Original Article

The Role of the Nasal and Paranasal Sinus Pathologies on the Development of Chronic Otitis Media and its Subtypes: A Computed Tomography Study

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Abstract

Objective: This objective of this study is to evaluate the presence and the coincidence of common nasal and paranasal sinus pathologies in adults suffering from chronic otitis media (COM) and its subtypes. **Materials and Methods:** The study group comprised 354 ears of 177 patients who underwent tympanoplasty with or without mastoidectomy from January 2013 to February 2015 due to uni/bilateral COM. Chronic suppurative otitis media, intratympanic tympanosclerosis (ITTS), cholesteatoma, and tympanic membrane with retraction pockets constituted subtypes of COM. The control group consisted of 100 ears of 50 adult patients with aural diseases other than middle ear problems. All patients were evaluated for the evidence of mucosal disease on paranasal sinuses, the presence of concha bullosa (CB), and the angle of nasal septal deviation (NSD) and thickness of the medial mucosa of the inferior turbinate were measured by coronal computed tomography images. **Results:** The incidence and the angle of NSD were found significantly higher in patients with COM (P = 0.028, P = 0.018; respectively). When ears with unilateral and bilateral COM compared in term of sinonasal pathologies, CB was found higher in patients with unilateral COM (P = 0.040). The presence of CB was significantly higher in ITTS when compared to other subtypes (P = 0.028). **Conclusions:** Our study suggests that obstructive nasal pathologies such as NSD and CB may play a role in the pathogenesis of especially unilateral COM. However, there was no correlation between COM and inflammatory pathologies such as sinusitis.

Keywords: *Chronic otitis media, computed tomography, concha bullosa, nasal septal deviation*

Introduction

Chronic otitis media (COM) is an inflammation of the middle ear that results in long-term or permanent changes in the tympanic membrane. These changes include perforation, atelectasis, retraction, tympanosclerosis (TS), and cholesteatoma.[1] Pathogenesis of COM is multifactorial that genetic, environmental factors, anatomical and functional characteristics of Eustachian tube, nasal and paranasal sinus pathologies are accused in etiology.[2,3]

Middle ear cleft constitutes a continuous air space contained in bone, lined by epithelium, and in continuity with the atmosphere of the nose and nasopharynx. Middle ear and paranasal sinuses have many common features. First, middle ear space, paranasal sinuses, and Eustachian tube are formed by the pseudostratified columnar epithelium. Second, the mucous membranes of middle ear space and paranasal sinuses include goblet cells and mucus-producing cells. Paranasal sinus drainage

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is provided through the superior and middle meatus to the nasopharynx passing under and above the Eustachian tube. The ventilation and drainage of mastoid system are provided by the Eustachian tube. Because of those closed anatomical, histological and physiological relations, the pathologies of the nose and paranasal sinuses can impair the functions of the middle ear.

The paranasal sinuses and mastoid air cell system have similar developmental patterns postnatally. It is shown that during the development process nasal pathologies decrease the development of mastoid air cell system, and there is relation between the decreased mastoid cell development and otitis media.[4,5] Nasal and paranasal pathologies may have role on the development of unilateral or bilateral COM and its subtypes. Chronic suppurative otitis media (CSOM) tubotympanic type, TS, tympanic membrane retraction pockets (TMRP), and cholesteatoma are common subtypes of COM. The present study evaluated the presence and coincidence of the common nasal and paranasal sinus pathologies in adult patients suffering from COM. We also aimed to investigate the effects of nasal and paranasal sinus pathologies on the development of COM and its subtypes.

