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Variations in the Branching Pattern of Facial Nerve

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ABSTRACT

The seventh cranial nerve, known as the facial nerve, is situated in the head and neck region and governs the mimic muscles responsible for facial expressions. The anatomy of the facial nerve exhibits variations, a matter of particular interest for surgeons operating in the head and neck areas. Incidents of facial nerve injury during such surgeries are frequent and can significantly impact the patient's quality of life, potentially leading to facial nerve paralysis. The facial nerve's main trunk emerges from the stylomastoid foramen which passes through the parotid gland, and divides into upper (temporofacial) and lower (cervicofacial) divisions which further gives rise to five terminal branches: temporal, zygomatic, buccal, marginal mandibular, and cervical. A comprehensive understanding of the branching and anastomosis patterns of the facial nerve is of significant importance for the surgeons to avoid inadvertent injury to the facia nerve which has devastating effects.

INTRODUCTION

A lot of what makes each of us unique is attributed to the seventh cranial nerve the expressions on our faces. For examination purposes, the facial nerve (CN VII) is typically split into four segments: the intratemporal segment (which passes through the bony facial nerve canal), the peripheral segment, the cisternal segment that passes via the internal auditory canal, and the nucleus and tracts. As soon as the peripheral section of CN VII leaves the temporal bone at the stylomastoid foramen, it becomes almost impossible to track and is not visible on imaging. Moreover, the nerve most commonly injured in head and neck trauma is the facial nerve (FN). With the exception of injuries from traffic accidents (temporal bone fractures, facial abrasions), the majority of lesions to the FN are either post-operative (removal of parotid resections or cerebellopontine angle tumors) or the result of extrinsic compressions during surgery.[1] Second, a thorough understanding of anatomical structures, their locations, and the topographical relationships between them is necessary for flawless surgical practice. As a result, human anatomy remains the fundamental and essential field of study for surgeons. They need to be especially attentive to the possible presence of anatomical variations and comprehend their clinical importance. A focus on clinically oriented cranial anatomy enables an insight into the underlying causes of numerous critical issues.[2]

FACIAL NERVE COURSE: The motor and sensory portions of the facial nerve, as well as the vestibulocochlear nerve, originate from the lateral region of

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pontomedullary sulcus and travel together in the cerebellopontine angle (CPA) to reach the internal acoustic meatus (IAM) porus. The facial nerve enters the facial (Fallopian) canal in the anterosuperior quadrant of the fundus, or lateral end, of the IAM, by passing through the canal slightly anterior to and above the vestibulocochlear nerve. From the vestibule posteriorly and the cochlea anteriorly, it proceeds laterally and somewhat horizontally until it reaches the medial wall of the epitympanic recess, where it abruptly reverses direction and is referred to as the first or proximal external genu. After that, it proceeds backward along the medial wall of the tympanic cavity, over the stapes footplate and oval window, and parallel to and below the lateral (horizontal) semicircular canal protrusion. Here, the nerve bends again (second genu), this time downward and blunted, and it is situated on the tympanic cavity's posterior wall.[3]

ANATOMY OF TERMINAL FACIAL NERVE BRANCHES:

From the skull, the facial nerve exits via the stylomastoid foramen. It quickly releases the posterior auricular nerve, which supplies the occipitofrontalis muscles, auricularis posterior and occipital belly. The facial nerve's main trunk then passes through the parenchyma of the parotid gland before splitting into the temporofacial and cervicalofacial divisions near the mandible's posterior border. The temporal, zygomatic, buccal, marginal mandibular, and cervical branches are among the five terminal branches that emerge from each division, which is further divided into several branches in a plexiform pattern. These branches disseminate throughout the face and upper neck, supplying the facial expression muscles. In 1956, Davis et al first described the branching of facial nerve.[4] They listed six facial nerve types (I, II, III, IV, V, and VI) and their recurrence based on whether or not there were anastomoses between terminal branches. This classification is still commonly used as a classic pattern in scientific literature. However, in 1987, Katz and Catalano published a newer classification that did not correspond to the Davis classification.[5] This newer classification had nine types of branching patterns (IA, IB, II, IIIA, IIIB, IIIC, IVA, IVB, and V) and was based on anastomoses between terminal branches, the origin of the buccal branch, and the number of facial nerve trunks. However, there is a greater range of variety in the facial nerve's branching pattern. For example, Pitanguy et al[6] and Stankevicius et al[7] have discovered 8 branching patterns, Kopuz et al[8] have defined 11 varieties, and Martínez Pascual et al[9] have established 12 forms.

COMMON VARIATIONS IN FACIAL NERVE BRANCHING:

Variances exist in the anatomy of the facial nerve, and surgeons who operate on the middle ear, upper neck, parotid, posterior and middle cranial fossa, temporal bone, and middle ear should be especially aware of these variances. Owing to wide differences in the branching pattern of the facial nerve, only a small percentage of instances will match the traditional textbook description of its separation into five branches. It might be challenging or impossible to clearly divide the nerve into its five primary terminal branches—temporal, zygomatic, buccal, mandibular, and cervical.

