

Relationship between Septum Deviation Type and Radiologic Extent of Middle Ear and Mastoid Infection in CSOM

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Abstract

Chronic suppurative otitis media (CSOM) is a multifactorial inflammatory disease of the middle ear that may be influenced by chronic upper airway pathology, including nasal septum deviation, which can contribute to impaired ventilation of the Eustachian tube and persistence of infection. Several previous studies have demonstrated an association between CSOM and septal deviation. However, the relationship between specific types and directions of septum deviation and the radiologic extent of CSOM infection has not been clearly elucidated. This descriptive-analytical study evaluated medical record data from patients diagnosed with CSOM and nasal septum deviation at Dr. Hasan Sadikin Hospital Bandung, Indonesia, from 2023 to 2024. The radiologic extent of infection was evaluated using temporal bone CT scans and categorized based on the degree of middle ear and mastoid involvement, while the septum deviation type was determined according to the Mladina classification and its direction was also recorded. A total of 35 patients met the inclusion criteria. Most patients (80%) demonstrated grade 3 radiologic involvement, and Mladina type 2 was identified as the most common septal deviation pattern. Despite the predominance of certain deviation types in patients with higher radiologic grades, statistical analysis revealed no significant relationship between septum deviation type or direction and the degree of radiologic CSOM involvement ($p>0.05$). These findings suggest that, although septum deviation is frequently observed in patients with CSOM, its specific type and direction are not significantly associated with the extent of radiologic infection involvement in this study population.

Keywords: Chronic suppurative otitis media, deviated septum, disease progression

Introduction

Chronic suppurative otitis media (CSOM) is a chronic inflammatory disease of the middle ear characterized by tympanic membrane perforation that is accompanied by fluid secretion from the middle ear that is either intermittent or continuous for more than 2 months.^{1,2} This condition remains a significant health problem, particularly in developing countries such as Indonesia, where its prevalence reaches 3.1%, or approximately 6.6 million out of 220 million people.³ Despite advances in treatment and prevention, the burden of CSOM remains substantial, suggesting that several predisposing factors may continue to contribute to disease persistence and progression. Clinically, patients commonly present with hearing loss, otorrhea,

otalgia, and tinnitus.^{1,4}

One of the factors that may contribute to the development and persistence of CSOM is nasal septum deviation. Septal deviation is a common anatomical abnormality that may be congenital or acquired and can alter nasal airflow dynamics.⁵ This condition can cause changes in airflow through the nose and is associated with Eustachian tube dysfunction.⁶ On the side with deviation, there is a significant decrease in airflow volume through the nasal cavity, while on the contralateral side, airflow may increase as a compensatory response. This can create turbulence, potentially disrupting intranasal pressure distribution as well as moisture balance within the nasal cavity. Conversely, a decrease in airflow on the deviated side leads to stagnation, which can affect the movement of cilia within the nasal passages and Eustachian tubes. Cilia are responsible for removing secretions and foreign particles from the respiratory tract, hence improperly functional cilia can contribute to a buildup of secretions that may increase the

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risk of CSOM infection as well as expansion of the disease.⁷

Airflow disruption from nasal septum deviation causes a pressure imbalance in the nasal cavity and nasopharynx, affecting the Eustachian tube's ability to equalize pressure between the middle ear and the external environment. Impaired tube function leads to negative middle ear pressure, discomfort, pain, and increased risk of infection. This imbalance can cause fluid accumulation and elevate the risk of CSOM.^{7,8} giving variable results for correlation between Eustachian dysfunction and DNS. Hence, there was a need for anatomic classification of DNS, taking into account the deviation of individual parts of the septum, which is possible now due to advances in endoscopic surgery and imaging. Objective: To devise an endoscopic anatomic classification of deviated nasal septum (DNS)

Untreated CSOM can lead to complications such as extent of infection to other organs around the middle ear, including the mastoid bone.^{7,9} If the infection continues, it can even reach further organ structures and cause both intratemporal and intracranial complications.¹⁰

Several studies have reported an association between septal deviation and CSOM, suggesting that altered nasal anatomy may influence middle ear ventilation and predispose individuals to chronic infection.^{4,8} However, most previous investigations have focused on the presence or absence of septal deviation as a risk factor, without evaluating whether specific deviation types or directions are associated with the extent of disease involvement.^{5,9} Therefore, this study aimed to evaluate the relationship between the type and direction of nasal septum deviation and the radiologic extent of middle ear and mastoid involvement in patients with CSOM treated at Dr. Hasan Sadikin General Hospital Bandung (RSHS), Bandung, Indonesia during 2023–2024.

