Original Article

Association of Temporal Bone Pneumatization and Dehiscence of Facial Nerve Canal: A Cadaveric Study

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Abstract

Introduction: Facial nerve runs an extensive and complicated course through the temporal bone. Integrity of this nerve is affected by the anatomy of temporal bone. Hence, in-depth knowledge of facial canal and its surrounding structures is of utmost importance to avoid any iatrogenic injury during surgery of the middle ear. Temporal bone pneumatization has a great influence on pathogenesis and prognosis of temporal bone diseases. Hence, this study was planned to observe the pneumatization status of the temporal bone and whether there is any association between pneumatization of temporal bone and dehiscence of facial canal. **Materials and Methods:** The present study was conducted on 30 formalin-fixed adult temporal bones. Dissection of temporal bone was done in the Anatomy Department, TMMC and RC, TMU, Moradabad. Various cells groups were observed in the temporal bones. Facial canal was exposed, and any dehiscence present was then noted. **Results:** Out of total temporal bones studied, 20 belongs to the right side and 10 of the left side. Pneumatization status of bones was observed by the assessment of different cells present in the bone. Out of 30 bones, 19 (63.3%) bones were well pneumatized, in which 14 bones were of right side and five were of left side. About 11 (36.6%) bones were poorly pneumatized. In which, six were of the right side and five of the left side. In this study, dehiscence of the facial canal was observed in 9 (30%) temporal bones in which eight bones were well pneumatized and one bone was nonpneumatized. In our study, 21 (70%) bones showed no or insignificant dehiscence. Fisher exact test and Spearman's correlation test were applied to observe any association between the two variables. **Conclusion:** No association exists in between pneumatization of temporal bone and dehiscent facial nerve canal.

Keywords: Dehiscence, facial canal, pneumatization, temporal bone

Introduction

The temporal bone or os temporal is a paired, irregular, and thickest bone present in the human skeleton, located on the sides and at the base of the skull. The anatomy of temporal bone is complex and difficult to understand. An in-depth understanding of the anatomy is essential to be able to identify the etiology of ear diseases and for their safe and effective treatment.[1] The temporal bone comprises four developmentally different parts: Squamous (Flat part), tympanic part mastoid, and petrous parts, and it articulates with the parietal, sphenoid, occipital, and zygomatic bone. The term "pneumatization" commonly refers to the extent of air cells in the temporal bone. According to the pneumatization pattern, temporal bone can be divided into largely pneumatized, well pneumatized, poorly pneumatized, or finally nonpneumatized (sclerotic bones). The process of pneumatization takes place from the perinatal age to puberty and is genetically determined, although strongly influenced through the environment to which these bones are exposed during the development. The gradation of pneumatization varies widely, and no two temporal bones are the same, even in the same person, which creates mastoid surgery so challenging. Surgeons must understand and know the extent of air cells to be expected in the different regions of this bone and he must also understand that when to discontinue exenteration of the air cells.[2]

Cholesterol granuloma, otitis media, and cholesteatoma are the temporal bone diseases that has been related to variable level

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of temporal bone pneumatization (TBP).[3-5] The pneumatized zones of these bones represent the zones of minimal resistant which permits the proliferation of these pathologies inside the temporal bone.[6] The increased incidence of cerebrospinal fluid fistula after skull base surgery is also associated with the increased TBP.[7-9]

The facial nerve was first recognized and described by Galen (130–200 BC), this cranial nerve is the nerve of the 2nd branchial arch and is made up of approximately 10,000 sensory, parasympathetic fibers and motor fibers.[10] For years, it was believed that facial canal and facial nerve abnormalities did not occur, and the nerve pathway appeared to be protected in its bony canal from outside influences and injury. Therefore, from time to time, when the 7th nerve (facial nerve) has been injured alongside its extent, it has been presumed that the injury was still because of negligence or deficiency of surgical skill. However, now it is well documented that the extent of the 7th nerve canal (facial canal), as it passes through the temporal bone is somewhat variable and sometimes presents bone dehiscence, which are of vital importance to otologists.[11]

Numerous factors such as abnormal development or pathologies can be predisposed of facial nerve canal dehiscence (FND), which directly or indirectly affect the integrity of the bony canal of FN.[12-14] Inadvertent injury can lead to 7th cranial nerve dysfunction due to surgeon's negligence at the site where bone defects are frequently expected.

To avoid these complications, it is really essential to identify the comprehensive relationship of this nerve with the adjacent structures within the mastoid bone.

With these considerations, this study was planned to assess the pneumatization status of the temporal bone. Moreover, to study whether the pneumatization pattern of temporal bone affects the integrity of facial nerve canal.

Materials and Methods

Study design

This study was an observational study.

Study sample

The present study was performed on 30 formalin-fixed adult temporal bones. Out of which, 20 belongs to the right side and 10 were of the left side.

