Comparison of angle, length, and diameter of the eustachian tube of safe and unsafe CSOM based on CT scan in Dr. Zainoel Abidin General Hospital, Banda Aceh, Indonesia

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ABSTRACT

Introduction: Damages in middle ear structures correlated with tubal dysfunction and impaired drainage; thus, it’s associated with changes in angle, length, and tubal diameter. This study aimed to determine the ratio of angle, length, and diameter of Eustachian tube with safe and unsafe types of chronic suppurative otitis media (CSOM).

Methods: Cross sectional analytical retrospective design, CT-Scan assessment for angle, length, the diameter of the tube on safe and unsafe type CSOM from January to December 2019 Angle is assessed using Reid’s line, tube length by a tympanic orifice to pharyngeal orifice line, Tube diameter is measured from anteroposterior pre-tympanic line diameter.

Results: From 61 CSOM patients, 70.5% safe type, 29.5% unsafe type. Safe type tube angle mean is 29.12°, unsafe type tube angle mean is 29.95°, normal ear 28.23°, thus no significant difference. A significant difference in the tube length (P = 0.001) is that the mean normal ear is 35.39 mm, smaller on safe type 33.58 mm, and unsafe type 29.53 mm. A significant difference in tubal diameter ratio (P = 0.001), normal diameter 2.19 mm, on safe type is 2.02 mm smaller, unsafe type 1.86 mm.

Conclusion: The smaller length and diameter of the Eustachian tube will lead to unsafe type CSOM.

Keywords: Chronic suppurative otitis media (CSOM), Eustachian tube dysfunction, Reid’s.

INTRODUCTION

Chronic suppurative otitis media (CSOM) is defined as chronic inflammation of the middle ear and mastoid cavity, accompanied by recurrent discharge of ear fluid (otorrhea) through the perforated tympanic membrane. The disease usually begins in childhood as a spontaneous tympanic perforation due to an acute middle ear infection or as a sequel of otitis media.1-3

60% (39-200 million) of CSOM patients had significant hearing loss globally. It is also reported around 21,000 people died from complications of CSOM. More than 90% of CSOM cases are found in Southeast Asia, West Pacific, and Africa.4 The prevalence of CSOM in each country shows a difference in number. Meanwhile, the official report in Indonesia shows incidence rate in each region ranged from 2.1-5.2%. Official data from RSUD dr. Zainoel Abidin Banda Aceh from January to December 2019 illustrates 297 patients who had OMSK.4

Continued tubal dysfunction will eventually interfere with the healing process further and worsen the disease progression. The method of damage in middle ear structures, bones, and cartilage of the Eustachian tube can be a guide to diagnose CSOM patients.1-2

Takasaki et al., Evaluated the Reid line from the infraorbital margin with the upper edge of the ear canal meatus and compared it with the line along the Eustachian tube from the tympanic orifice to the pharyngeal orifice. The condition is reported to correlate with otitis media.5

Aksoy et al., who evaluated the angle of the Eustachian tube in 210 patients with temporal CT scan, found a significant association between lower and horizontal Eustachian tube angles in otitis media. The low angle change is a sign of impaired drainage and cleaning of the Eustachian tube.6-8 Sarah et al. explained a significant difference in the mean angle of the Eustachian tube between CSOM patients with cholesteatoma and without cholesteatoma (p <0.001).7-8

In addition, to changes in the angle of the Eustachian tube, the CSOM condition also triggers changes in the anatomical characteristics of the length and diameter of the Eustachian tube. Dinc et al., who compared the length of the Eustachian tube in patients with chronic and otitis media, found that it was markedly shorter in chronic otitis media than in regular patients.9-11

Until now, there’s no further report regarding the evaluation of the angle, length, and diameter of the Eustachian tube inpatient with unsafe or safe type CSOM in Aceh. Therefore, this study aims to determine the ratio of angle, length, and diameter of the Eustachian tube in a patient with unsafe or safe type CSOM in
Methods
This study used a cross-sectional analytical design that compared the angle, length, and diameter of the Eustachian tube as safe and unsafe type CSOM. The sample was taken from the Radiology Department of RSUDZA Banda Aceh. Based on the evaluation of the temporal CT-scan, the Reids angle assessment was performed, the length of the tube was assessed by drawing a line from the tympanic orifice line to the pharyngeal orifice, and the diameter is evaluated by measuring the diameter of the pre-tympanic anteroposterior line. The study data was assessed with an independent T-Test with Mann-Whitney as an alternative test. The statistical analysis using Statistical Product and Service Solutions (SPSS) application version 20.

