Facial Anatomy: Nerves

4

Onur Erdoğan, Nuray Bayar Muluk, and Dennis Chua

4.1 Introduction

There are three principal origins in the head and neck region providing the nervous supply to the superficial structures of the face and scalp [1]:

- The seventh cranial nerve (facial nerve) supplies motor nerves to the facial musculature.
- The fifth cranial nerve (trigeminal) supplies sensory nerves for the facial region. It has three divisions, i.e. the ophthalmic (V1), maxillary (V2) and mandibular (V3).
- The nerves derived from the cervical plexus supply the scalp region.

4.1.1 The Seventh Cranial Nerve

This nerve supplies the facial musculature. There are five divisions of this nerve, i.e. the temporal, zygomatic, buccal, mandibular and cervical branches [1].

O. Erdoğan
Department of Otorhinolaryngology, Silifke Olbamed Hospital, Mersin, Turkey

N. Bayar Muluk (✉)
Faculty of Medicine, Department of Otorhinolaryngology, Kırıkkale University, Kırıkkale, Türkiye

D. Chua
Department of Otorhinolaryngology, ENT Surgeons Medical Centre, Mount Elizabeth Hospital, Mount Elizabeth, Singapore

C. Cingi et al. (eds.), *Minor Interventions, Major Outcomes on the Face*, Comprehensive ENT, https://doi.org/10.1007/978-3-032-01305-7_4

4.1.1.1 The Ophthalmic Division of the Trigeminal Nerve (V1)

This nerve supplies the superior facial third, including the superior blephara, ocular conjunctivae and frontal skin. It divides forming the supraorbital, supratrochlear, external nasal and infratrochlear nerves [1].

4.1.1.2 The Maxillary Division of the Trigeminal Nerve (V2)

This nerve supplies the mid-facial third, including the nose and the skin overlying the cheekbones. It divides into the zygomaticofacial, zygomaticotemporal and infraorbital branches [1].

4.1.1.3 The Mandibular Division of the Trigeminal Nerve (V3)

This nerve supplies the inferior facial third, including skin in the peri-auricular and mental regions. It divides into the auriculotemporal, buccal and mental branches [1].

4.1.2 Cervical Plexus

This is the origin of nerves supplying the skin of the mastoid, scalp and parotid gland. It gives rise to the great auricular and greater and lesser occipital nerves [1].

4.2 Facial Nerve

In general terms, the muscles involved in producing different facial expressions are all ultimately supplied by the seventh cranial nerve (=facial nerve). This nerve springs from the brainstem at the level of the pontomedullary junction, inferolateral to the origin of the sixth cranial nerve and superomedial to the origin of the eighth cranial nerve [1].

The facial nerve consists of three types of fibres, motor, sensory and autonomic (secretomotor, i.e. parasympathetic), which supply numerous structures of the head and neck. Three nuclei within the central nervous system give rise to the fibres of the seventh cranial nerve, namely [2]:

- The facial motor nucleus
- The superior salivary nucleus
- The facial sensory nucleus

4.2.1 Structure and Function

The seventh cranial nerve fulfils four main roles:

- It innervates the muscles of the face via general somatic efferent fibres.

- It innervates the facial salivary glands (submandibular and sublingual), as well as the lacrimal gland. Thus, it also carries visceral efferent fibres of the parasympathetic division of the autonomic nervous system.
- It innervates the anterior and mid-third of the tongue, supplying special visceral afferent input to the brain.
- It innervates the auricular skin and the external ear canal. Thus, it provides somatic afferent input to the brain [2–4].