Methods

This retrospective cross-sectional study was conducted using secondary data obtained from the medical records of patients diagnosed with chronic suppurative otitis media (CSOM) and nasal septum deviation who attended the Otorhinolaryngology–Head and Neck Surgery outpatient clinic at Dr. Hasan Sadikin General Hospital, Bandung, Indonesia, between May 2023 and May 2024. A total of 35 eligible patients were included using a total sampling method.

Septal deviation was classified according to the Mladina's classification system, which categorizes nasal septum deformities into seven distinct types. type 1, midline septum or mild vertical or horizontal deviation; type 2, anterior vertical deviation; type 3, posterior vertical deviation; type 4, S-shaped septum with posterior deviation on one side and anterior deviation on the opposite side; type 5, horizontal septal crest with or without contact with the lateral nasal wall; type 6, prominent maxillary crest contralateral to the deviation accompanied by a septal crest on the deviated side; and type 7, a combination of the previously described deformities. The direction of septal deviation was also recorded.

The radiologic extent of CSOM was assessed using temporal bone computed tomography (CT) scans and categorized into four grades: grade 1, infection limited to the middle ear; grade 2, extension of infection to the mastoid antrum with preserved pneumatization and no pathological tissue; grade 3, extension of infection to the mastoid antrum with loss of pneumatization or filling of the mastoid cavity by pathological tissue; and grade 4, the presence of intratemporal or intracranial complications.. The inclusion criteria consisted of patients diagnosed with both CSOM and nasal septum deviation who underwent temporal bone CT examination during the study period. Patients with incomplete physical examination findings, unavailable CT scan data, or incomplete medical records were excluded from the study.

Descriptive data were presented as frequencies and percentages. The relationship between septal deviation type, deviation direction, and the radiologic extent of CSOM was analyzed using the Spearman correlation test. Statistical analyses were performed using IBM SPSS Statistics version 25.0, with statistical significance defined as $p < 0.05$.

This study was approved by the Health Research Ethics Committee Dr. Hasan Sadikin General Hospital Bandung (Approval No. DP.05.04/D.XIV.6.5/56/2024). Informed consent was written by all participants.

Results

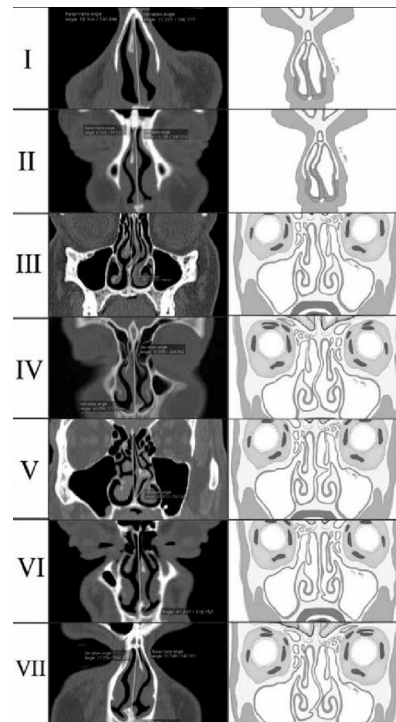
A total of 35 patients met the inclusion criteria and were included in the analysis. The patients ranged in age from 15 and 58 years, with the mean age of 33 years and the median age of 28 years. Most patients were female (65.7%). This

Table 1 Characteristics of Patients (n=35)

Characteristic	n (%) Median (Min-Max)
Age (years)	28 (15–58)
Gender	
Male	12 (34.3)
Female	23 (65.7)
Degree of Nasal Septum Deviation	
Grade 1	8 (22.9)
Grade 2	21 (60.0)
Grade 3	6 (17.1)
Grade 4–7	0 (0%)
Direction of Deviation	
Right	13 (37.1)
Left	22 (62.9)
Extent of CSOM Infection*	
Grade 1	3 (8.6)
Grade 2	4 (11.4)
Grade 3	28 (80.0)
Grade 4	0 (0)
CSOM Involvement	
Unilateral	23 (65.7)
Right	12
Left	11
Bilateral	12 (34.3)

*CSOM: chronic suppurative otitis media

explains that the age distribution of patients fairly evenly distributed because it can represent the characteristics of patients from adolescents to old adults.

