Intratemporal Anatomical Study of Facial Nerve in Cadaveric Bone in Nepal

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ABSTRACT

Background

The facial nerve courses in the intracranial, intratemporal and extratemporal regions. Intratemporal part of facial nerve is divided into meatal, labyrinthine, tympanic and mastoid segments.

Objective

The objective of this study was to measure the length of tympanic segment of facial nerve, mastoid segment of facial nerve and distance between the second genu of facial nerve and origin of chorda tympani nerve.

Method

It was a descriptive study conducted from April 2025 till July 2025. A total of 65 temporal bones were dissected and the lengths of different segments of facial nerve were measured with a thread and millimetric scale.

Result

The mean length of tympanic segment of facial nerve was 7.86 ± 1.37 mm, which ranged from 5 mm to 11 mm. The length of mastoid segment of facial nerve ranged from 11 mm to 30 mm and its mean length was 16.84 ± 3.50 mm. The mean distance between the second genu of facial nerve to point of origin of chorda tympani nerve was found to be 12.87 ± 3.89 mm. This distance ranged from 2 mm to 24 mm.

Conclusion

There was a variability on anatomical measurements of different segments of facial nerve in the tympanomastoid compartment. This needs to be considered while performing middle ear and mastoid surgeries.

KEY WORDS

Anatomy, Cadaver, Chorda tympani nerve, Facial nerve, Temporal bone

INTRODUCTION

Temporal bones are paired bones which form the lateral part and base of skull. Important neurovascular strucutres such as facial (VII) nerve, vestibulocochlear (VIII) nerve, internal carotid artery and jugular bulb pass through temporal bone.[1] Facial nerve has a complex and tortous course within the temporal bone.[2] Intratemporal part of facial nerve is divided into meatal, labyrinthine, tympanic and mastoid segments. Chorda tympani originates from the mastoid segment of facial nerve.

The risk of iatrogenic facial palsy during otologic surgery is 0.6-3.6%, which increases in revision surgery to 4-10%.[3] Facial nerve paralysis has devastating consequences, hampering patient's quality of life. Facial nerve palsy is an important cause of medicolegal litigation for an Otorhinolaryngologist.[4] Often, the anatomy of facial nerve is anomalous, adding challenges to the otologist. Therefore, an Ear, Nose, Throat (ENT) surgeon should be well versed with anatomy of the facial nerve in order to prevent its injury during surgery.

Cadaveric dissection helps to understand the three dimensional anatomical relationships, which is essential to enhance ones' surgical acumen.[5] This is practically more relevant for temporal bone because of its intricate anatomy. Facial nerve anatomy could be well perceived only after numerous temporal bone dissection. This would ultimately build surgical confidence and reduce complication rate. This aim of this study was to measure the lengths of different segments of facial nerve in middle ear and mastoid portion of cadaveric temporal bone.

METHODS

This was a cross-sectional, descriptive study conducted in the Dissection Laboratory in the Department of ENT-HNS, Institute of Medicine, Maharajgunj, Kathmandu, Nepal. Ethical Approval was obtained from Ethical Review Board, Research Directorate, Tribhuvan University with Reference number ERBTU-2081-014.

A total of 65 temporal bones were dissected microscopically from April 2025 till July 2025. Temporal bones of adult population of all gender were included in this study. Those bones with mutilated facial nerve due to trauma or disease were excluded.

The bone over facial nerve was removed from the first genu, tympanic segment, second genu, whole of mastoid segment, till the point of its exit at the stylomastoid foramen (Fig. 1). Similarly, the origin of chorda tympani nerve was well exposed. The lengths of tympanic segment, mastoid segment and length of facial nerve between second genu and origin of chorda tympani nerve were measured with the help of a thread and millimetric reading scale (Fig. 2, 3). The measurements were performed by a single person in all the bones to reduce inter-observer bias. The data were entered into the proforma in the laboratory and later transferred into Microsoft Excel. The data were verified by the co-researchers.

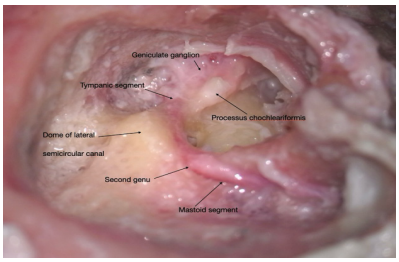

Figure 1. **Skeletonization of facial nerve from geniculate ganglion until mastoid segment.**