4.2.2 Motor Pathway

The upper motor neurones are situated in the precentral gyrus, within the motor area representing the face. The axons pass within the corticobulbar tract to the inferior pontine region without decussating, after which the majority of fibres do decussate before descending on the contralateral side towards the lower motor neurones of the pathway. The lower motor neurones are located in four distinct subnuclei, namely, the dorsal, intermediate, lateral and medial nuclei. Fibres originating from the dorsal motor nucleus supply the muscles of the face within the superior quadrant on the same side as the nucleus. There is bilateral input from the corticobulbar tracts to the dorsal motor nucleus. The lateral motor nucleus, in contrast, receives input via the corticobulbar tract of the opposite side alone. Fibres from the lateral motor nucleus supply facial muscles within the inferior quadrant on the same side as the nucleus [5, 6]. This neuroanatomical configuration explains why a facial palsy involving upper motor neurones is confined to the inferior facial quadrant on the opposite side to the lesion, whereas a facial palsy affecting the lower motor neurones causes both the superior and inferior facial quadrants on the same side as the lesion to be paralysed. The main motor nucleus is the origin of conscious control of the muscles of the face. Furthermore, it sends fibres to the auricular muscles, the posterior belly of the digastric muscle, the stapedius muscle and the stylohyoid muscle. Face expressions that occur in response to various emotional states involve different mechanisms, with involvement of both the limbic lobe and the extrapyramidal tract [2, 7].

4.2.3 Parasympathetic Pathway

The superior salivatory nucleus, a portion of which is the lacrimal nucleus, contributes parasympathetic outflow to the seventh cranial nerve. This nucleus lies in the inferior pontine region behind and lateral to the facial motor nucleus. It receives projections from the hypothalamus, as well as gustatory information from the nucleus of the solitary tract. The superior salivatory nucleus sends efferent fibres to the sublingual salivary glands and submandibular salivary glands, in addition to the glands of the palate and those within the nose. The lacrimal nucleus receives two types of input. The hypothalamus mediates crying in response to strong emotion, whereas crying brought about by ocular irritation is triggered via the sensory

division of the fifth cranial nerve. Parasympathetic efferent outflow from the brainstem within the seventh cranial nerve passes in the glossopalatine nerve [2, 3].

4.2.4 Sensory Pathway

The motor nucleus and pontine parasympathetic nuclei lie anteromedial to the sensory nucleus, which receives gustatory input originating in the palate, the base of the oral cavity and the anteriormost and mid-third of the tongue. The geniculate ganglion is the location of the first-order gustatory neurones, which form a synaptic connection with the second-order neurones in the nucleus of the tractus solitarius, lying within the medulla oblongata. These second-order neurones decussate prior to their ascent to the thalamus via the medial lemniscus. In the thalamus, they have a synaptic connection to axons of third-order neurones, which ultimately terminate in the gustatory cortical region within the insula and post-central gyrus, having passed through the internal capsule and the corona radiata. A few fibres terminate within the hypothalamus [8].

The pathway carrying general sensory information consists of first-order neurones with their cell bodies in the geniculate ganglion, with the second-order neurones in the spinal trigeminal nucleus. The axons of the seventh cranial nerve carrying sensory and parasympathetic information are bound together, forming the glossopalatine nerve (also termed the nervus intermedius) [2, 4].

4.2.5 The Course of the Axons of the Seventh Cranial Nerve Within the Brainstem

The seventh cranial nerve consists of motor neurones arising from the motor root and the bundled sensory and parasympathetic axons making up the glossopalatine nerve. The motor portion passes in a backwards direction, skirting around the nucleus of the sixth cranial nerve before traversing the facial colliculus located on the floor of the fourth ventricle. It then exits at a point on the anterolateral medulla just inferior to the pons, the pontomedullary junction. The glossopalatine nerve also exits the brainstem at the same location [8].

4.2.6 Segments of the Seventh Cranial Nerve

The initial segment of the seventh cranial nerve is referred to as the intracranial or cisternal portion. The nerve contains the motor root and the glossopalatine nerve, which exit the pons as described above. These two roots enter the posterior cranial fossa at the cerebellopontine angle. They are accompanied by the eighth cranial nerve at this point. The two cranial nerves pass into both the temporal bone and the internal auditory canal [2].

The second segment is termed the meatal or canalicular portion. At this stage, the seventh cranial nerve is contained in the upper quadrant of the internal auditory canal [2].

