

## Study of Eustachian Tube-Reid's Plane Angles in HRCT Temporal Bone of Patients with Chronic Otitis Media

Deepa G<sup>1</sup>, Shrikrishna BH<sup>2</sup>

### Abstract

**Introduction:** Chronic Otitis media is still a serious disease all around the world. The disturbance in the ventilation of the middle ear appears to play a major role in etiology of chronic otitis media especially in formation of cholesteatoma. The angle between the Reid's plane and the eustachian tube (ET) decides the ventilating function of the eustachian tube. This study aimed to compare the mean of Eustachian tube- Reid's plane angle in Chronic Suppurative Otitis Media (CSOM) patient with and without cholesteatoma. **Objective:** To compare the mean of Eustachian tube - Reid's plane angle in Chronic Suppurative Otitis Media (CSOM) patients with and without cholesteatoma using high resolution computed tomography (HRCT) Temporal bone. **Materials and Methods:** This is a retrospective study of 2 patient groups. First group consisted of 50 patients with Chronic Otitis media with cholesteatoma and the second group consisted of 50 patients without cholesteatoma. The presence or absence of cholesteatoma was decided based on records of intra-operative findings and HRCT temporal bone reports. The Reid's plane- ET angle was measured using High Resolution Computed Tomography (HRCT) of the temporal bones in both groups and compared. **Results:** The mean Reid's plane-ET angle was 27.20 degrees in the first group with cholesteatoma with a standard deviation of +1.92. The mean Reid's plane-ET angle was 31.69 degrees in the second group without cholesteatoma with a standard deviation of +2.25. Independent t test (student t test) used for analysis. t value was 10.709. p value was <0.0001. The findings were statistically significant. There was highly significant difference in mean Eustachian tube- Reid's plane angle between group 2 and group 1 (it was higher among group 2 compared to group 1). **Conclusion:** The Reid's plane-ET angle has a major role in assessing the eustachian tube dysfunction. A reduced Reid's plane-ET angle noted in a pre-operative tomographic assessment gives clues about the possibility of cholesteatoma in chronic otitis media. This assessment will help the ear surgeon to plan surgery accordingly for better post-operative results.

**Keywords:** otitis media; cholesteatoma; eustachian tube; middle ear ventilation; computed tomography.

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### Introduction

Chronic suppurative otitis media (CSOM) is a major health burden throughout the world. It is a long standing infection of the middle

ear cleft associated with tympanic membrane perforation and ear discharge. The infection may be associated with cholesteatoma or not associated with cholesteatoma. The cholesteatomatous type of CSOM is unsafe as it is associated with serious intra-temporal and intra-cranial complications.

Factors which play role in the occurrence of CSOM are genetic pre-disposition, environmental factors and craniofacial anatomy. The size of the mastoid and Eustachian tube are cranio-facial anatomy which related in the occurrence of the CSOM disease. Middle ear ventilation, drainage, and protection of the middle ear to pathogens are major functions of the eustachian tube. There are many studies on the function of Eustachian

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tube. Dysfunction of the eustachian tube leads to poor ventilation of the middle ear cavity leading to formation of retraction pocket and cholesteatoma [1]. Aksoy et al. has observed in their study that a more horizontal Eustachian tube angle will cause eustachian tube dysfunction and impaired clearance in the middle ear. In their study, there was a significant relationship between lower eustachian tube angle and CSOM with cholesteatoma [2]. However, the role of the Eustachian tube angle and the relationship with the occurrence of CSOM has not been widely studied [3]. Research on the anatomy of eustachian tubes involving radiology is still less. Takasaki K et al. have shown in their study how one can measure the angle and length of the eustachian tube on computed tomography using the multiplanar reconstruction technique. By using multiplanar reconstruction techniques, the image can be adjusted as desired by changing the angle of the plane every 0.5 degrees and changing the station every 1 millimetre. Angle of the ET is the angle of a straight line from the pharyngeal orifice to the tympanic orifice of the ET against Reid's standard plane, which is defined as the plane connecting the infraorbital margins with the upper margins of the external auditory meatus [4].

The purpose of our study is to measure the eustachian tube-Reid's plane angles in patients with CSOM with or without cholesteatoma using HRCT temporal bone and compare the findings.

### Materials and Methods

Our study is an observational; hospital based retrospective study conducted during June 2015 to May 2017. Ethical clearance was received from our institutional ethical clearance committee. Our study consisted of patients of CSOM who underwent surgeries in the department of ENT at Navodaya Medical College Hospital, Raichur during the above mentioned period. Paediatric patients of age less than 8 years and those showing a damaged temporal bone on tomography were excluded from the study. The patients were divided into 2 groups. First group consisted of 50 patients with CSOM with cholesteatoma and the second group consisted of 50 CSOM patients without cholesteatoma. The presence or absence of cholesteatoma was decided based on records of intra-operative findings and HRCT temporal bone reports. A multi-slice CT scan was used in the study with 1 mm of slice thickness. The horizontal plane, crossing bilateral inferior orbital wall and the bilateral upper wall of the external ear canal known as "Reid horizontal

plane," is selected. The orifices of eustachian tubes can be seen in the same section by using multiplanar reconstruction technique in the coronal images. Pharyngeal and tympanic orifices of the eustachian tubes were demonstrated exactly at the same section. This direction was determined as the line of the eustachian tube. The angle was measured between the horizontal plane and this line. The data collected was tabulated and statistically analysed. Statistical significance between the two groups was calculated by paired t-test (SPSS software). p value < 0.05 was considered to be statistically significant.