Result
Sixty-one patients included in this study, with CSOM patients' characteristics, were primarily found in the 31-50 years age group (57.4%), followed by the young age group 18-30 years (36.1%). In terms of gender, the male sex experienced the most CSOM (55.7%), while the female group was only 44.3%. Based on the location of CSOM, it can be seen that the right ear is the most affected than the left ear (from Table 1). From Table 2, that patients with safe type CSOM showed a mean of age 35.67 (17-61) years and did not differ too much from the unsafe type CSOM group 34.38 (24-47) years. In Table 3, that tube angle means were most prominent in the safe type of CSOM 29.12±2.71; meanwhile, the angle means looks smaller in normal ear conditions 28.23±2.46 and smaller in unsafe type CSOM 26.95±4.19. The difference analysis shows there is no significant result (p >0.05).

The evaluation of the length of the Eustachian tube showed that the greatest means were found in the standard ear group 35.39 mm (SD ± 2.00). In contrast, the tube length was smaller in the safe type CSOM condition 33.58 mm (SD ± 2.39), and it is smaller in unsafe type CSOM 29.53 mm (SD ± 2.81). In the ANOVA difference test analysis, there was a significant difference (p =0.00). So it can be explained that there was a substantial difference between the length of the Eustachian tube in normal ear conditions, safe and unsafe CSOM.

Meanwhile, the Eustachian tube diameter shows that the largest diameter was found in the normal ear 2.19 mm (SD ± 0.21), while in the CSOM condition, the diameter is 2.02 mm (SD ± 0.28) in safe type CSOM and smaller in unsafe type 1.86 mm (SD ± 0.18). We did a Kruskal Walls analysis, and the result of the p-value was 0.000. So it can be explained that there was a significant difference between the diameter of the Eustachian tube under normal conditions with safe and unsafe CSOM.

Discussion
This study was conducted on 61 patients included in the inclusion criteria experiencing safe and unsafe types of CSOM. There were 43 patients of the safe and 18 patients of the unsafe type. In comparison, the side of normal/healthy ear side was also examined, and the data is collected. In both groups, patients were generally adults with a mean of 35.67 (SD ± 17 - 61) years for the safe type, and not too different from the unsafe type 34.38 (SD ± 24-47) years. In gender, it can also be seen that the male sex experienced the most CSOM (55.7%) while the female group is (44.3%). Safe type CSOM patients were primarily found in male patients.
24 (39.3%) and female 19 (31.1%), while in the unsafe type of CSOM was found in male at 10 (16.4%) patients and eight females (13.1%). These results indicate that most of the patients are in the adult age group and are male.

Globally, it is reported that CSOM occurs primarily in children and adolescents. In a developing country, the child population is most vulnerable to infection and diagnosed with CSOM. Several studies have shown that the peak prevalence occurs at the age of 4-5 years and according to the school entry age. Although CSOM can occur at any age, 80-90% of cases occur in children under six years of age. Children diagnosed with Acute Otitis Media during the first year of life were much more likely to develop CSOM, wherein the first middle ear infection occurred after one year of age. In the sex group, a higher number of men are affected by outdoor activities and lousy hygiene, although it is common in men, in several research reports, there was no specific difference in the sex of CSOM patients.11,12

Nabila et al. explained that the incidence of CSOM in adults was in the range of 21-30 years, with safe CSOM as the most typical.13 Foster et al. explained that the highest age group of CSOM patients in Nigerian referral hospitals from 2009-2010 was age ranged from 11 to 20 years (22.7%) and continue to increase in the age group of 31-40 years (20.2%) and older adults> 50 years (16.7%). The distribution of CSOM cases has changed compared to the incidence of CSOM in 1990-1991, which showed the highest incidence in the 11-20 year age group (45.8%) and children aged 0-5 years (21.6%).14 Developed countries such as South Korea, which have a good level of community hygiene, the general CSOM population was found in the adult to the elderly group, from Chung et al., reported that the incidence increased with advancing age with a prevalence of 8.5 in the population (12.11%), while the adult age was 19-29, showed a prevalence of 9.84%.4