The third segment of the seventh cranial nerve is the labyrinthine portion, which commences at the point where the two roots exit the internal auditory canal and enter the facial canal. The roots both bypass the cochlea and vestibular apparatus and turn in a posterior direction after joining the geniculate ganglion. Here, the motor root and glossopalatine nerve combine. There the third segment divides into three, forming the greater superficial, lesser and external petrosal nerves. The first of these carries parasympathetic information to the tear glands and gustatory fibres which extend to the palate [2].

The fourth portion of the seventh cranial nerve is the tympanic segment. This segment extends from the point where the nerve progresses in a posterior direction after the geniculate ganglion and is contained in the medial wall of the middle ear space. It is just under the lateral semicircular canal [2].

The mastoid segment is the term applied to the fifth portion of the seventh cranial nerve. This section of the nerve starts with an inferior flexion of the nerve at the pyramidal eminence of the middle ear space. It passes within the facial canal as far as the stylomastoid foramen. The mastoid portion of the seventh nerve divides three times: once to supply the stapedius muscle, a second time to form the chorda tympani and a third time to give off sensory fibres which blend with the auricular nerve (a branch of the tenth cranial nerve). The chorda tympani supplies the parasympathetic control to the sublingual and submandibular salivary glands, whereas the sensory fibres which join the auricular nerve carry general somatic sensory information from the external ear and ear canal [2].

The extratemporal segment then forms the last section of the seventh cranial nerve. The start of the segment is the point where the seventh cranial nerve leaves the temporal bone by passing through the stylomastoid foramen. At this point, the nerve branches twice, giving rise to the posterior auricular and digastric nerves. The former innervates the posterior and superior auricular muscles, plus the occipital belly of the occipitofrontalis, whilst the latter innervates the posterior belly of the digastric and the stylohyoid muscles. The seventh cranial nerve then passes through the parotid gland, where it again divides, resulting in two principal trunks, the superior temporofacial and inferior cervicofacial. Together, the trunks represent the origin of the parotid plexus. The parotid plexus then gives rise to five branches: the temporal (frontal), zygomatic, buccal, mandibular and cervical. It is these branches which provide motor innervation to the muscles of the face [3, 4, 8, 9].

4.2.7 Extratemporal Divisions of the Seventh Cranial Nerve

The seventh cranial nerve consists of five main divisions supplying the face. These divisions are the temporal, zygomatic, buccal, mandibular and cervical [1].

The temporal division of the seventh cranial nerve may also be termed its frontal division. On its path towards the temporal facial region, it goes across the zygomatic

arch, where a branch heads off to the auricularis anterior. Fibres also connect to the mandibular nerve's auriculotemporal branch and the maxillary nerve's zygomaticotemporal branch. The branches of the frontal division lying most anterior within the face innervate the corrugator supercilii, frontalis and orbicularis oris. Fibres also supply the efferent portion of the corneal (blink) reflex arc [1].

Another term for the zygomatic division is the malar division. The nerves cross over the zygoma on their way towards the lateral angle of the eye. The lateral angle is the point where fibres enter the orbicularis oculi and some fibres attach to the lacrimal nerve [1].

The buccal region of the face, which refers to the region of the cheek, perioral and infraorbital regions, is supplied by the seventh cranial nerve, too. There are fibres found just deep to the skin, as well as over the outside of the superficial facial musculature. The seventh cranial nerve innervates such muscles, one of which is the procerus. At the medial angle of the eye, it accompanies fibres originating from the frontal division of the fifth cranial nerve, specifically the infratrochlear and nasociliary branches. The small muscles in the nose are innervated by deeper running fibres of the facial nerve. The deeper fibres are deep to the quadratus labii superioris and the zygomaticus muscles, both of which they supply. These fibres contribute to an infraorbital plexus, to which the maxillary nerve's infraorbital branch also contributes. The deep fibres also innervate the buccinator and orbicularis oris muscles [1].

The marginal mandibular branch also arises from the seventh cranial nerve. It travels deep to the platysma and anguli oris muscles, innervating the chin and inferior lip. It also connects to a branch of the inferior alveolar nerve, the mental branch.