Materials and Methods

Patients

We retrospectively identified 356 patients with unilateral or bilateral COM who underwent tympanoplasty with or without mastoidectomy from January 2013 to July 2015 in our clinic. Computed tomography (CT) images of temporal bones or paranasal sinuses, demographic, and clinical characteristics of the patients were obtained from the archives of Bulent Ecevit University Faculty of Medicine. Patients with previous nasal surgery history, sinonasal tumors, sinonasal polyposis, S‑shaped septal deviation, hemotympanum, traumatic tympanic membrane perforation, acute upper respiratory tract infection, and age under 16 years were excluded from the study. The study was approved by the Institutional Review Board of Medical School of Bulent Ecevit University.

CT images and clinical characteristic of 177 consecutive patients were available for this study. The unilateral COM group (group 1) consisted of 99 patients (54 males and 45 females; ranging from 16 to 69 years). The bilateral COM group (group 2) comprised 78 patients (45 males and 33 females; ranging from 16 to 71 years). Contralateral normal ear (n = 99) of the patients with unilateral COM was considered as group 3.

Diagnoses of the patients with unilateral or bilateral COM were rendered according to otomicroscopy, operative findings, audiometry, and multislice CT images; diseased ears were variously characterized by CSOM with normal middle ear mucosa (CSOM 1), CSOM with poor middle ear mucosa (hypertrophic or edematous) (CSOM 2), intratympanic TS (ITTS), cholesteatoma, and TMRP. The control group (group 4) consisted of 50 adult patients (24 males, 26 females; ranging from 22 to 79 years) with aural diseases (i.e., sensorineural hearing loss, tinnitus, or otitis externa) other than middle ear problems. Patients in group 4 had no history of, or current, otorrhea; otomicroscopic examination revealed that ear drums were normal. All multislice CT images for group 4 indicated normal inner and middle ears.

Computed tomography imaging and assessment of the parameters

A multidetector CT system (Activision 16‑row CT scanner; Toshiba Medical Systems, Otawara, Japan) was used for CT imaging. Imaging parameters included 120 kVp, 150 mA, a slice thickness and reconstruction interval of 0.5 mm, a pitch factor of 1.4, a matrix size 512 × 512, a field of view of 20 cm × 20 cm, a window width 2700, and a window level 350. Reconstructed coronal images were generated using the software, and the measurements and assessments were performed at a separate workstation (INFINITT Pacs version 3.0.9.1 BN6).

All the patients were evaluated for the evidence of mucosal disease on paranasal sinuses, the presence of concha bullosa (CB), the direction and degree of septal deviation, and the thickness of the medial mucosa of inferior turbinate on coronal images by CT scans. Sinusitis was defined as 3 mm or more mucous thickening of the mucosa in the paranasal sinuses [Figure 1a].[6] Retention cysts in the maxillary or sphenoid sinuses were not considered as sinusitis. CB was defined as the pneumatization of both lamellar and bulbous parts of middle turbinate [Figure 1b].[7] The angle of septal deviation (ANS) was measured between the mostly deviated point and midline on coronal CT images. This angle was defined as the angle between a line drawn from the superior insertion of the septum at the crista galli to the inferior insertion of the septum at the level maxillary crest and another line from the superior insertion of the septum at the crista galli to the apex of the septal deviation [Figure 1b]. The direction of deviation was described by the convexity of the septal curvature. The angle of nasal septal deviation (NSD) on contralateral side was considered as “0°”. To measure the thickness of the medial mucosa of the inferior turbinate, the thickest site of the anterior portion of the inferior turbinate was selected for measurement. To allow for accurate measurement, all images were magnified. Thickness of the medial mucosa for each patient was measured on the anterior portion of the inferior turbinate at a plane perpendicular to the mucosal surface at the right and left sides [Figure 1b].

Statistical analysis

Statistical analyses were performed with SPSS 19.0 software (SPSS Inc., Chicago, IL, USA). Distribution of data was determined by Shapiro–Wilk test. Continuous variables were expressed as mean ± standard deviation, categorical variables as frequency and percent. Pearson’s Chi-square test was used to determine for difference between groups for categorical variables. Continuous variables were compared with the Mann–Whitney U-test for two groups. Kruskal–Wallis test was used to determine for differences between three or more groups. The Dunn’s test was used for *post hoc* test after Kruskal–Wallis test. $P < 0.05$ was considered statistically significant for all tests.

