

**Research****Relationship mastoid pneumatization and eustachian tube shape with tympanic cavity in chronic otitis media****Ferry Herjanto\***, **Zulfikar Naftali\***, **Yanuar Iman Santosa\***, **Farah Hendara Ningrum\*\***\*Department of Otorhinolaryngology-Head and Neck Surgery,  
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Universitas Diponegoro/Dr.Kariadi Hospital, Semarang**ABSTRACT**

**Background:** Chronic suppurative otitis media (CSOM) is one of the causes of morbidity and mortality in developing countries. The worldwide prevalence of CSOM according to WHO is estimated at 330 million people. Pneumatic type mastoid pneumatization, narrow Eustachian tube angle, and narrow Eustachian tube diameter in the diseased ear can result in cholesteatoma formation. **Objective:** This study aimed to determine the relationship between mastoid pneumatization, Eustachian tube angle and diameter with tympanic cavity abnormalities in CSOM patients. **Methods:** This was a retrospective analysis study using cross sectional method. The data were taken from the patient's medical records at Dr. Kariadi Hospital, Semarang, from January 2020 to June 2021. Subjects were CSOM sufferers. Mastoid multisliced computed tomography (MSCT) scan examination was carried out in the Radiology Section, using the AW Volume Share 5 application, to assess the type of mastoid pneumatization, Eustachian tube angle, Eustachian tube diameter, and tympanic cavity abnormalities in the form of cholesteatoma, granulation, and erosion of the ossicles. Statistical analysis using Chi Square test, and multivariate test. **Result:** There were 90 subjects with CSOM, 44 (48.9%) had tympanic cavity abnormalities and 46 (51.1%) without tympanic cavity abnormalities. Sclerotic mastoid pneumatization was more than pneumatic ( $p=0.001$ ), narrow Eustachian tube angle ( $p=0.041$ ), and narrow Eustachian tube diameter ( $p<0.001$ ). Logistic regression results showed that mastoid pneumatization had a dominant relationship to abnormalities in the tympanic cavity. **Conclusion:** There was a relationship between sclerotic mastoid pneumatization, narrow Eustachian tube angle, and narrow Eustachian tube diameter with abnormalities in the tympanic cavity.

**Keywords:** csom, mastoid pneumatization, Eustachian tube angle, Eustachian tube diameter, and tympanic cavity abnormalities

**ABSTRAK**

**Latar belakang:** Otitis media supuratif kronik (OMSK) merupakan salah satu penyebab morbiditas serta mortalitas di negara berkembang. Prevalensi OMSK menurut WHO di seluruh dunia diperkirakan 330 juta orang. Pneumatisasi mastoid tipe pneumatik, sudut tuba Eustachius yang sempit, dan diameter tuba Eustachius yang lebih sempit pada telinga yang sakit dapat menyebabkan terjadinya kolesteatoma. **Tujuan:** Penelitian bertujuan untuk mengetahui hubungan pneumatisasi mastoid, sudut dan diameter tuba Eustachius dengan kelainan kavum timpani pada penderita OMSK. **Metode:** Merupakan penelitian analisis retrospektif menggunakan metode cross sectional. Data diambil dari rekam medis pasien di RSUP Dr.Kariadi Semarang, dari Januari 2020 sampai Juni 2021. Subjek adalah penderita OMSK. Pemeriksaan multisliced computed tomography (MSCT) scan mastoid dilakukan di Bagian Radiologi, dengan aplikasi AW Volume Share 5, untuk menilai jenis pneumatisasi mastoid, sudut tuba Eustachius, diameter tuba Eustachius, dan kelainan kavum timpani berupa kolesteatoma, granulasi, dan erosi pada osikula. Analisis statistik menggunakan uji Chi Square, dan uji multivariat. **Hasil:** Didapatkan 90 subjek penderita OMSK, adanya kelainan kavum timpani 44 (48,9%) dan yang tidak adanya kelainan kavum

timpani 46 (51,1%). Pneumatisasi mastoid sklerotik lebih banyak daripada pneumatik ( $p=0,001$ ), sudut tuba Eustachius sempit ( $p=0,041$ ), dan diameter tuba Eustachius pendek ( $p=<0,001$ ). Hasil regresi logistik menunjukkan bahwa pneumatisasi mastoid memiliki hubungan yang dominan terhadap kelainan pada kavum timpani. **Kesimpulan:** Terdapat hubungan antara pneumatisasi mastoid sklerotik, sudut tuba Eustachius sempit, dan diameter tuba Eustachius kecil dengan kelainan pada kavum timpani.

