Main Article

SURGICAL ANATOMY OF TYMPANO-MASTOID SEGMENT OF FACIAL NERVE

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ABSTRACT: ***Objective:*** *Facial nerve is known to have a considerable variations more so in the temporal bone. An otologist with inadequate familiarity with facial nerve usually have a tendency to do incomplete surgery in chronic suppurative otitis media. The present study was conducted to explore the microanatomy of tympanic and mastoid segments of facial nerve.*

Setting: *Temporal bone lab.*

Materials and Methods: *This study was conducted at PGIMS Rohtak in 25 wet temporal bones which were dissected under the microscope. Various parameters studied included the length of tympanic and mastoid segments of facial nerve, various anomalies, depth from the cortex and relation to various important structures.*

Results: *The mean length of tympanic segment was 11.1 mm ± 0.88 and mastoid segment was 15.4 mm ± 2.4. The angle at second genu was 95-125° and the facial canal was dehiscent in 12% cases.*

Conclusions: *The tympanomastoid segment of facial nerve has variations in length and in its relation with various middle ear structures. Further the nerve, in Indians is also at variance as compared to Japanese and Americans probably because of different racial configuration of the skull.*

Key Words: *Facial nerve, temporal bone, congenital anomalies*

INTRODUCTION

Facial expression controlled by facial nerve, is an important mean of social communication in human beings. The facial nerve surpasses all other nerves in the human body with respect to the length and tortuousity of its intra-osseous course through the temporal bone. The diseases of the middle ear, may involve the facial nerve, leading onto its paresis or paralysis, more so, if there is any developmental anomaly. With the advent of microscope in the ear surgery, there is a renewed interest amongst otologists to study the microscopic anatomy. It is now well established that in developmental anatomy lay the means of understanding the previously baffling aspects of adult structure of the human ear and temporal bone (Anson et al,).

Facial nerve traverses the petrous part of the temporal bone from the internal auditory meatus to the stylomastoid foramen displaying variations and anomalies in its course. It provides a great challenge and has always captured the spirit and imaginations of the neuro-otological surgeons (Basek,). The tympanic segment of facial nerve is most important as it traverses the middle ear and may inadvertantly be injured in the otologic surgery if one is not well conversant with its surgical anatomy and congenital variations. Familiarity with the facial nerve results in respect, for its help in guiding the operator through the temporal bone (Anson et al,). This study was undertaken to know and explore the microanatomy of the facial nerve and its anomalies in the temporal bone.

MATERIALS AND METHODS

The present study was conducted in the Department of ENT, PGIMS, Rohtak, on 25 adult human wet cadaveric temporal bones, which were obtained from unclaimed dead bodies from the Department of Forensic Medicine. Thirteen right and twelve left temporal bones were dissected under the microscope. Transmastoid approach was utilized for surgical exposure of the facial nerve in its entire horizontal and vertical parts. After the complete exposure of the intratemporal course of the facial nerve, measurements were made with the divider, measuring probe and read against the millimeter scale.

Observations

The anterior end of the tympanic segment of the facial nerve was found to lie slightly above and medial to the cochleariform process in 68% of the specimens, while it was adjacent to it in 32%. The mean distance between the two was 2 mm ±

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0.67 (range 1 mm to 3 mm). The mean length of the tympanic segment was 11.1 mm ± 0.88 (range 9 mm to 13 mm). It was found to incline inferiorly and descend obliquely in 80% of specimens, whereas in the rest 20% the course was horizontal from geniculate ganglion to second genu and was parallel to the horizontal semicircular canal. In middle part of the tympanic segment, the facial nerve was observed to lie above the oval window and stapes and was showing bony dehiscence in 12% of the specimens which was replaced by fibrous connective tissue in 4%. The bony horizontal semicircular canal was found protruding laterally over the facial nerve in all the specimens. The postero-inferior part of the tympanic segment of facial nerve was universally found to lie close to the pyrimidal eminence and then changed its direction at second genu into the vertical segment [Figure 1].

The mean length of mastoid segment of facial nerve was 15.4 mm ± 2.14 (range 10 mm to 20 mm) which was lying lateral to the stapedius muscle and the sinus tympani. The mean distance at the level of the posterior border of the oval window and the facial nerve was 4 mm ± 1.29 (range 2 mm to 6 mm), whereas from the round window it was 4 mm ± 1.22 (range 2 mm to 6 mm). In all the specimens, the lower one third of the mastoid segment of the facial nerve was antero-medial to the digastric ridge. The mean distance between facial nerve and digastric ridge was 3.8 mm ± 0.8 (range 2 mm to 5 mm). The distance from the digastric ridge was 4 mm in 60% of the specimens, 5 mm in 16%, 3 mm in 16% and 2 mm in 8% of the specimens. The course of the vertical or mastoid segment of the facial nerve showed variations in its descent from the second genu to the stylomastoid foramen. In 60% of specimens, it was showing a vertical descent upto the stylomastoid foramen, in 20% each the nerve was observed to descend slightly laterally or medially.

Angle at the second genu between the tympanic and mastoid segment was 110° in 64%, 95° in 32% and 125° in 4% of the specimens. The mean depth of the second genu from outer cortex was 21.6 mm ± 2.62 (range 18 mm to 26 mm). The distance between the ampullary end of the horizontal semicircular canal and second genu of the facial nerve was 2 mm ± 0.76 (range 1 mm to 3 mm). The second genu was observed to have a normal course in 68% of the specimens, a lateral hump or postero-lateral bulge below the horizontal semicircular canal in 20% and in 12% it was lateral to the prominence of the horizontal semicircular canal.