Results

Four hundred fifty-four ears of 227 patients who had temporal bone CT images were included in this study. There were 117 male and 110 female patients, whose mean age was 41.92 ± 14.51 years, ranging from 16 to 79 years. Hundred and ninety-nine of 454 ears did not have COM, diseased ears (n = 255) consisted of CSOM with normal middle ear mucosa (n = 101), CSOM with poor middle ear mucosa (hypertrophic or edematous) (n = 23), ITTS (n = 30), cholesteatoma (n = 50), and TMRP (n = 51).

When all of the ears were evaluated including the healthy ears, the most common sinonasal pathology was NSD in 172 (37.9%). 110 ears (24.2%) had sinusitis, commonly maxillary and ethmoid sinuses were affected. CB was found in 106 ears (23.3%). The mean NSD angle was 4.1° ± 5.7, ranging from 0° to 21.8°. Mean thickness of the medial mucosa of inferior turbinate was 4.1 ± 1.1 mm, ranging from 1.8 to 7.7.

Patients with COM and healthy control group were compared in terms of nasal and paranasal sinus pathologies in Table 1. The prevalence of nasal septum deviation and the ANS was found significantly higher in patients with COM (P = 0.028, P = 0.018; respectively). There was no difference between the ears of the patients with unilateral COM and ears of healthy control group in terms of nasal and sinonasal pathologies ($P > 0.05$ for all parameters).

There was statistically significant difference between the ears of patients with uni/bilateral COM and healthy control group in terms of the presence of CB and the NSD (P = 0.043, P = 0.030); respectively). However, the ANS was higher at the border when compared to control group (P = 0.05) [Table 2]. When ears with unilateral and bilateral COM compared in term of sinonasal pathologies, CB was found higher in patients with unilateral COM (P = 0.040). The comparison of subtypes of COM in terms of sinonasal pathology is given in Table 3. The presence of CB was significantly higher in ITTS when compared to the other subgroups (P = 0.028). Other parameters did not differ between subgroups.

Table 1: Comparison of nasal and paranasal sinus pathologies between chronic otitis media and control group

	COM group Group 1 and 2, *n* (%)	Control group Group 4, *n* (%)	Total, *n* (%)	*P*
Sinusitis				
No	268 (75.7)	76 (76)	344 (75.8)	1.000
Available	86 (24.3)	24 (24)	110 (24.2)	
NSD				
No	210 (59.3)	72 (72)	282 (62.1)	0.028
Available	144 (40.7)	28 (28)	172 (37.9)	
Concha bullosa				
No	266 (75.1)	82 (82)	348 (76.7)	0.194
Available	88 (24.9)	18 (18)	106 (23.3)	
	Mean±SD			*P*
	COM group	Control group	Total	
ASD (°)	4.5±5.9	2.8±4.8	4.1±5.7	0.018
IT-MMT (mm)	4.1±1.2	4.0±0.9	4.1±1.1	0.594

n=Number of patients; COM=Chronic otitis media; NSD=Nasal septal deviation; ASD=Angle of septal deviation; IT-MMT=Inferior turbinate-medial mucosal thickness; SD=Standard deviation

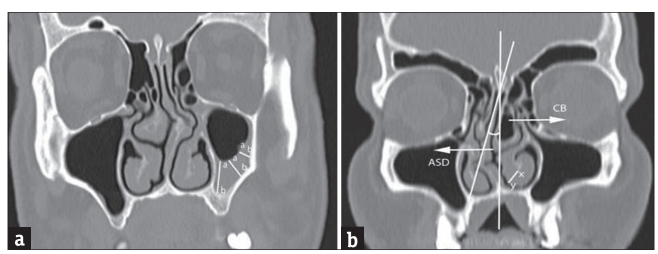

Figure 1: Coronal computed tomography image of a 50-year-old man who has left maxillary sinusitis. a-b length shows the measurement of the mucosal thickness on maxillary sinus. (a) Coronal computed tomography image shows a 44-year-old woman who has left concha bullosa, the measurement of medial mucosal thickness of the inferior turbinate (XY length) and the angle of septal deviation (b)