From gender characteristics of patients, that the safe type CSOM patient group was mainly found in male 24 (39.3%) and female 19 (31.1%), while the unsafe type was mostly in male 10 (16.4%) patients and eight women (13.1%). So far, the prevalence of sex on the incidence of CSOM is the same between men and women, and generally, there are no differences that affect it. The incidence of the male was higher in the report of Fontes et al. It was reported that 62.6% of adult CSOM patients were male, and 37.4% were female.15 Rosito et al. also noted, CSOM with labyrinthine fistula cholesteatoma in males most affected than females (55.6% vs. 54.6%). All of these groups were in the adult age group range 44.4 years.16 Another study report also found that among 356 CSOM patients with cholesteatoma, the average of patients’ age was 33.23 (19.81) years (ranged from 4–82 years), and 125 patients (35.1%) were women.17

In this study, we found that the ear location most affected in safe type was on the left ear than the right ear patients. While in the unsafe type of CSOM, the majority in the right ear than in the left ear patients. For the location of the ear with CSOM, there is generally no difference in the area of the affected ear. Rayneu et al. reported that CSOM with cholesteatoma who underwent surgery and bone structure damage found no difference between right and left ear.18 Similarity result from Rosito et al. that the right ear was most affected than the left ear. A total of 272 ears came from adults, but the location was not a significant indicator of cholesteatoma development.17

Comparison of the angle of the Eustachian tube is the safe and unsafe type CSOM
In this study, an evaluation of the Eustachian tube’s angle, length, and diameter was conducted. The results of the mean value of the safe type Eustachian tube angle was 29.12 (SD ± 2.71) more significant than the unsafe type condition 26.95 (SD ± 4.19) and normal ears 28.23 (SD ± 2.46). The results show there is no significant difference. However, the results of this study still illustrate the tendency for unsafe type CSOM to have smaller Eustachian tube angle values 26.95 (SD ± 4.19) compared to normal conditions and safe types. It is assumed that the angular results are not significant because most of the study subjects were adults who had patentated orbital and temporal bone structures as adults. Although there is a change in Eustachian tube drainage in CSOM, the Eustachian tube angle tends to be within normal limits, so that significant changes may not be found in the Reid angle formed in the adult population, in contrast to pediatric patients who have a more horizontal angle and position of the Eustachian tube. The similar results from Aksoy et al. also found insignificant difference results, but it was found that the Eustachian tube angle in patients with cholesteatoma tended to be smaller, ranging from 26.85° (SD ± 4.04) and without cholesteatoma was significantly higher with the mean 28.94° SD. ± (4.06).7

Dinc et al. also reported a tendency for CSOM with cholesteatoma to affect the smaller angle of the Eustachian tube, but there was no significant difference. Written in the evaluation group of CSOM patients aged 8-79 years who underwent evaluation of tube angle, the lowest value was in the condition of cholesteatoma 22.3 (± 2.5), tympanic membrane retraction condition 23.5 (SD ± 2.6), CSOM 22.9 (SD ± 3.1) and the highest value in the normal contralateral ear 23.4 (SD ± 26).9

Comparison of the length of the Eustachian tube
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Comparison of the length of the Eustachian tube
The evaluation of the length in the Eustachian tube showed that the most extended mean value was in the normal ear group 35.39 mm (SD ± 2.00), while the safe type CSOM condition showed smaller 33.58 mm (SD ± 2.39) and more minor in unsafe type CSOM 29.53 mm (SD ± 2.81). The analysis of different tests has a significant difference between the length of the Eustachian tube under the conditions of safe, unsafe, and normal CSOM. Conditions will indeed cause the length of the Eustachian tube to be smaller. This occurs due to the dysfunction and inflammation of the Eustachian tube, which progressively changes CSOM conditions. Assessing the decreasing length can be an indicator of diagnosis and monitoring CSOM disease progression towards a worse situation, such as a cholesteatoma. The results of this study were also the same as the report of Dinc et al., who found that the mean
length of the Eustachian tube in the ear with chronic suppurative otitis media was 37.9 mm; this value was smaller than the normal contralateral ear condition of 39.3 mm.1