There are notable differences in the facial nerve's terminal division. The primary divisions or trunks may have different numbers. There have been reports of the facial nerve bifurcating and trifurcating inside the parotid gland. The temporofacial and cervicofacial trunks of the facial nerve were consistently identified as the primary trunk in the 350 facial specimens dissected by Davis et al.[4] 13.3% of the specimens from Korean cadavers that Kwak et al[10] dissected had a facial nerve trifurcation that ended in the parotid. The facial nerve was found to be bifurcated before entering the parotid gland in 6 cases (13%), bifurcated within the gland in 39 cases (85%), and trifurcated within the gland in 1 case (2%) according to Salame et al[11] who dissected 46 cases. Because of endotemporal division or division shortly before entering the gland, the facial nerve may already have a major and a minor trunk before it enters the parotic gland. A minor trunk that coursed below the major trunk and joined the cervical branch after providing a brief communication to the cervicofacial division was present in 26.7% of the cases in the Kwak et al[10] study. In 3% of cases, Katz and Catalano[5] noted the presence of an extra minor trunk; this minor trunk travelled above the major trunk, briefly connected to the temporofacial division, and then separated as the buccal branch. While Myint et al[12] revealed 3.8% trifurcation only. It was reported that FNT split as trifurcation in 9% of cases.[7] In Type III there are distinct double trunks of FN, accounts for 6.52% of the cases; other researchers have identified this type as accounting for 8.57%, 9%, and 12% of instances, respectively.[7,8,13] According to Botman and Jongkees' conclusion, FN within the mastoid segment may split, resulting in two or three FNTs that escape through different osseous foramen.[14]

Type I was the most prevalent branching pattern based on the Davis categorization,[13,15,16] but Davis et al. and Myint et al. reported a lower occurrence of type I.[4,12] According to Khaliq et al., the Type III branching-pattern was the second most common kind, and according to Davis and Myint et al., it was the first most common pattern. [4,12,13] While a study by

Myint et al[12] found a greater rate of type VI branching patterns, other studies showed that types IV, V, and VI were the least common types of branching patterns.

A meticulous examination of facial nerve branching patterns across multiple studies sheds light on intriguing variations that reflect regional and demographic influences. In South Korean investigations conducted by Park and Lee and Lee et al., a distinctive prevalence pattern emerges.[17,18] These studies reveal a noteworthy lower incidence of Type I facial nerve branching patterns compared to North American counterparts. Type III and Type IV patterns, however, exhibit a higher prevalence in the South Korean population.[17] This discrepancy suggests a potential regional specificity in the anatomical distribution of facial nerve branches among South Koreans, emphasizing the importance of considering ethnic and geographic factors in the understanding of facial nerve anatomy. In the Malaysian study conducted by Myint et al[12] and the Thai study by Weerapanta et al[19] an entirely different set of proportions in facial nerve branching patterns comes to light. Myint et al[12] observed that 11.4% of their Malaysian cohort exhibited Type I patterns, 15.2% Type II, 34.2% Type III, 19% Type IV, 7.6% Type V, and 12.7% Type VI. This distinct distribution underscores potential regional disparities in facial nerve anatomy within Southeast Asian populations. Similarly, the Thai study by Weerapanta et al[19] provides unique insights, with 1% showing Type I, 10% Type II, 20% Type III, 18% Type IV, 29% Type V, and 21% Type VI patterns. These findings not only highlight diversity within Asian populations but also contribute to the growing body of evidence emphasizing the need for a nuanced understanding of facial nerve anatomy based on geographical and ethnic considerations. In the African study by Thuku et al, a different set of observations comes to the fore. Thuku et al[20] reported a higher prevalence of Type I and Type II patterns, accounting for 25% and 22.5% of their study population, respectively. Comparatively, the incidence of Type III, Type IV, Type V, and Type VI patterns was lower, signifying a distinct facial nerve branching profile in the African population. This suggests that genetic and ethnic factors may play a role in shaping the facial nerve anatomy. These divergent findings underscore the complexity of facial nerve anatomy and its susceptibility to demographic and regional influences. Such nuances in branching patterns have significant implications for medical practitioners, especially in surgical procedures involving the facial nerve. Surprisingly, each author observed a different percentage pattern for kinds I and IV of instances, but most writers reported comparable percentage patterns for types II, III, V, and VI of cases. As a result, there is no agreement regarding pattern variation. Surgeons must be attuned to the possibility of variations in facial nerve anatomy based on the patient's ethnic background and geographical origin. Additionally, these insights contribute to the broader field of anatomical research, fostering a more comprehensive understanding of the intricate variations in facial nerve branching patterns across diverse populations. Continued research in this area is crucial for refining surgical techniques, enhancing patient outcomes, and advancing medical knowledge.

CONCLUSIONS

The anatomy of the facial nerve can be classified into intracranial, intratemporal, and extratemporal components. Surgeons undertaking procedures in this facial region need to be meticulous in considering the diverse branching patterns of the facial nerve. The arrangement of the facial nerve during parotidectomy poses a distinctive and challenging task due to variations in its branching pattern.

A comprehensive understanding of the facial nerve, encompassing its trunk anatomy and topography, is vital for successful surgical procedures. A foundational knowledge of intracranial and intratemporal anatomy is necessary for distinguishing between different clinical diagnoses. Moreover, a robust familiarity with extratemporal facial nerve anatomy is equally crucial for the secure dissection through facial planes during various head and neck procedures.

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