Table 2: Comparison of sinonasal pathologies in patients with unilateral or bilateral otitis media

	Unilateral COM group, *n* (%)	Bilateral COM group, *n* (%)	Control group, *n* (%)	Total, *n* (%)	*P*
Sinusitis					
No	146 (73.7)	122 (78.2)	76 (76)	344 (75.8)	0.621
Available	52 (26.3)	34 (21.8)	24 (24)	110 (24.2)	
NSD					
No	113 (57.1)	97 (62.2)	72 (72)	282 (62.1)	0.043
Available	85 (42.9)	59 (37.8)	28 (28)	172 (37.9)	
Concha bullosa					
No	140 (70.7)	126 (80.8)	82 (82)	348 (76.7)	0.030
Available	58 (29.3)	30 (19.2)	18 (18)	106 (23.3)	
	Mean±SD				*P*
	Unilateral COM group	Bilateral COM group	Healthy control group	Total	
ASD (°)	4.5±5.7	4.3±6.2	2.82±4.80	4.1±5.7	0.050
IT-MMT (mm)	4.2±1.1	4.1±1.2	4.0±0.9	4.1±1.1	0.794

n=Number of patients; COM=Chronic otitis media; NSD=Nasal septal deviation; ASD=Angle of septal deviation; IT-MMT=Inferior turbinate-medial mucosal thickness; SD=Standard deviation

Table 3: Comparison of nasal and paranasal sinus pathologies among different types of chronic otitis media

	CSOM 1, *n* (%)	CSOM 2, *n* (%)	ITTS, *n* (%)	TMRP, *n* (%)	Cholesteatoma, *n* (%)	Total, *n* (%)	*P*
Sinusitis							
No	73 (72.3)	19 (82.6)	27 (90)	37 (72.5)	42 (84)	198 (77.6)	0.161
Available	28 (27.7)	4 (17.4)	3 (10)	14 (27.5)	8 (16)	57 (22.4)	
NSD							
No	54 (53.5)	15 (65.2)	19 (63.3)	33 (64.7)	30 (60)	151 (59.2)	0.629
Available	47 (46.5)	8 (34.8)	11 (36.7)	18 (35.3)	20 (40)	104 (40.8)	
Concha bullosa							
No	77 (76.2)	18 (78.3)	16 (53.3)	41 (80.4)	84 (84)	194 (76.1)	0.028
Available	24 (23.8)	5 (21.7)	14 (46.7)	10 (19.6)	8 (16)	61 (23.9)	
	Mean±SD						*P*
	CSOM 1	CSOM 2	ITTS	TMRP	Cholesteatoma	Total	
ASD (°)	4.8±5.7	3.2±5.0	4.4±6.6	4.1±6.4	4.6±6.0	4.4±5.6	0.711
IT-MMT (mm)	3.9±1.0	4.1±1.1	4.4±1.3	4.4±1.3	4.2±1.1	4.2±1.2	0.193

ASD and IT-MMT values are given as mean and SD. *n*=Number of patients; NSD=Nasal septal deviation; ASD=Angle of septal deviation; IT-MMT=Inferior turbinate-medial mucosal thickness; CSOM=Chronic suppurative otitis media; ITTS=Intratympanic tympanosclerosis; TMRP=Tympanic membrane with retraction pockets; SD=Standard deviation