Eustachian tube length in this study also showed a decrease in CSOM conditions, both safe and unsafe type. Erick et al. explained that the length of the Eustachian tube was around 35mm, while when the pathological conditions were generally below this value.19 Yakub et al. also reported the benefits of using the evaluations of tube length in assessing the progressiveness of perforated otitis media and post tympanoplasty damage. It was found that the length of the orifice to the tympanic of the Eustachius tube was 40.8 mm (range 30-47.4 mm) smaller than the healthy ear 41.6 mm (30-45.0). It is also Includes the female sex that the mean length of the Eustachian tube in the ear that was affected is 37.9 mm (range 31.8 - 45.2 mm), smaller than the standard ear 39.1 mm (range 30.0 - 43.7 mm).20

**Comparison of Eustachian tube diameter in the safe and unsafe type CSOM**

In evaluating the Eustachian tube diameter, that the broadest diameter was in the normal ear condition 2.19 mm (SD ± 0.21), the diameter value was smaller in the safe type CSOM condition 2.02 mm (SD ± 0.28), and smaller in unsafe type 1.86 (SD ± 0.18), in further analysis, the p-value was 0.00. So it can be explained that there was a significant difference between the Eustachian tube diameter under normal conditions and in CSOM conditions. These results can support that the smaller the diameter of the Eustachian tube will lead to an unsafe type of CSOM condition. It can occur due to repeated inflammatory processes in the Eustachian tube that trigger fibrotic scars and tubal dysfunction due to inflammation. In the other method, there will be bone destruction due to the formation of cholesteatoma. All of these events can trigger a narrowing of the Eustachian tube diameter.

Evaluation of the diameter and the assessment of the length of the Eustachian tube will be useful in monitoring the progress of the CSOM patient’s condition and the suspicion of the formation of CSOM conditions accompanied by cholesteatoma. The results of this study can also provide an idea that a smaller change in diameter could be a hint if the patient is experiencing worse CSOM conditions. This information can also be an additional diagnostic source of tubal conditions affected by CSOM. So far, the evaluation of CSOM conditions using CT Scan is still only about evaluating the temporal bone structure, findings of the perforated tympanic membrane, and the presence of a cholesteatoma. In advanced conditions, the presence of bone damage will be a difficult hint. Thus the information on the diameter and length of the Eustachian tube will help assess patients with safe and unsafe type CSOM. Pultura et al. explained that tubal anatomical dysfunction or anomaly was correlated with CSOM. Diameter values were 1.947 mm (SD ± 0.5247) for healthy ears and 1.788 mm (SD ± 0.5306) for CSOM ears. Furthermore, it was explained that measuring bone diameter during temporal CT scan would be a good routine indicator of CSOM.11 Nemade et al. Also support that assessing the pre-tympanic diameter of the Eustachian tube was significantly useful in assessing patients with CSOM progression. In addition, the Eustachian tube diameter also has a significant correlation with other parameters such as the length and angle of the Eustachian tube. For this reason, further assessment using parameters of angle, diameter, and length of the Eustachian tube can be used in assessing the response of the disease’s treatment.

**CONCLUSION**

The smaller value of the length and diameter of the Eustachian tube, the more it will lead to the unsafe type CSOM condition. There was a tendency for the Eustachian tube angle to be smaller in the malignant type CSOM condition, although it was not significantly different.

**ETHICAL CONSIDERATION**

The study has been approved by the Health Research Ethics Committee of the Faculty of Medicine at Universitas Syiah Kuala and the Dr. Zainoel Abidin General Hospital with a number of Ethical contributions KEPPKN Registration Number: 1171012P (Description of Ethical Exempted “Ethical Exempted” Number: 130/EA/FK-RSUDZA/2020).

**CONFLICT OF INTEREST**

There was no conflict of interest in this research.

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This study uses independent costs.

**AUTHOR CONTRIBUTION**

All authors are contributed equally to the content of the study, including data gathering, statistical analysis, and data synthesis.

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