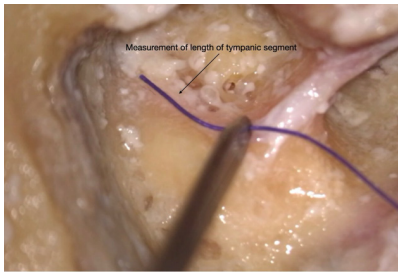

Figure 2. **Measurement of tympanic segment of facial nerve with a thread.**

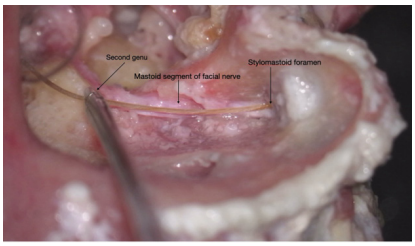

Figure 3. **Measurement of mastoid segment of facial nerve with a thread.**

RESULTS

A total of 65 temporal bones were dissected during the study period of four months. Thirty (46.15%) bones were right sided while 35 (53.85%) bones were left sided. The mean length of tympanic segment of facial nerve was 7.86 ± 1.37 mm. The length of tympanic segment ranged from 5 mm to 11 mm. Most of the tympanic segment of facial nerve measured 8 mm in length (Table 1).

Table 1. **Length of tympanic segment of facial nerve (n=65)**

Length of tympanic segment (mm)	Number of bones	Percentage
5	2	3.08
6	9	13.85
7	14	21.54
8	21	32.31
9	12	18.46
10	4	6.15
11	3	4.62
Total	65	100

The mean length of mastoid segment of facial nerve was 16.84 ± 3.50 mm. The length of mastoid segment ranged from 11 mm to 30 mm. Most of the mastoid segment of facial nerve measured 14 mm in length (Table 2).

Table 2. Length of mastoid segment of facial nerve (n=65)

Length of mastoid segment of facial nerve (mm)	Number of bones	Percentage
11	1	1.54
12	3	4.62
13	2	3.08
14	15	23.08
15	6	9.23
16	7	10.77
17	7	10.77
18	6	9.23
19	7	10.77
20	1	1.54
21	3	4.62
22	4	6.15
23	1	1.54
26	1	1.54
30	1	1.54
Total	65	100

Table 3. Length between second genu of facial nerve to origin of chorda tympani nerve (n=65)

Length between second genu to origin of chorda tympani (mm)	Number of bones	Percentage
2	1	1.54
4	1	1.54
6	1	1.54
7	1	1.54
8	5	7.69
9	3	4.62
10	3	4.62
11	4	6.15
12	10	15.38
13	7	10.77
14	11	16.92
15	4	6.15
16	6	9.23
17	2	3.08
18	1	1.54
19	2	3.08
21	2	3.08
24	1	1.54
Total	65	100

The mean distance between the second genu of facial nerve to point of origin of chorda tympani nerve was found to be 12.87 ± 3.89 mm. This distance ranged from 2 mm to 24 mm (Table 3). The mean distance between stylomastoid foramen and point of origin of chorda tympani nerve was 3.96 ± 3.30 mm, which ranged from 0 mm to 14 mm. In 15 (23%) bones, chorda tympani originated from the region of stylomastoid foramen.

DISCUSSIONS

The anatomy of facial nerve is quite complex to understand because of its tortuous course from the brainstem till its motor and sensory nerve endings. Moreover, the course of facial nerve can be highly variable in the temporal bone. The knowledge of lengths of different segments of facial nerve guides the surgeon during ear surgery, especially, in cases with lost landmarks during revision ear surgery and in cases with extensive pathology.

The tympanic segment of facial nerve starts from geniculate ganglion, then courses posteriorly, inferiorly and laterally till the level of lateral semicircular canal, which marks the second genu. The length of tympanic segment of facial nerve is variable in different studies. Its average length was 7.86 ± 1.37 mm in this study. Most of the bones had 7 mm, 8 mm and 9 mm length.

Gupta et al. noted the mean length of tympanic part of facial nerve to be 10.44 ± 1.42 mm and its length ranged from 8 to 13 mm.[6] They also observed that maximum bones had 10 mm and 11 mm length. Yadav et al. found the mean length to be 11.1 ± 0.88 mm.[7] Kharat et al. observed the mean length to be 9.28 ± 1.13 mm, which ranged from 7 to 12 mm.[8] In most of their bones, the length measured 9 mm and 10 mm. These studies are from different parts of India. The length of tympanic segment of facial nerve in these studies were longer than that in the current study. This might be due to differences between races and ethnicity. The differences in dimensions of skull and height of people might have played a role as well.

Maru et al., Ezzat et al., Nikolaidis et al. and Bayram et al. reported the mean length of tympanic segment of facial nerve to be 10.25 ± 0.75 mm, 12.50 ± 1.04 mm, 10.97 ± 1.29 mm and 9.55 ± 1.54 mm respectively.[9-12] These studies from Europe and Africa have also shown their mean length to be longer than that in the current study.