**Kata kunci:** OMSK, pneumatisasi mastoid, sudut tuba Eustachius, diameter tuba Eustachius, dan kelainan kavum timpani

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## INTRODUCTION

Chronic suppurative otitis media (CSOM) is one of the causes of morbidity and mortality in developing countries. CSOM or commonly called 'congek' is a chronic middle ear infection with perforation of the tympanic membrane, and a history of discharge from the ear (otorrhoea) for more than 2 months continuously and is usually accompanied by hearing loss.<sup>1,2,3</sup>

The worldwide prevalence of CSOM according to WHO is estimated at 330 million people. The prevalence in Indonesia according to the Health Survey for the Senses of Sight and Hearing, Ministry of Health in 2006-2009, was 3.1% of the population, while at Dr. Kariadi Hospital Semarang it was found to be 21% in Otology clinics during 2011.<sup>2</sup>

Craniofacial anatomy is considered to play a role in the occurrence of chronic otitis media, that is septal deviation, mastoid pneumatization, and Eustachian tube size. The Eustachian tube has a role in the occurrence of chronic otitis media, especially in the function and size of the tube.<sup>4</sup> Shan et al.<sup>5</sup> found a narrow Eustachian tube angle in patients with otitis media. Other researchers compared the angle and length of the Eustachian tube in normal patients with otitis media, the results of the study found that shorter Eustachian tube with a horizontal angle was more common in otitis media and cholesteatoma.<sup>6</sup>

The reduced diameter of the Eustachian tube may be due to long-standing tubal dysfunction that can inhibit the growth of the bone segment.<sup>7</sup> Shan et al.<sup>5</sup> study showed significant results in a narrower Eustachian tube diameter on the affected ear side and the occurrence of a cholesteatoma, this explained the anatomical effect in the pathophysiology of otitis media.

The air system in the mastoid plays an important role in the physiology of the middle ear. Good pneumatization of the mastoid indicates a biologically competent middle ear mucosa. Iqbal et al.<sup>8</sup> stated that pneumatic pneumatization of mastoid could facilitate cholesteatoma formation, this is because the mastoid that undergoes good pneumatization is not fully balanced. The good pneumatization of the mastoid has a greater potential to exert prolonged negative pressure on the middle ear, which can lead to the development of cholesteatoma.<sup>4</sup>

This study aimed to determine the relationship between mastoid pneumatization, Eustachian tube diameter and angle with tympanic cavity abnormalities in CSOM patients.

## METHOD

This was a retrospective study using cross-sectional method. Data were taken from

patient medical records at Dr. Kariadi Hospital Semarang, from January 2020 to June 2021. The inclusion criteria for the study were patients with a diagnosis of CSOM and aged more than 18 years. The exclusion criteria were if they had had a mastoidectomy, congenital abnormalities, and other malignancies. Mastoid multisliced computed tomography (MSCT) scan examination was carried out in the Radiology Department, using the application of AW Volume Share 5. Mastoid pneumatization assessment was defined as sclerotic or pneumatic, for Eustachian tube angles: narrow  $<27$  degrees and wide  $\geq 27$  degrees, Eustachian tube diameter: narrow  $< 6$  mm and wide  $\geq 6$  mm, tympanic cavity abnormalities in the form of cholesteatoma, granulation, and erosion of the ossicles.

Descriptive data including age, gender, diagnosis, type of mastoid pneumatization,

Eustachian tube angle, Eustachian tube diameter, and tympanic cavity abnormalities were performed using the Chi Square test, the limit of significance was stated at  $p < 0.05$  with a 95% confidence interval, and the test was performed multivariate to find the most influential variables between mastoid pneumatization, angle and diameter of the Eustachian tube with abnormalities of the tympanic cavity.

## RESULT

The research subjects who met the inclusion and exclusion criteria were 90 patients. A total of 47 subjects experienced CSOM in the right ear and 43 subjects in the left ear. Characteristics of research subjects are shown in Table 1.

**Table 1. Characteristics**

Variable	F	%
Age		
17 – 25	30	33.3
26 – 45	37	41.1
46 – 65	23	25.6
Gender		
Man	38	42.2
Woman	52	57.8
Ear		
Left	43	47.8
Right	47	52.2
Tube angle		
Narrow	60	66.7
Wide	30	33.3
Tube diameter		
Narrow	58	64.4
Wide	32	35.6
Mastoid pneumatization		
Pneumatic	45	50.0
Sclerotic	45	50.0
Tympanic cavity abnormalities		
Yes	44	48.9
No	46	51.1

Tympanic cavity abnormalities included ossicular erosion, granulation, or cholesteatoma, and are influenced by mastoid pneumatization, Eustachian tube angle, and Eustachian tube diameter. Characteristics of patients according to the diagnosis on the right ear 47 (52.2 %), and left ear 43 (47.8% %), Gender 38 male (42.2%) and 52 female (57.8%).

The statistical analysis showed that sclerotic pneumatization, angle, and narrow Eustachian tube diameter, could cause abnormalities in the tympanic cavity (Table 2). The multivariate analysis showed tubal angle ( $p=0.003$ ), mastoid pneumatization ( $p<0.001$ ) (Table 3).

