Comparison between the angle of Eustachian tube in patients with chronic suppurative otitis media and normal ears based on computed tomography scan of temporal bones in Haji Adam Malik general hospital Medan

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Abstract. The function of the Eustachian tube plays a significant role in increased risk chronic suppurative otitis media (CSOM). The angle of the Eustachian tube is a predisposing factor for Eustachian tube dysfunction and clearance disorder of the middle ear. The aim of this study was to compare the mean angle of a Eustachian tube of CSOM ears and normal ears. This research was a cross-sectional study consisting of 19 patients of CSOM without cholesteatoma, 19 patients of CSOM with cholesteatoma and 19 patients with normal ears. All patients were examined using CT Temporal, and the angle of the eustachian tube was measured using multiplanar reconstruction technique. The mean angle of Eustachian tube in CSOM patients without cholesteatoma was 32.82° (SD=3.82), in CSOM with cholesteatoma was 27.74° (SD=4.44) and in normal ears was 33.61° (SD=3.83). Based on Kruskal-Wallis test, there was a significant difference in the angle of a Eustachian tube of these three groups (p<0.001). There was a significant difference between the mean angle of the Eustachian tube in CSOM ears and normal ears.

1. Introduction
The anatomy of the Eustachian tube is associated with otitis media. Middle ear ventilation, drainage and protection of the middle ear to pathogens are major functions of the Eustachian tube. The Eustachian tube in children is shorter and more horizontal than in adults. In adults, the tube forms an angle of 30-40° with a horizontal plane, whereas in children it only forms an angle of 10°. The more horizontal angle of the Eustachian tube, the more it may cause otitis media in children.[1] CSOM in an adult is predicted by recurrent acute otitis media (AOM) or effusions otitis media (EOM) in childhood.[2]

The multiplanar reconstruction technique (MPR) is one of several new imaging techniques in computed tomography (CT) that makes the anatomical features of the Eustachian tube more apparent. With multiplanar reconstruction techniques, the image can be adjusted as desired by changing the angle of the plane by 0.5 degrees and changing the place by 1 millimeter.[3]

The aim of this study is to compare the mean angle of Eustachian tube in patients with CSOM and normal ears based on temporal CT scans. The angle of the Eustachian tube will be measured by multiplanar reconstruction techniques. Length of the Eustachian tube was defined as the distance from the pharyngeal orifice to the tympanic orifice. The angle of the Eustachian tube was defined as the...
angle of the straight line representing the length of the Eustachian tube against Reid's standard plane, which is defined as the plane connecting between the infraorbital margins and both upper margin of the external auditory meatus.[3]

Figure 1. Reid’s horizontal plane.[4]

2. Methods
This study was analytical research with across-sectional design. This study was performed on outpatients care in otology division of Otorhinolaryngology Department of Haji Adam Malik General Hospital Medan. Temporal CT scan performed at Radiology Department of Haji Adam Malik General Hospital Medan between May 2017 - August 2017.

Subjects were 57 patients consisting of 19 people in the CSOM with cholesteatoma group, 19 people in the CSOM without cholesteatoma group and 19 people in the normal ear group. Subjects were enrolled by consecutive sampling technique. The criteria for sample selection include CSOM patients and normal ears that have been undergone a temporal CT scan with 1 mm cut. CT scan of patients which was damaged or pieces of CT scan is too large (≥ 1mm) were excluded.

The diagnosis of CSOM was made based on anamnesis, history, physical examination and CT scan. If the results of CT scan showed the suspicion of cholesteatoma, then it was confirmed by the presence of cholesteatoma during tympanomastoidectomy surgery. Normal ears are from patients who were not diagnosed with CSOM or normal people who have performed a temporal CT scan with 1 mm cut. The length of the Eustachian tube was measured by using the Osirix lite program. The length of the Eustachian tube was defined by the distance from the pharyngeal orifice to the tympanic orifice and Reid’s standard plane (the plane connecting the infraorbital margins and both upper margins of the external auditory meatus).