The cervical division of the seventh cranial nerve is the most inferior division. It follows a path passing deep to the platysma. The path of this branch is unusual, as it consists of arched segments as it traverses the suprahyoid region and the neck proper. It gives off branches to the platysma and the depressor anguli oris. One of its branches, the cervical cutaneous nerve, forms a junction with the cervical plexus [1].

The posterior auricular nerve also branches off the seventh facial nerve as it exits the stylomastoid foramen. This is where it is joined by a ramification of the greater auricular nerve, itself a branch of the tenth cranial nerve. The posterior auricular nerve passes upwards with the mastoid process on one side and the external ear canal on the other, before bifurcating to form the occipital branch and the auricular branch. The latter innervates the superficial muscles intrinsic to the external ear, along with the auricularis posterior. The former extends for a lengthier course, passing backwards along the superior nuchal line. This landmark is on the occipital bone and represents the continuation laterally of the external occipital protuberance. The occipital branch innervates the occipitalis [1].

4.3 Trigeminal Nerve (Fifth Cranial Nerve)

The facial sensory nerve supply is provided by the fifth cranial nerve. This is the sole cranial nerve to have a direct origin from the pons. The nerve forms three divisions, namely, the ophthalmic (V1), maxillary (V2) and mandibular (V3), each of

which innervates a particular facial territory. The muscles of the face involved in chewing, i.e. the medial pterygoid, lateral pterygoid, temporalis and masseter, are also innervated by the fifth cranial nerve [1].

4.3.1 Nerves Belonging to V1 (Ophthalmic Division)

The supraorbital nerve divides from the last portion of the frontal nerve. It exits via the supraorbital foramen, giving off branches supplying the superior blephara (palpebral branches). In addition, it provides innervation to the ocular conjunctivae, transparent structures which extend over the inner blepharal surface and cover the white-coloured orbit, as well as the frontal skin up to the mid-scalp region and the frontal sinus [1].

The frontal nerve branches off V1, then itself gives rise to the supratrochlear nerve. This branch passes upwards above the pulley mechanism of the superior oblique muscle, after which a delicate branch arises which forms a junction with the infratrochlear nerve. This latter is a branch of the nasociliary nerve. At this point, the supratrochlear nerve passes in a superior fashion, curving slightly, along the frontal region. The path crosses between two of the facial muscles, the frontalis and corrugator supercilii, where it enters the body of the muscle and divides to innervate the skin of the superior blepharon, the frontal skin, the glabellar skin and the ocular conjunctivae [1].

The anterior ethmoidal nerve is another branch of V1. It gives rise at its end to the external nasal branches, which supply cutaneous sensation to skin overlying the portion of the septum composed of cartilage and the inferior 50% of the nose [1].

The nasociliary nerve also branches off V1. Its terminal branch is the infratrochlear nerve, which begins at the point where the anterior ethmoidal nerve enters its namesake foramen. The course of this branch is in an anterior direction, following the upper margin of the medial rectus. As described above, it is usual for a junction to be formed with a slender branch coming off the supratrochlear nerve, in the vicinity of the pulley formed by the superior oblique muscle. The course is then in a medial direction, providing innervation to the kin overlying the nasal bridge, the upper blepharal skin, the caruncle and the lacrimal sac [1].

4.3.2 Nerves Belonging to V2 (Maxillary Division)

The zygomaticofacial nerve arises from V2 and supplies cutaneous innervation to the skin covering the temporal and zygomatic bones. This nerve passes through the orbit. There is commonly confusion between the zygomaticofacial and the zygomatic nerve arising from the seventh cranial nerve. However, the latter supplies motor, rather than sensory, innervation [1].

The maxillary nerve has another, slender branch, the zygomaticotemporal nerve. The path it follows is along the orbital wall laterally within its own groove in the zygoma. It also forms a junction with one of the diminutive branches of the lacrimal

nerve. Before passing into the temporal fossa, the nerve goes through its namesake foramen within the zygoma, after which its path is deep to the temporalis muscle and superficial to the temporal bone. At a point above the zygomatic arch, it penetrates the temporal fascia before forming several branches which provide sensation to the lateral frontal skin. After the zygomaticotemporal nerve penetrates into the fascia, its path is between the two fascial layers up to the point where it enters the eye socket at the lateral angle. There are connections between this nerve and the seventh cranial nerve, as well as the auriculotemporal nerve, which comes off V3.