Discussion

Mastoid ear cells and sinuses are in contact with each other and have similar anatomic and physiologic features. As middle ear and sinonasal region coated with the same epithelium (pseudostratified columnar epithelium) and have similar drainage pathways, sinonasal pathologies may play role in the development of otitis media. In addition, paranasal sinuses and mastoid air cells have similar postnatal development. The development of paranasal sinuses and mastoid air cells during postnatal development process can be supported by positive pressure of air flow on the nasal cavity and nasopharyngeal mucosa. It has been shown that nasal pathologies such as NSD decrease mastoid air volume[4] and maxillary sinus volume[8] by decreasing nasal airflow and so mastoid pneumatization and by this way have effects on otitis media and other otological problems.[5]

The relationship between NSD and otitis media has been researched by studies published in the literature.[9,10] In a study conducted by Singh *et al*.,[11] it was shown that NSD was at a rate of 31% in 6–65 years old patients with CSOM. Yeolekar and Dasgupta[2] found this rate as 80% in 11–60 years old patients with otitis media. Another study performed by Gopalakrishnan and Kumar in 18–49 years old patients with COM active mucosal type the rate of NSD was 73%.[12] Yeolekar and Dasgupta[2] reported overall improvement of 79.31% of diseased ears after the correction of septal deviation. In our study, the incidence of NSD was 40.7% in ears with COM and 28% in healthy ears. The difference was statistically significant (*P* = 0.028). Similarly, the degree of ANS in ears with COM was higher when compared with healthy ears (*P* = 0.018). In particular, the incidence of NSD and CB was found higher in ears with unilateral COM. These results show that ipsilateral nasal pathologies can affect postnatal development of mastoid air cell system or cause the dysfunction of Eustachian tube in patients who have unilateral COM. There was no difference among the subtypes of COM in terms of NSD frequency. The presence of CB (46.7%) was significantly higher in patients with ITTS. This condition may point the effects of nasal dynamics on the development of TS.

The role of paranasal sinus pathologies on the development of COM is not clear, and studies on adults are not enough.[2,11,12] Studies were conducted on pediatric patients with otitis media with effusion have shown that sinusitis is an etiological factor for otitis media.[13,14] Fujita *et al*.[15] a study on 83 adolescent patients (10–20 years) with refractory effusion otitis media had shown paranasal sinusitis 49%, in pediatric group (4–9 years) 78%. They stated that sinusitis was the main focus of pathology/infection in patients with otitis media. Yeolekar and Dasgupta[2] found out that the prevalence of sinusitis in patients with (11–60 years) acute and COM was 13.5% and complete resolution in 82.35% of these patients by the treatment of sinusitis medically or surgically. Singh *et al*.[11] reported a study on 6–65 years old patients with COM and found prevalence of sinusitis 13.5%. In our study, the prevalence of sinusitis in ears with COM was 24.3% and 24% in control group, and so, there was no significant difference between the two groups. Similarly, there was no difference among subtypes of COM in terms of sinusitis.

To evaluate the inferior concha hypertrophy, we measured the thickness of medial mucosa of inferior concha in patients with diseased ears and in normal ears. There was no difference between healthy and diseased ears in the point of thickness. In addition, among the subtypes of COM, there was no difference.

The current investigation had limitations that are common in any retrospective studies. We anticipate that prospective trials with a larger number of patients are necessary to confirm our results.

Conclusions

The incidence of NSD and the degree of ANS were found higher in diseased ears compared to the healthy control group. Our study suggests that NSD and CB and similar obstructive nasal pathologies may play a role in the pathogenesis of COM by influencing the development of mastoid air cell system or cause the dysfunction of the Eustachian tube. This situation appears to be particularly important in patients with unilateral COM. There was no correlation between COM and inflammatory pathologies such as sinusitis. We can suggest that genetic and local inflammatory mechanisms rather than paranasal sinusitis play role in the development of COM and its subtypes. Further, studies are required to achieve more accurate results.

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Conflicts of interest

There are no conflicts of interest.

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