivatory nucleus and ascending GVA, GSA, and SVA fibers from the geniculate ganglion). It ensures a number of vital functions and represents the facial nerve's sensory and parasympathetic division.

Disclaimer (Artificial intelligence)

The author hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

References

1. Alfieri A, Strauss C, Prell J, Peschke E. History of the nervus intermedius of Wrisberg. Ann Anat. 2010;192(3):139-44. doi: 10.1016/j.aanat.2010.02.004.
2. Meybodi AT, Liang AS, Mokhtari P, Moreira LB, Zhao X, Lawton MT, Preul MC. Nervus intermedius: microsurgical and anatomic relationships to the cerebellopontine angle neurovascular complex. Surg Neurol Int. 2023;14:37. doi: 10.25259/SNI_1097_2022.
3. Rhoton AL Jr, Kobayashi S, Hollinshead WH. Nervus intermedius. J Neurosurg. 1968;29(6):609-18. doi: 10.3171/jns.1968.29.6.0609.
4. Rao A, Tadi P. Anatomy, head and neck, chorda tympani. [Updated 2023 Mar 4]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK546586/.
5. Tubbs RS, Steck DT, Mortazavi MM, Cohen-Gadol AA. The nervus intermedius: a review of its anatomy, function, pathology, and role in neurosurgery. World Neurosurg. 2013;79(5-6):763-7. doi: 10.1016/j.wneu.2012.03.023.
6. Lovely TJ, Jannetta PJ. Surgical management of geniculate neuralgia. Am J Otol. 1997; 18:512-7.
7. Walker H. Cranial nerve VII: the facial nerve and taste. In: Walker HK, Hall WD, Hurst J, eds. Clinical methods: the history, physical, and laboratory examinations. 3rd ed. Boston: Butterworths; 1990.
8. Mtui E, Gruener G, Dockery P. Fitzgerald's clinical neuroanatomy and neuroscience. 7th ed. 2015.
9. Monkhouse WS. The anatomy of the facial nerve. Ear Nose Throat J. 1990;69(10):677-83, 686-7.
10. Basinger H, Hogg JP. Neuroanatomy, brainstem. [Updated 2023 Jul 4]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK544297/.
11. Dobozi M. Surgical anatomy of the geniculate ganglion. Acta Otolaryngol. 1975;80(1-2):116-9. doi: 10.3109/00016487509121309.

12. de Castro DC, Marrone LC. Neuroanatomy, geniculate ganglion. [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK555950/.
13. Kim CY, Park JS, Chung BS. Identification of cranial nerve ganglia using sectioned images and three-dimensional models of a cadaver. Korean J Pain. 2022;35(3):250-60. doi: 10.3344/kjp.2022.35.3.250.
14. Aoun G. Neuroanatomy: the parasympathetic ganglia of the head and neck. Advanced Concepts in Medicine and Medical Research. 2023;11:150-8. doi: 10.9734/bpi/acmmr/v11/7130E.
15. Tayebi Meybodi A, Mignucci-Jiménez G, Lawton MT, Liu JK, Preul MC, Sun H. Comprehensive microsurgical anatomy of the middle cranial fossa: part II-neurovascular anatomy. Front Surg. 2023;10:1132784. doi: 10.3389/fsurg.2023.1132784.
16. Shafique S, Das JM. Anatomy, head and neck, maxillary nerve. [Updated 2023 Jun 5]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK542277/.
17. Ikeda M, Ikui A, Tomita H. Gustatory function of the soft palate. Acta Otolaryngol Suppl. 2002;(546):69-73. doi: 10.1080/00016480260046436.
18. Dulak D, Naqvi IA. Neuroanatomy, cranial nerve 7 (Facial) [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK526119/.
19. Myckatyn TM, Mackinnon SE. A review of facial nerve anatomy. Semin Plast Surg. 2004;18(1):5-12. doi: 10.1055/s-2004-823118.
20. Morton David A. The big picture: gross anatomy. 2nd ed. New York. 2019.
21. Seneviratne SO, Patel BC. Facial nerve anatomy and clinical applications. [Updated 2023 May 23]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK554569/.
22. Takezawa K, Townsend G, Ghabriel M. The facial nerve: anatomy and associated disorders for oral health professionals. Odontology. 2018;106(2):103-16. doi: 10.1007/s10266-017-0330-5.