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Imaging of facial nerve pathology

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The facial nerve is structurally complex, both functionally and anatomically. In this article, we review the functional and structural anatomy of the facial nerve, using computed tomography (CT) and magnetic resonance (MR) imaging to emphasize important details that comprise thorough radiological assessment of the facial nerve. Additionally, CT and MR studies represent important tools for the diagnosis of facial nerve pathology, and the structural information that aids in preoperative planning and postoperative evaluation and CT and MR imaging of varied pathology of the facial nerve have been presented.
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Introduction

The facial nerve is a highly complex structure, both functionally and anatomically. Knowledge of the functional and structural anatomy of the facial nerve anatomy is critical before any diagnosis, clinical management, or surgical treatment that may follow.

Firstly, we review the functional components of the facial nerve, which include the functional components comprising somatomotor, parasympathetic, special sense (taste buds of the tongue and palate), and sensory innervation (skin of the outer ear). Subsequent review of the structural anatomy from the brainstem through the temporal bone to the soft tissues of the face has been illustrated with computed tomography (CT) and magnetic resonance imaging (MRI). Secondly, important pathology has been reviewed in the light of how CT and MRI can help characterize lesions further. Briefly, high-resolution CT is ideal for evaluating the bony abnormalities associated with facial nerve disorders and characterization of the calcifications within facial nerve lesions. MRI is superior for the evaluation of intrinsic properties of the facial nerve and facial nerve lesions.

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Major functions of the facial nerve

Functionally, cranial nerve (CN) VII, also known as the facial nerve, contains motor components as well as sensory and parasympathetic nervous system components.

Motor component

The motor nucleus is the principal nucleus of the facial nerve, situated in the lateral pontine tegmentum. The motor functions of the facial nerve include the following: (1) innervation of the occipitalis and the posterior auricular muscles, which control movements of part of the scalp; (2) innervation of the stylohyoid muscle, which draws the hyoid muscle posteriorly and elevates the tongue, and posterior belly of the digastric muscle, which elevates the hyoid bone; (3) innervation of the stapedius muscle, which stabilizes the stapes ossicle; and (4) ultimately, innervation of the muscles of facial expression via the terminal extracranial branches of the facial nerve.[1]

Parasympathetic efferent component

The parasympathetic efferent nucleus is the superior salivatory nucleus (SSN), located lateral and slightly anterior to the motor nucleus. The preganglionic efferent

fibers branch off the facial nerve as part of the chorda tympani, a distinct facial nerve branch within the facial canal carrying the preganglionic efferent fibers to the salivary glands. The greater petrosal nerve, also branching off the facial nerve, innervates the lacrimal glands and the mucosal membranes of the nasal cavity and palate.[2]

Special sensory afferent

The chorda tympani also conveys the sensory components of the facial nerve containing afferent fibers carrying the sensation of taste from the anterior two-thirds of the tongue, ultimately reaching the nucleus solitarius in the brainstem, which is located in the pons between the motor nucleus and the SSN. The nervus intermedius (NI), which contains the parasympathetic root and special sensory root of the facial nerve, intervenes between the main facial nerve and the vestibulocochlear nerve in the internal auditory canal (IAC) and converges to form the facial nerve proximal to the genu.[3]

Structural anatomy of the facial nerve

Before delving into finer detail, it is helpful to consider the overall path of the facial nerve (Figure 1). Grossly, the components of the facial nerve arise as nuclei from the brainstem (intra-axial segment) and traverse the cerebrospinal fluid (CSF) cisternal segment at the cerebellopontine angle (CPA) to enter the temporal bone through the IAC (intratemporal segment). The facial nerve then takes a circuitous, Z-shaped path, also known as the fallopian canal, through the temporal bone, ultimately exiting through the stylomastoid foramen into the extracranial soft tissues (extracranial segment). Each of these segments (the intra-axial, cisternal, intratemporal, and extracranial segments) have been discussed individually later (Figure 1). Of these

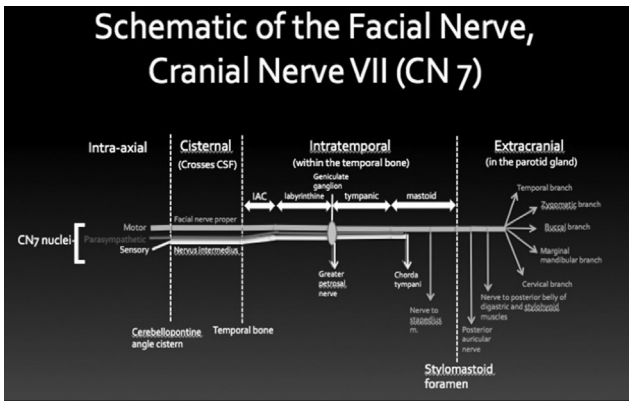

Figure 1 Schematic of the facial nerve. The facial nerve is divided into the following 4 anatomical components: intra-axial, cisternal, intratemporal, and extracranial. Of these, the intratemporal component of the facial nerve is further subdivided into the following 4 anatomical components: the IAC (meatal), labyrinthine, geniculate, tympanic, and mastoid components.

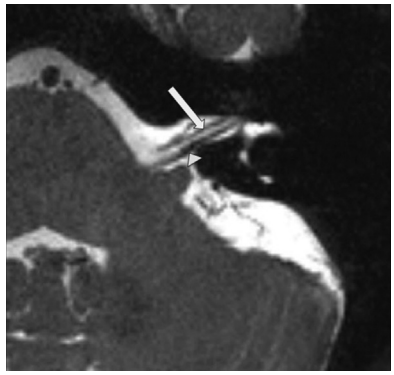

Figure 2 The cisternal and meatal facial nerve. MR T2-weighted image at the level of the IAC. This image shows the facial nerve as it courses across the left cerebellopontine cistern (the cisternal segment of the facial nerve) and enters the internal auditory canal. This segment within the IAC represents the meatal facial nerve (arrow), anterior to the superior vestibular nerve (arrowhead). Of note, the facial nerve here is seen as a single nerve, though it comprises both the facial nerve proper and the nervus intermedius.

4 segments, the intratemporal segment is further subdivided, which is also be discussed later.

Intra-axial facial nerve

The following nuclei ultimately become components of the facial nerve: the trigeminal motor nucleus (spinal tract of CN V), the superior salivary nucleus, and the nucleus of the tractus solitarius. Although the facial nerve nuclei are characteristically located within the caudal aspect of the ventrolateral pontine tegmentum, for the purposes of radiological evaluation, these nuclei are not radiologically distinguishable from the rest of the brainstem on CT or on state-of-the-art clinical MRI.

Cisternal facial nerve

The facial nerve emerges from the lateral aspect of the lower pons and traverses the CPA cistern. (Figure 2) shows the facial nerve, anterior and close to the superior vestibular nerve, as it crosses the CPA cistern on its way to the IAC. It is worth noting that the facial nerve here comprises 2 substructures, the facial nerve proper (containing the motor fibers) and the NI (containing the parasympathetic and sensory fibers). However, the 2 nerve bundles are poorly visualized and distinguished on CT. However, occasionally, the NI can be recognized as a thin, wispy structure on high-resolution, thin-slice T2-weighted MRI (Figure 3), often situated more closely to the cochleovestibular nerve fibers than the facial nerve proper (Figure 3), before it converges with the facial nerve proper.

Intratemporal facial nerve

The intratemporal facial nerve traverses the temporal bone through the IAC (the meatal segment) and then distally