**Figure 1 Types of Nasal Septum Deviation Based on the Mladina Classification**

According to the Mladina classification, type 2 septal deviation was the most common finding, occurring in 21 patients (60%), followed by type 1 in 8 patients (22.9%), and type 3 in 7 patients (17.1%). No patients presented with Mladina types 4–7. Left-sided septal deviation was observed more frequently than right-sided deviation (62.9% vs. 37.1%). The characteristics of the study population are presented in Table 1.. Regarding the radiologic extent of infection, most patients demonstrated grade 3 involvement (80.0%), followed by grade 2 (11.4%) and

Table 2 Relationship Between the Degree of Nasal Septum Deviation and the Extent of CSOM Infection

Degree of Nasal Septum Deviation	Grade 1		Grade 2		Grade 3		Grade 4	
	Unilateral	Bilateral	Unilateral	Bilateral	Unilateral	Bilateral	Unilateral	Bilateral
Grade 1	1 (2.9)	1 (2.9)	0	1 (2.9)	5 (14.3)	0	0	0
Grade 2	0	1 (2.9)	2 (5.7)	0	11 (31.4)	7 (20.0)	0	0
Grade 3	0	0	1 (2.9)	0	3 (8.6)	2 (5.7)	0	0
p-value	0.225							

Note: Data are presented as n (%). CSOM = chronic suppurative otitis media. Grade 1 = infection limited to the middle ear; Grade 2 = extension to the mastoid antrum with pneumatization; Grade 3 = extension to the mastoid without pneumatization; Grade 4 = involvement of adjacent critical structures. P-value obtained using the appropriate association test (please specify)

Table 3 Relationship Between the Direction of Septal Deviation and the Extent of CSOM Infection

Direction of Septal Deviation	Grade 1	Grade 2	Grade 3	Grade 4	Total	p-value
Right	1 (2.9)	1 (2.9)	13 (37.1)	0 (0.0)	15 (42.9)	0.069
Left	2 (5.7)	3 (8.6)	15 (42.9)	0 (0.0)	20 (57.1)	

Note: Data are presented as n (%). CSOM = chronic suppurative otitis media. Grade 1 = infection limited to the middle ear; Grade 2 = extension to the mastoid antrum with pneumatization; Grade 3 = extension to the mastoid without pneumatization; Grade 4 = involvement of adjacent critical structures. P-value obtained using the appropriate association test (please specify)

grade 1 (8.6%). No patients exhibited grade 4 involvement. Unilateral CSOM was identified in 23 patients (65.7%), whereas bilateral disease was present in 12 patients (34.3%) (Table 1). The distribution of septal deviation types according to the Mladina classification is shown in Figure 1. Based on the Table 2, statistical analysis showed no significant association between septal deviation type and the extent of CSOM infection ($p=0.225$). Similarly, no significant association was observed between the direction of septal deviation and the extent of CSOM infection ($p=0.069$; Table 3).

Discussion

The age distribution in this study demonstrates that chronic suppurative otitis media (CSOM) predominantly affects individuals in early to young adulthood. This pattern closely mirrors the epidemiological findings of Atiyah et al.⁴ and Kombade et al.¹¹, which highlighted a high prevalence of chronic middle ear pathology within similar age cohorts. Furthermore, the high alignment with the younger demographic reported by Alotaibi et al. underscores a notable clinical intersection: nasal septal deviations, frequently originating from neglected childhood micro-trauma or developmental asymmetries, often become fully symptomatic or lead to secondary obstructive complications like CSOM by the time a patient reaches young adulthood.^{1,12} Because specific lifestyle and environmental exposures were not explicitly analyzed as independent risk factors in this research, this strong demographic clustering instead emphasizes the necessity of early structural screenings. Identifying nasal septal pathologies in young adults presenting with early otologic symptoms may serve as a critical preventive measure against the progression into long-standing, chronic middle ear disease.¹³ The proportion of female patients in this study

was higher than that of male patients. This finding differs from previous reports, including the study by Shankar et al., which reported a higher prevalence of CSOM among males.⁸ frequently have an underlying nasal pathology, which can worsen the middle ear disease secondary to Eustachian tube dysfunction, leading to negative middle ear pressure, tympanic membrane retraction, chronic otitis media with effusion and/or cholesteatoma. Present study was conducted to study the correlation of a etiopathogenesis, bacteriology of CSOM with the deviation of the nasal septum (DNS Variations in sex distribution between studies may be influenced by differences in study populations, healthcare-seeking behavior, referral patterns, and sample characteristics.

According to the Mladina classification, type 2 septal deviation was the most common pattern observed in this study, followed by types 1 and 3. This findings is consistent with the study by Choi et.al., which also identified type 2 as the predominant septal deviation pattern.¹⁴ Type I and II deviations represent vertical ridges involving the nasal valve area, and their high prevalence in symptomatic populations may reflect the clinical significance of nasal valve obstruction in driving patient presentation.¹⁵

This study found no significant association between septal deviation type and the radiologic extent of CSOM involvement. These findings are consistent with those reported by Sistani et al., who found no significance relationship between the degree of nasal septum deviation and mastoid pneumatization or chronic otitis media. This is because deviated nasal septum does not always directly affect the degree of expansion of infection due to the existence of other factors, including Eustachian tube dysfunction, patient immunological status, ciliary dysfunction, congenital abnormalities and other pathophysiological conditions.¹⁶ Tubal dysfunction caused by nasal septum deviation may not be significant enough to cause the degree

of CSOM infection.¹⁷ Therefore, septal deviation alone may not be sufficient to determine the radiologic extent of CSOM involvement.