In the current study, few of the temporal bones had length of 5 mm and 6 mm in the tympanic segment, which is shorter as compared to other literature. This signifies the importance of conducting cadaveric studies in own group of population.

The length of tympanic segment of facial nerve carries special value in cases of anterior epitympanic cholesteatoma, petrous bone cholesteatoma, meningocele in tegmen tympani and in cases with extensive granulation tissue. In these cases, tympanic segment of facial nerve might be at risk of iatrogenic injury. At times, when the

normal anatomical landmarks are lost, the surgeon needs to follow along the possible length and direction of the nerve.

Tympanic segment of facial nerve is prone to have bony dehiscence. Moreano et al. observed the incidence of facial canal dehiscence to be 56%.[13] The dehiscent tympanic portion could be at risk of injury during stapes surgery and during atticotomy, especially for beginner surgeons. Dehiscence of the nerve makes it prone to paralyze due to infection and inflammation.[14] The variation in facial nerve might be due to dual ossification of temporal bone, i.e. partly cartilaginous and partly bony.[2]

Rarely, the nerve may prolapse and overhang the oval window. In the current study, there was a case of prolapsed facial nerve over the oval window. Other variations could be bifurcation near oval window, transcrural course, transpromontorial course and facial nerve coursing below oval window.[15]

The mastoid segment of facial nerve extends from second genu to the stylomastoid foramen. Kharat et al. reported the mean length of mastoid segment of facial nerve to be 13.7 ± 1.45 mm in 25 temporal bone dissection.[8] This length ranged from 10 to 16mm. Gupta et al. reported the mean length of mastoid segment to be 13.33 ± 2.20 mm, with length ranging from 9 to 17 mm.[6] Yadav et al. found the mean length to be 15.4 ± 2.14 mm, which ranged from 10 mm to 20 mm.[7] These lengths were found to be shorter than that in the current study, where a wider range of 11 mm to 30 mm was found. However, most of the bones had similar lengths from 14 mm to 19 mm in the current study.

The length of mastoid segment is practically important while dealing with pathologies in the retrofacial area and while performing retrofacial tympanotomy. Occasionally, a high riding jugular bulb might be dehiscent along the length of mastoid portion of facial nerve.[16,17] Similarly, the consideration of length of facial nerve is important during nerve grafting procedures.[18]

The mastoid segment of facial nerve may have variable course during its descent towards the stylomastoid foramen. The nerve could descend laterally or medially.[19] There may be bifurcation of the mastoid segment of facial nerve.[20] The pneumatization pattern of temporal bone may be responsible for such variable course of facial nerve.[15] These anatomical variations must be considered during tympanomastoid surgeries to prevent facial nerve injury.

The mean distance between the second genu of facial nerve to point of origin of chorda tympani nerve was found to be 12.87 ± 3.89 mm. This distance ranged from 2 mm to 24 mm. Most of the studies have calculated the distance between stylomastoid foramen and point of origin of chorda tympani nerve, in contrast to the current method. In this study, the mean distance between stylomastoid foramen and point of origin of chorda tympani nerve was 3.96 ± 3.30 mm.

Yadav et al. found the mean distance between stylomastoid foramen and point of origin of chorda tympani nerve to be 6.2 ± 2.66 mm. It ranged from 2 mm to 12 mm.[7] Maru et al. found this distance to be 7.2 ± 2 mm. In two of their bones, chorda tympani originated distal to the stylomastoid foramen.[9] Liu et al. found 13.33 mm distance between these nerves.[21] Kalaiarasi et al. found that the distance between these nerves ranged from 2 to 6 mm, with the average distance being 4.4 mm.[20] Jatale et al. observed the mean distance between chorda tympani origin and stylomastoid foramen to be 5.69 mm.[22] This signifies a variability on origin of chorda tympani nerve.

The clinical significance of chorda tympani nerve is highly appreciated during facial recess approach, for example: cochlear implantation surgery and combined approach tympanoplasty. Delineation of faint appearance of mastoid segment of facial nerve and chorda tympani nerve prevents their injury during facial recess approach with successful completion of posterior tympanotomy. Similarly, in cases with altered anatomy due to extensive disease in the middle ear and antrum, in revision cases or occasionally, in middle ear anomalies the facial nerve needs to be traced retrograde, wherein, chorda tympani would be followed till its origin from the facial nerve.

The limitations of this study were its limited sample size, inability to study on different landmarks of facial nerve and lack of segregation of lengths of facial nerve into different ethnicity.

CONCLUSION

Anatomical variations were noticed in lengths of different segments of facial nerve in the temporal bone. This wide variability of facial nerve in the tympanomastoid compartment of facial nerve needs to be considered while performing middle ear and mastoid surgeries. In future, study on distance between facial nerve and its various landmarks in the middle ear and mastoid can be performed in a larger sample size.

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