### Results

The mean Reid's plane-ET angle was 27.20 degrees in the first group with cholesteatoma with a standard deviation of  $\pm 1.92$ . The mean Reid's plane-ET angle was 31.69 degrees in the second group without cholesteatoma with a standard deviation of  $\pm 2.25$ . Independent t test (student t test) used for analysis. t value was 10.709. p value was <0.0001. The findings were statistically significant. There was highly significant difference in mean Eustachian tube-Reid's plane angle between group 2 and group 1 (it was higher among group 2 without cholesteatoma compared to group 1 with cholesteatoma).

### Discussion

The middle ear and mastoid space is ventilated by a properly functioning eustachian tube. The Reid's plane-ET angle has a role in proper functioning of the eustachian tube. The more horizontal angle of the Eustachian tube causes eustachian tube dysfunction and leads to poor ventilation of the middle ear cavity leading to otitis media. Children are more prone for otitis media compared to adults due to their more horizontally placed eustachian tube. In adults, a horizontal orientation of the eustachian tube will lead to retraction pockets in the tympanic membrane which is a precursor of cholesteatoma.

The supporters of the genetic theory of the temporal bone pneumatization claim that the temporal bone pneumatization is genetically determined. On the other hand, the supporters of the environmental theory of the temporal bone pneumatization claim that the temporal bone pneumatization is reduced due to chronic otitis media which in turn is caused by environmental factors such as frequent upper respiratory tract infections, poor living conditions and smoking. The variation in the ET angles can affect the middle ear and mastoid pneumatization secondary to poor ventilation through ET [4].

Our study proves that lower Reid's plane-ET angle is associated with cholesteatoma. The difference brings to mind that the idea may be a factor in combination with other factors in the development of cholesteatoma in these patients. A similar finding was noticed by Aksoy et.al, where in there was a significant relationship between lower eustachian tube angle and CSOM with cholesteatoma [2]. Takasaki et al. detected the eustachian tube angles in Reid plane  $27.3^{\circ} \pm 2^{\circ}$  for the right ear,  $27.3^{\circ} \pm 2.8^{\circ}$  for the left ear in the normal adult population. These angles of the children were found significantly lower (for the right ear  $20.4^{\circ} \pm 3.5^{\circ}$ , for the left ear  $21.2^{\circ} \pm 4.8^{\circ}$  in the children with effusion and serous otitis media; the angles in the children with otitis media without effusion were  $19.9^{\circ} \pm 3^{\circ}$  right, left  $20.0^{\circ} \pm 3.6^{\circ}$ ,  $p < 0.01$ ) [4].

Eustachian tubal dysfunction leads to middle ear pathology. In an experiment, excision of some tensor veli palatini muscle fibres in the pterygoid hamulus in the palate caused negative pressure in the middle ear and accompanied by the occurrence of middle ear effusion. Total excision resulted in under-pressures in the middle ear followed by persistent middle ear effusion [5].

Eustachian tube is a complex and in-accessible structure [6]. However, if its functional status is ignored by the ear surgeon, it will lead to failure of tympanoplasty surgeries, retraction pockets post-operatively and recurrence of cholesteatoma. Thus, ET dysfunction is an important prognostic factor for the success in tympanoplasty [7]. If the Reid's plane-ET angle is known pre-operatively to be on lower sides, the ear surgeon can compensate for the apparent dysfunction of the eustachian tube by doing cartilage tympanoplasty to prevent retraction pockets in post-operative period. During cartilage tympanoplasty, the graft (temporalis fascia/perichondrium) is supported by single cartilage slice anteriorly. This offers extremely reliable method for reconstruction of tympanic membrane in cases of ET dysfunction [7]. In cases of severe ET dysfunction due to pre-tympanic segment narrowing, balloon tuboplasty of the pre-tympanic segment can be combined with tympanoplasty, resulting in significantly high graft take up rate and restoration of middle ear integrity [8,9].

## Conclusion

Although CSOM with cholesteatoma is a multifactorial disease, eustachian tube dysfunction has

an important role to play in its etiology. The Reid's plane-ET angle has a major role in assessing the eustachian tube dysfunction. A reduced Reid's plane-ET angle noted in a pre-operative tomographic assessment gives clues about the possibility of cholesteatoma in chronic otitis media. This assessment will help the ear surgeon to plan surgery accordingly for better post-operative results.

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