The mastoid bone, located behind the ear as part of the temporal bone, undergoes pneumatization, the development of air cells, particularly during the first two years of life. This process improves middle-ear ventilation and helps regulate pressure within the middle ear.^{1,5} Two main theories have been proposed to explain mastoid pneumatization: (1) the genetic theory, which suggests that congenital factors determine the extent of pneumatization, and (2) the environmental theory, which proposes that pathological processes in the middle ear, such as chronic inflammation or Eustachian tube dysfunction, may impair normal air-cell development.⁵ In the present study, the radiologic extent classification reflects the degree of middle ear and mastoid involvement, where higher grades indicate wider mastoid extension and reduced pneumatization. According to the environmental theory of mastoid pneumatization, chronic middle ear inflammation and Eustachian tube dysfunction may inhibit normal air cell development. Septal deviation may contribute to altered nasal airflow and tubal dysfunction; however, the absence of a significant association in this study suggests that septal deviation alone may not be sufficient to influence the radiologic classification of CSOM extent. It is possible that other factors affecting mastoid pneumatization, including early childhood infections, genetic predisposition, and long-standing inflammatory processes, may also contribute to the extent of disease observed on CT imaging.

Shankar et al. reported a significant association between nasal septum deviation and the incidence of CSOM.⁸ frequently have an underlying nasal pathology, which can worsen the middle ear disease secondary to Eustachian tube dysfunction, leading to negative middle ear pressure, tympanic membrane retraction, chronic otitis media with effusion and/or cholesteatoma. Present study was conducted to study the correlation of a etiopathogenesis, bacteriology of CSOM with the deviation of the nasal septum (DNS The difference between Shankar's study and this study could be due to various contributing factors, including the relatively small sample size in this study and the uneven distribution of patient characteristics. This may have led to the data obtained not adequately describing the disease state in the wider population, thus not being able to

accurately describe the relationship between those variables.

In this study, there was a straight relationship between the direction of deviation and the infection expansion but it was not significant. These findings were compared with the results of a study that is indirectly related to this study. Rahman et.al. explained the relationship between septum deviation and ipsilateral CSOM. Their study suggested a possible relationship where the actual direction of deviation may be associated with CSOM and the expansion of infection ipsilaterally.¹⁸ Nasal septum deviation is widely theorized to potentially affect Eustachian tube function and middle ear pressure regulation, which may subsequently contribute to CSOM pathogenesis.¹⁶ However, our study found no statistically significant association between septal deviation and the radiologic extent of CSOM. This lack of significance suggests that while structural airflow disruption plays a theoretical role, the physical expansion of CSOM infection within the middle ear cleft may be more heavily influenced by other multifactorial elements rather than nasal septal patency alone.

Furthermore, while literature suggests that the severity or precise angle of septal deviation could influence upper airway dynamics⁵, a definitive correlation with infection extension could not be established in this work. It is important to note that the exact angle and severity of the septal deviation were not objectively quantified in this study, which constitutes a limitation. Future investigations incorporating precise radiologic measurements of the deviation angle are warranted to better clarify this relationship and eliminate speculative assumptions regarding infection progression.^{5,19}

In contrast to expectations regarding advanced complications, this study observed a complete absence of patients with Grade 4 CSOM infection involving adjacent vital structures (0%). This finding aligns with epidemiological data showing that the tubotympanic (safe) type of CSOM is more prevalent than the atticointral (unsafe) type, with safe type accounting for the majority of CSOM cases in the general population.²⁰ The safe type is characterized by central perforation without bone erosion or cholesteatoma, resulting in minimal risk for serious intracranial complications.² Complications of CSOM are rare overall, with intracranial complications reported in only 0.04–2.3% of all CSOM cases.²¹ This suggests that the low prevalence of Grade 4 infection in our sample reflects the natural distribution of CSOM types

in the general population rather than specific protective factors. Currently, there are no studies explaining the relationship between the types of deviation and CSOM infection expansion, making it challenging to identify any specific contributing factors. Overall, these findings suggest that although several previous studies have reported a potential relationship between nasal septal deviation and CSOM, the strength and nature of this association may vary according to study design, population characteristics, disease severity, and other confounding factors.

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