Study setting

The study was done over a period of 1 year and 8 months from October 2019 to May 2021. Deformed and mutilated temporal bones were omitted in the present study. The study has been approved by the Institutional Review Board (IRB/32/2021).

Dissection of temporal bone was done in the, TMMC and RC (department of Anatomy), TMU, Moradabad. The full lateral approach has been attempted to achieve whole middle ear exposure. After the removal of soft tissue, the temporal bone was fixed in the temporal bone holder. McEwen's triangle was identified. The complete dissection of external auditory meatus, mastoid bone, and the flat (squamous) portion of the temporal bone was performed.

Various cell groups have been observed in the temporal bone, including periantral cells, squamosal cells, tip cells, retrofacial cells, sinodural cells, perisinus cells, zygomatic cells, retrosigmoid cells, and retrolabyrinthine cells. The pneumatization pattern of each temporal bone was noted as well pneumatized or poorly pneumatized. A mastoid with a large antrum and well-defined cellularity in the periantral/perisinus/perifacial area was labeled as well pneumatized, while the one with a small/contracted mastoid and periantral sclerosis was labeled as poorly pneumatized.[15]

The entire 7th nerve canal was shown throughout its "tympanomastoid section". The facial canal was observed for any break in continuity or visible lacunae, and then, the integrity of the canal was observed by palpation with a metal surgical instrument.

Statistical analysis

The collected data were entered on MS Excel and analyzed using the SPSS statistics for windows version 27.0 (IBM SPSS Statistics for windows, Armonk, NY: IBM Corp). Descriptive statistics were run for all the quantitative variables under the study. Association between TBP and dehiscence was assessed with the help of Fisher exact test and two-tailed *P* value was calculated to be 0.1000. No significant association found in between pneumatization and dehiscence. All the categorical variables were present as frequency and percentage. Spearman's correlation assessment was used for presumptive examination. *P* value set at (<0.05) was considered statistically significant for the assessment.

Results

In the present study, 30 temporal bones were studied by gross dissection. Out of total bones studied, 20 were of right side and 10 were of left side. Pneumatization status of bones was observed by the assessment of different cells present in the bone [Figure 1]. Out of 30 bones, 19 (63.3%) bones were well pneumatized, in which 14 bones were of right side and five were of left side. About 11 (36.6%) bones were poorly pneumatized [Figure 2] in which six were of right side and five of left side [Table 1].

In this study, dehiscence of the facial canal was observed in 9 (30%) temporal bones in which eight bones were well pneumatized and one bone was poorly pneumatized [Figure 3]. In our study, 21 (70%) bones showed no or insignificant dehiscence. Fisher exact test was applied to observe the association between pneumatization and dehiscence. No

Table 1: Pneumatization status of temporal bones

	Right side temporal bone (20)	Left side temporal bone (10)	Total temporal bones (30) (%)
Well pneumatized	14	5	19 (63.3)
Poorly pneumatized	6	5	11 (36.6)