At a point where V2 goes into the infraorbital canal, the infraorbital branch arises. This nerve provides sensation to the inferior blepharon, inferior lip, the maxillary infraorbital foramen and the vestibule of the nose [1].

4.3.3 Mandibular Division (V3) Branches

The auriculotemporal nerve is a branch of V3 which follows the general direction taken by the superficial temporal vessels, i.e. both the artery and vein. (The superficial temporal artery is the last branch given off by the external carotid artery). The auriculotemporal nerve provides cutaneous sensation to the side of the head.

The nerve providing cutaneous sensation to the inner cheek within the oral cavity is the buccal nerve, which also branches off V3. This nerve should not be confused with the buccal branch of the seventh cranial nerve, which is a motor nerve supplying the buccinator. The fifth cranial nerve also supplies cutaneous sensation to the rest of the facial region. The last branch given off by the inferior alveolar nerve, itself a branch of V3, is the mental nerve, which passes out of the mandible through the mental foramen and supplies sensory innervation to the chin region [1].

4.4 Nerves of the Cervical Plexus

From the cervical plexus, there arises the great auricular nerve. Its roots are C2 and C3. This nerve provides cutaneous sensation to the mastoid process, external ear and the region overlying the parotid gland [1].

The cervical plexus also gives rise to a spinal nerve, the great occipital nerve, which originates in the medial branch of the dorsal primary ramus of C2. The point of emergence is between the first and second cervical vertebrae, where the lesser occipital nerve also emerges. The suboccipital triangle is formed by the rectus capitis posterior major, the obliquus capitis inferior and the obliquus capitis superior. The nerve passes inferior to the obliquus capitis inferior, which forms the base of the suboccipital triangle and penetrates the trapezius. Its path is thereafter in a superior direction. This nerve supplies cutaneous sensation to the posterior scalp, the auricle and the region overlying the parotid gland [1].

The lesser occipital nerve is sometimes referred to by the term ‘small occipital nerve’. Its root is C2 alone, and the point of emergence lies below the first cervical

vertebra, as described above for the greater occipital nerve. This nerve supplies cutaneous sensation to the side of the head lying behind the ear [1].

References

1. Bengochea K. Superficial nerves of the face and scalp. Last reviewed: July 13, 2020. https://www.kenhub.com/en/library/anatomy/superficial-nerves-of-the-face-and-scalp. Accessed online at 2 Aug 2020.
2. Seneviratne SO, Patel BC. Facial nerve anatomy and clinical applications. StatPearls [Internet]. Treasure Island: StatPearls Publishing; 2020. Last Update: January 24, 2020. https://www.ncbi.nlm.nih.gov/books/NBK554569/. Accessed online at 2 Aug 2020.
3. Takezawa K, Townsend G, Ghabriel M. The facial nerve: anatomy and associated disorders for oral health professionals. Odontology. 2018;106(2):103–16.
4. Phillips CD, Bubash LA. The facial nerve: anatomy and common pathology. Semin Ultrasound CT MR. 2002;23(3):202–17.
5. Jenny AB, Saper CB. Organization of the facial nucleus and corticofacial projection in the monkey: a reconsideration of the upper motor neuron facial palsy. Neurology. 1987;37(6):930–9.
6. Kuypers HG. Corticobular connexions to the pons and lower brain-stem in man: an anatomical study. Brain. 1958;81(3):364–88.
7. Gothard KM. The amygdalo-motor pathways and the control of facial expressions. Front Neurosci. 2014;8:43.
8. Myckatyn TM, Mackinnon SE. A review of facial nerve anatomy. Semin Plast Surg. 2004;18(1):5–12.
9. Kochhar A, Larian B, Azizzadeh B. Facial nerve and parotid gland anatomy. Otolaryngol Clin N Am. 2016;49(2):273–84.