Figure 2. MPR technique on Osirixlite program.
3. Results

Table 1. Results measurement angle of the eustachian tube.

| Angle tube                     | n=19 | Mean (SD) | p         |
|-------------------------------|------|-----------|-----------|
| CSOM with cholesteatoma       |      | 27.47 (4.44) | 0.001b   |
| CSOM without cholesteatoma    |      | 32.82 (3.82) | <0.001a   |
| Normal ears                   |      | 33.61 (3.83) | 0.611d   |

Table 2. Mean difference angle of Eustachian tube in subjects CSOM with cholesteatoma, without cholesteatoma and normal ears.

| Angle tube                     | n=19 | Mean (SD) | p         |
|-------------------------------|------|-----------|-----------|
| CSOM with Cholesteatoma (C)   |      | 27.47 (4.44) | <0.001b   |
| CSOM without Cholesteatoma (NC)| | 32.82 (3.82) | <0.001c   |
| Normal ear (N)                |      | 33.61 (3.83) | 0.611d   |

In this study, the angle of Eustachius tube in CSOM with cholesteatoma subjects showed a mean of 27.74° (SD=4.44), in CSOM without cholesteatoma subjects showed a mean of 32.82° (SD=3.82) and in subjects with normal ears showed a mean of 33.61° (SD=3.83).

The Eustachian tube angle measurements in the three groups of subjects showed that CSOM with cholesteatoma group had the lowest mean value of ET angle of 27.47° (SD=4.44). The largest Eustachian tube angle was found in subjects with normal ear with the mean value of 33.61° (SD=3.83). Meanwhile, in the CSOM without cholesteatoma group showed the mean value of 32.82° (SD=3.82).

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4. Discussion
The anatomy and function of Eustachian tube play a significant role in increasing the risk of CSOM. The more horizontal and short Eustachian tube causes an increased risk of bacterial reflux from the nasopharynx to the middle ear and facilitates the occurrence of acute and chronic otitis media. During the occurrence of upper respiratory tract infections, viral and bacterial infections in the nasopharyngeal region may infect the middle ear through the Eustachian tube. Inflammation of the Eustachian tube mucosa causes obstruction in the narrowest portion of the Eustachian tube, the isthmus. This obstruction causes a negative pressure in the middle ear effusion as well as adisturbance in the drainage of middle ear secretions to the nasopharynx.[5]

In recurrent inflammatory conditions, there is an increased risk of retraction, adhesion, and release of tympanic membrane cells. In the process of release of the tympanic membrane, some cells of the tympanic membrane are trapped in the tympanic cavity and form the cholesteatoma.[6,7]

In this study, the mean angle of Eustachian tube is more horizontal in the CSOM with cholesteatoma group than CSOM without cholesteatoma. The mean angle of the Eustachian tube patients without cholesteatoma in this study was 32.82° (SD=3.82) and with cholesteatoma 27.7° (SD=4.44).

Aksoy et al. (2016) in Turkey reported a study of the mean angle of the Eustachian tube in 210 patients who undergone a temporal CT-scan and concluded that there was a significant relationship between CSOM patients with cholesteatoma with a more horizontal angle of the Eustachian tube.[1]

In adults, the Eustachian tube forms an angle of 30-40° with a horizontal plane, whereas in children it only forms an angle of 10°. [1] Dinc et al. (2015) in Turkey measured the angle of the Eustachian tube is more horizontal in CSOM than in normal ears.[2] Takasaki et al. measured the angle of the Eustachian tube using Reid’s plane, and they obtained 27.3° ± 2° for the right ear and 27.3° ± 2.8° for the left ear in normal ears group. Graves and Edwards reported the angle of Eustachian tube is 30°-40°.[1]

In this study, the mean angle of Eustachian tube in the normal ear group was 33.61° (SD=3.83), with the minimum angle of 22.79° and the maximum angle of 38.86°.

The results were analyzed by using Kruskal-Wallis test. It showed that there was a significant difference in the mean angle of the Eustachian tube of these three groups (p<0.001). Analysis of the subjects with cholesteatoma and without cholesteatoma also showed a significant difference in the mean angle of Eustachian tube (p<0.001). The results of the analysis between subjects with cholesteatoma and subjects with normal ears showed significant differences in angle tube (p<0.001). There was no significant difference in the angle of the Eustachian tube between subjects without cholesteatoma and subjects with normal ears (p=0.611).

Aksoy et al. measured the angle of the Eustachian tube in CSOM patients with cholesteatoma and without cholesteatoma compared to those with normal ears and reported that there was a significant difference among the groups. The angle of the Eustachian tube was more horizontal in CSOM with cholesteatoma compared to the normal ears. At the same time, they also measured the angle of the Eustachian tube in CSOM patients with cholesteatoma and without cholesteatoma and found that the angle of the Eustachian tube without cholesteatoma was significantly higher than CSOM with cholesteatoma.[1]

Dinc et al. (2015) concluded that the angle of the Eustachian tube was significantly decreased and more horizontal in CSOM than in normal ear. A more horizontal angle of the Eustachian tube may be a predisposing factor for chronic otitis media.[2]

5. Conclusion
CSOM is still a common problem in the world. In this study, there was a significant difference in the angle of the Eustachian tube among these three groups.

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