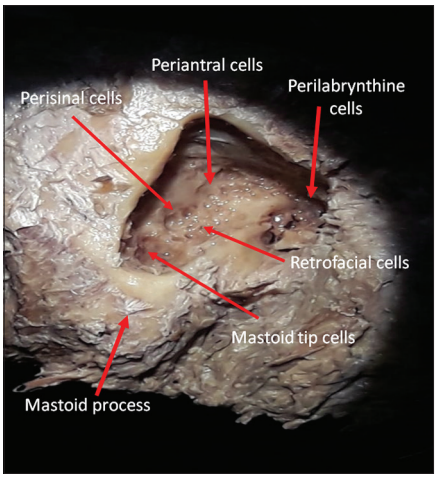

Figure 1: Well pneumatized temporal bone showing pneumatic cells

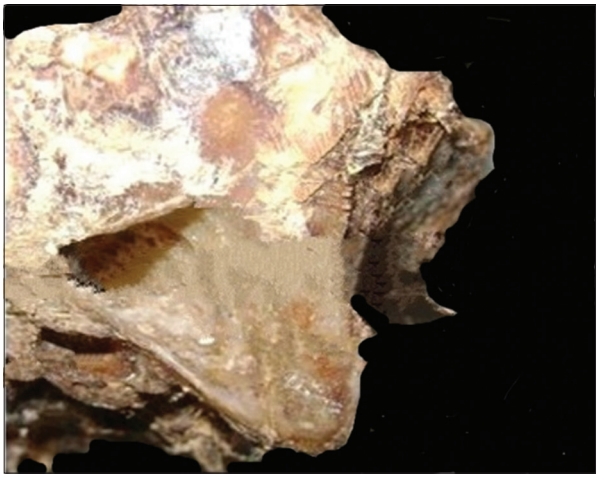

Figure 2: Poorly pneumatized temporal bone showing sclerosis

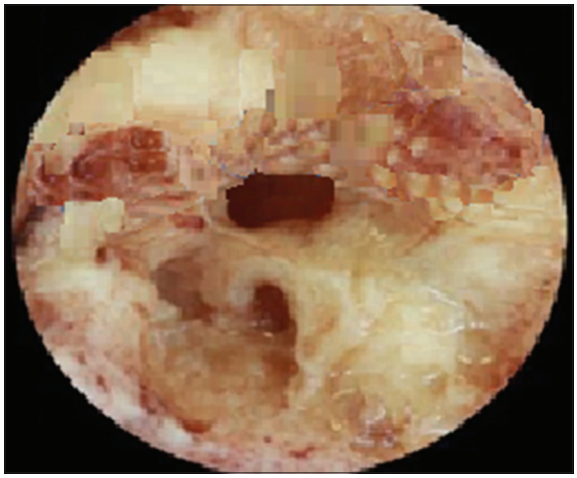

Figure 3: Dehiscence observed in the facial canal

association was found in between pneumatization of temporal bone and dehiscence [Table 2].

The Spearman correlation coefficient value of 1.96 between dehisced and pneumatized bones show that there is a weak positive correlation between them, whereas the Spearman correlation coefficient between dehisced and poorly pneumatized bone is 0.96 which shows that they are negatively correlated with each other. $P > 0.05$ for both cases which indicates that correlation between them is not statistically significant.

Table 2: 2×2 Contingency table between pneumatization and dehiscence of temporal bone

Temporal bones	Dehisced (%)	Nondehisced (%)	Total
Well pneumatized	8 (42)	11 (57.8)	19
Poorly pneumatized	1 (9.1)	10 (90)	11
Total	9	21	30

Table 3: Incidence of dehiscence of facial nerve canal

Author	Dehiscence present (%)	Number of temporal bones	Method of study
Beddard	25	52	Gross dissection
Mollica	25	64	Gross dissection
Cawthorne	20	31	Operative observations
Kaplan	7	100	Operative observations
Dietzel	57	211	Histological study
Takahashi	74	160	Histological study
Gupta	23	30	Gross dissection
Alomiery	41	22	Gross dissection
Present study	30	30	Gross dissection

Discussion

The development of TBP starts as early as in fetal life.[16] Pneumatization refers to both the process by which the epithelium expands into the developing bone and the resulting interconnected air cells within the temporal bone.[17] According to many studies, correlations exist between the degree of TBP and the various pathologies such as otitis media, cholesteatoma, and atelectasis while the role of TBP remain indefinite.[18-22] Increased incidence and poor prognosis of the above-mentioned pathologic disorders are associated with poor pneumatization of temporal bone. The seventh nerve canal, as it passes through the temporal bone, may display bony dehiscence, variations, and peculiarities of its normal development. All of the features mentioned may have clinical and surgical importance. Pathological element can assume a significant part either in exacerbating existing canal dehiscence or in the occurrence of facial canal dehiscence. In such cases, the patient might present with facial paresis. However, several cadaveric dissections and radiological imaging techniques such as high-resolution computed tomography now have revealed many anatomical variations in the course of the facial nerve including displacement, dehiscence of the bony fallopian canal, and reduplication of the nerve in the normal population.[23]

The incidence in our study is higher than that reached in other gross dissection studies such as those of Beddar

and Saunders (1962)-which indicates a 25% incidence of dehiscence (14/52) and Gupta *et al*. which reports an incidence of 23%.[24,25] Various researchers report different incidence of dehiscence, which might be due to different approaches [Table 3]. Dietzel and Takahashi and Sando observe the incidence of dehiscence of facial canal by histological study and report the incidence of 57% and 74% dehiscence, respectively.[26] Alomiery *et al*. conducted a research on dehiscence of facial canal by different techniques and found the incidence of FND was 41% (9/22 specimens) and among all techniques for examination analyzed, the gross anatomy dissection method proposes predominance in yielding precisely valid data.[27] Dehiscence of the facial canal must be at least 1 mm in size to be detected during surgery.[28] However, the incidence of facial canal dehiscence is higher in histological studies, since it can be detected in microdehiscences of <1 mm in cadaveric studies.[29]

Conclusion

Out of 30 temporal bones studied, only 63.33% bones were well pneumatized whereas rest 36.6% was poorly pneumatized or sclerotic. From the total bones studied, only 30% temporal bones showed dehiscence of facial nerve canal. It is apparent from the present study that no correlation exists in between the pneumatization and facial nerve canal dehiscence. This study disagreed the role of pneumatization in the dehiscence of facial canal. Hence more such cadaveric studies on temporal bone dissection gives adequate knowledge and confidence to surgeon both intra and postoperatively. Thorough knowledge of temporal bone surgical anatomy is mandatory to know variable anatomy of facial nerve to prevent iatrogenic injury and further complications.

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Conflicts of interest

There are no conflicts of interest.

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