**Table 2. Relationship of mastoid pneumatization, Eustachian tube angle, Eustachian tube diameter and tympanic cavity abnormalities**

Variable	Tympanic cavity abnormalities		P	OR (95% CI)
	Yes (n = 44)	No (n = 46)		
Tube angle				
Narrow	37 (84.1)	23 (50)	0.001*	5.29 (1.96 – 14.27)
Wide	7 (15.9)	23 (50)		
Tube Diameter				
Narrow	33 (75)	25 (54.3)	0.041*	2.52 (1.03 – 6.17)
Wide	11 (25)	21 (45.7)		
Mastoid pneumatization				
Sclerotic	33 (75)	12 (26.1)	<0.001*	8.50 (3.29 – 21.94)
Pneumatic	11 (25)	34 (73.9)		

**Table 3. Logistic regression test**

Variable	B	P	R <sup>2</sup>	95% CI
Tube angle	1.758	0.003	0.431	1.816 – 18.536
Tube diameter	0.778	0.160		0.736 – 6.443
Mastoid pneumatization	2.194	<0.001		3.136 – 25.658

## DISCUSSION

The results of this study showed that pneumatization of the sclerotic mastoid caused the most abnormalities in the tympanic cavity compared to pneumatics. This result was different from Iqbal et al.<sup>8</sup> which found that cholesteatoma mostly occurred in pneumatic mastoid type. A good pneumatization of the mastoid can serve as an air reservoir to buffer the effect of intermittent Eustachian tube obstructions on middle ear pressure, thereby providing protection from the development of a retraction bag, but with a longer period

of Eustachian tube obstruction, the buffering effect of the larger air volume will eventually wear off. A good pneumatization of the mastoid requires a larger volume of air than a sclerotic mastoid, therefore it takes longer time to balance the pressure, so it has a greater potential to exert a prolonged negative pressure on the middle ear so that the development of cholesteatoma could occur.

Different research by Jain<sup>9</sup> and Dyah et al.<sup>10</sup>, stated that an important association that had been observed was that pars flaccida retraction pockets or cholesteatoma were

more common in mastoids with poor pneumatization and the severity of retraction had been shown to have a direct relationship with the degree of mastoid pneumatization. A well-pneumatized mastoid usually exhibits a normal pars flaccida. Mastoid pneumatization plays the role of passive middle ear pressure buffer and therefore ears with a sclerotic mastoid type are at risk for complications such as retraction pouch, ossicular necrosis, and retraction pouch cholesteatoma.

The results showed that narrow Eustachian tube angles caused the most abnormalities in the tympanic cavity compared to wide Eustachian tube angles. This was in accordance with Aksoy et al.<sup>11</sup> measuring the angle of the Eustachian tube in patients with CSOM with and without cholesteatoma compared to adult patients. The results showed that the angle of the Eustachian tube with cholesteatoma was significantly narrower than the normal ear angle. On Takasaki's research cited by Aksoy<sup>11</sup> also concluded the same, a significantly narrower Eustachian tube angle could cause cholesteatoma formation compared to the normal ear, this difference might be an additional factor in combination with other factors in the development of cholesteatoma. Dinc<sup>4</sup> also stated that the Eustachian tube angle was found to be narrower in patients with intratympanic tympanosclerosis (ITTS), tympanic membrane with retraction pouch (TMRP), and cholesteatoma.

The anatomy and function of the Eustachian tube play an important role in increasing the risk of CSOM. The more horizontal and shorter Eustachian tube causes an increased risk of bacterial reflux from the nasopharynx to the middle ear and facilitates acute and chronic otitis media. During the occurrence of upper respiratory tract infections, viral and bacterial infections in the nasopharynx can infect the middle ear through the Eustachian tube. Inflammation of the mucosa of the Eustachian tube causes

obstruction of the narrowest part of the Eustachian tube, namely the isthmus. This obstruction causes negative pressure in the middle ear effusion and interferes with the drainage of middle ear secretions into the nasopharynx. In conditions of repeated inflammation, there is an increased risk of retraction, adhesion, and perforation of the tympanic membrane, in the process of cholesteatoma formation.<sup>12</sup>

This study found that the narrow diameter of the Eustachian tube caused more abnormalities in the tympanic cavity compared to the wide diameter of the Eustachian tube. This was in accordance with Shan et al.<sup>5</sup>, that narrower diameter of the Eustachian tube causes more abnormalities of the tympanic cavity than wider diameter. Sanjay et al.<sup>13</sup> measured the pre-tympanic diameter to assess the patency of the Eustachian tube and saw abnormalities in the narrower diameter of the Eustachian tube. Decreased pre-tympanic diameter occurs in patients with chronic otitis media with cholesteatoma, this will affect the process of pneumatization of mastoid air cells due to inadequate ventilation of the middle ear and mastoid and is a predisposing factor for chronic otitis media and cholesteatoma

The results of logistic regression (Table 3) showed that pneumatization of the mastoid had a dominant relationship to abnormalities in the tympanic cavity.

This study did not analyze several confounding factors such as genetic and environmental factors, and did not explain the onset/ duration of CSOM, types of bacteria, and resistance to antibiotics, so further research is needed on the relationship between MSCT Scan Mastoid examination with history and other examinations.

It was concluded that there was a relationship between pneumatization of the sclerotic mastoid, narrow Eustachian tube angle, and narrow Eustachian tube diameter with abnormalities in the tympanic cavity.

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