In all the specimens the chorda tympani nerve was found to point upwards and was at a mean distance of 6.2 mm ± 2.66 (range 2 mm to 12 mm) from stylomastoid foramen. The site of origin of chorda tympani was 4 to 8 mm proximal to the stylomastoid foramen in 64%, 8 to 12 mm in 20%, and 2 to 3 mm in 16% of the specimens [Figure 2]. Mean depth of the facial nerve from the cortex at the stylomastoid foramen was 12.8 mm ± 2.42 (range 9 mm to 17 mm). In 72% of the specimens, the depth of facial nerve at stylomastoid foramen was 15 mm, in 20% it was 17 mm and in rest 8% it was 9 mm.

DISCUSSION

Throughout the era characterized by frequent operations for mastoiditis, one of the principal operative hazard was traumatic injury to the endotemporal segment of the facial nerve resulting in temporary or permanent facial paralysis. Most common site for the facial nerve injury during ear surgery is the tympanic segment. If the anatomical landmarks are followed and extra caution taken, iatrogenic injury to the facial nerve can be prevented (Warren et al,). In our study the

Figure 1: Showing Tympanic segment changing into vertical segment at second genu near pyramidal eminence

Figure 2: Showing chorda tympani originating from mastoid part of facial nerve

mean length of tympanic and mastoid segment was found to be 11.1 mm ± 0.88 (range 9 mm to 13 mm), 15.4 mm ± 2.4 (range 10 mm to 20 mm) respectively and mean total length of tympano-mastoid segment was 26.4 mm, which is considerably at variance to the Japanese and the American skulls probably due to different cranial configuration of various races [Table 1].

The cochleariform process is most consistent landmark for the tympanic segment of the facial nerve in surgery of chronic suppurative otitis media. Its location is like a anatomical guidepost to identify and localize the facial nerve, indicating the anterior limit of the tympanic segment (Sullivan and Smith, Haynes). The anterior part of the tympanic segment of facial nerve in 68% of specimens was observed to lie slightly above and medial to the cochleariform process at a mean distance of 2 mm ± 0.67 whereas in 32% it was adjacent to the tympanic segment. The tympanic segment of the facial nerve was found to lie above the oval window in all specimens whereas Proctor and Nagar and Proctor reported that tympanic segment was coursing above oval window in 66% only.

The course of the tympanic segment of the facial nerve in 80% of specimens was found to incline inferiorly and descend obliquely and in 20% it was horizontal, parallel to the plane of the horizontal semi-circular canal. Similar findings have been reported by Botman and Jongkees, Rulon and Hallberg, Proctor and Nagar and Proctor.

Dehiscence of the bony facial canal in the horizontal segment within the middle ear entails a risk of immediate or delayed facial paralysis during middle ear surgery. The facial canal containing the facial nerve over the oval window was observed to show bony dehiscence in 12% of specimens whereas earlier workers reported dehiscence in the range of 6% to 70%. (Guild, Hough, Beddard and Saungers.

Table 1: Length of facial nerve segments of Japanese, American and Indian subjects

Race	Tympanic Segment (mm)		Mastoid Segment (mm)	
	Max.	Min.	Max.	Min.
Japanese (Kudo & Nori, 1974)	15.60	8.67	15.70	11.80
American (Rulon & Hallberg, 1962)	11	8	14	9
Indian (present study)	13	9	20	10

In 68% of specimens, the curvature of the second genu of the facial nerve was observed to show a normal course. In 20% the second genu of the facial nerve showed lateral hump or postero-lateral bulge below the horizontal semi-circular canal. Similar findings are reported by Fowler and Kettel. In rest 12% the second genu of the facial nerve was found to be lateral to the prominence of the horizontal semi-circular canal. This position of the second genu of the facial nerve is especially susceptible to injury during mastoidectomy as has been emphasised by Sullivan and Smith, Kettel and Green et al. The facial nerve at the second genu was found to form an angle of 95°-125° between the tympanic and the mastoid segment. Similar observation is reported by Proctor and Nagar and Proctor. The mean distance at the level of the posterior border of the oval window and the mastoid segment of the facial nerve was found to be 4 mm ± 1.29 (range 2 mm to 6 mm), which is in agreement with the finding of Proctor and Nagar and Proctor. The mean distance between the posterior border of round window and the mastoid segment of facial nerve was 4 mm ± 1.22 which is a significant landmark for surgical approach through facial recess to scala tympani during cochlear implantation.

In 60% of specimens, the mastoid segment of the nerve was showing a vertical descent upto stylomastoid foramen, in 20% it was observed to descend slightly laterally and in 20% the nerve had a medial descent. Similar findings are reported by Proctor and Nagar, whereas Sendulski reported 55% descend medially, 16% laterally and 29% in sagittal plane.

The site of origin, of the chorda tympani nerve was 4 to 8 mm proximal to the stylomastoid foramen in 64% whereas Kullman et al, reported that chorda tympani nerve arises 3 mm proximal to stylomastoid foramen in 75%. Over the years, the variations in the course of the mastoid segment of the facial nerve have become apparent. It does not always follow the vertical course as described in textbooks, but shows variations of surgical significance between the second genu and the stylomastoid foramen.

CONCLUSIONS

A number of anomalies are seen in the course and length of facial nerve in the tympanic and mastoid segment. The relation to various structures like cochleariform process, pyramidal eminence, lateral semicircular canal, round window, oval window and digastric ridge is also variable.

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ERRATUM

From the below article printed in special issue-1 in the pages 179-181 i.e.
Visual Deterioration After Trans-Spenoidal surgery for Pituitary adenoma.
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