Original Article

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Relationship between Severity of Nasal Septum Deviation and Pneumatization of Mastoid Cells and Chronic Otitis Media

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ABSTRACT

BACKGROUND AND OBJECTIVE: Nasal septum deviation (NSD) is one of the leading causes of chronic otitis media and pneumatization of mastoid air cells. In this study, the effect of NSD on pneumatization of mastoid cells and the relationship between NSD and chronic otitis media were investigated using CT scan.

METHODS: In this cross-sectional study, 75 paranasal sinus CT scans with NSD and mastoid view were investigated. Patients were divided into three groups based on the severity of NSD: mild (deviation less than 9 degrees, 25 patients), moderate (deviation from 9 to 15 degrees, 25 patients) and severe (deviation equal to or greater than 15 degrees, 25 patients). Chronic otitis media is defined as the presence of bone destruction or sclerosis accompanied by mass fluid or structural changes in temporal bone air cells. The pneumatization of mastoid cells was determined visually and as formation of mastoid air cells.

FINDINGS: There was no significant difference in the frequency of pneumatization of mastoid cells between mild (25 patients, 100%), moderate (25 patients, 100%) and severe (23 patients, 92%) nasal septum deviation (p = 0.128). However, the prevalence of chronic otitis media was significantly higher in severe NSD (13 patients, 52%) compared to mild (4 patients, 16%) and moderate (9 patients, 36%) NSD (p = 0.028)

CONCLUSION: The results of the study showed that the severity of NSD does not have an effect on pneumatization of mastoid cells, but severe NSD increases the frequency of otitis media.

KEY WORDS: *Nasal septum deviation, Otitis, Mastoid, CT scan*.

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Introduction

Mastoid process at birth is a cavity in the temporal bone. However, many air cells are formed in the mastoid within two years, which is referred to as pneumatization (1). Mastoid air cells act as a gas storage. In this way, the dependency of middle ear to the Eustachian tube to balance the pressure of the middle ear with the ambient pressure decreases (2). There are two theories about the pneumatization of the mastoid air cells. In the first theory (genetic theory), pneumatization is based on genetic factors. In the second theory (peripheral theory), pneumatization of mastoid air cells is affected by the middle ear pathologies. In other words, any pathological condition (such as paranasal sinus disease), which can change the pressure of the middle ear due to the proximity of the middle ear with mastoid, can affect the pneumatization of mastoid air cells (3, 4).

Several studies have been conducted to determine the relationship between middle ear disease and mastoid air cells. For example, excessive aeration of the mastoid cell system is a risk factor for the development of recurrent middle ear infections (5). On the other hand, due to the anatomical proximity of these two structures, middle ear infections can cause mastoiditis (6).

One of the factors that can affect the pressure of the middle ear/mastoid air cells system is nasal cavity anomalies (2). Nasal structures, such as nasal septum, balance the amount of air passing through the nose. For this reason, nasal septum deviation (NSD) is one of the factors that can affect mastoid pneumatization. Although numerous studies have been conducted on the association between NSD and paranasal sinus diseases such as chronic sinusitis (7, 8), limited studies have been conducted about mastoiditis (2, 9).

The studies have reported that the presence of NSD has been associated with a change in the amount of air passing through the nose and due to the relationship between nasopharynx and the middle ear through the Eustachian tube, this change in the air flow rate causes a change in the air pressure of the middle ear and as a consequence, affect mastoid pneumatization (2, 9). Considering that NSD is the most common nasal deformity and its prevalence based on CT scan imaging in patients with chronic sinusitis or nasal obstruction is reported to be about 47% (10), further studies are required to investigate the relationship between this factor and mastoid pneumatization and chronic otitis media. Therefore, the present study was conducted to determine the relationship between nasal septum deviation and mastoid pneumatization and chronic otitis media.

Methods

After being approved by the Ethics Committee of Kermanshah University of Medical Sciences with the code of ethics ir.kums.rec.1394.124, this cross-sectional study was conducted on all PNS (paranasal sinus) CT scans and mastoid view in coronal and axial planes, which were performed in the imaging department in 2014-2016. Imaging was performed using the Philips Brilliance 16-slice CT scanner. Patients were included in case of the presence of NSD, and were excluded from the study if there was a history of previous surgery of nasal sinus, middle ears, or mastoid, nasal polyps or the presence of cleft palate or other congenital anatomical abnormalities (11). Considering 95% confidence level and 80% power, and according to the mean and standard deviation of NSD degree in moderate and severe groups, the sample size was determined to be 25 patients in each group and a total of 75 patients (9).

Examination of CT scans: Examination of CT scans was done by a radiologist. First, the direction of the nasal septum deviation was determined (right or left). Then, nasal septal angle (NSA) was recorded at the coronal plane, which showed maximum NSD. The NSA is the angle between the two lines plotted on the image. The first line is plotted from the upper part of the nasal septum in crista galli to the lower part of the nasal septum in the maxillary horn. The second line is plotted from the upper part of the nasal septum in crista galli to the maximum point of the nasal septum. Based on the calculated degree, NSD was divided into three groups: mild (deviation less than 9 degrees), moderate (deviations of 9-15 degrees) and severe (deviation equal to or greater than 15 degrees) (9). Chronic otitis media is defined as bone destruction or sclerosis accompanied by mass fluid or structural changes in temporal bone air cells (2). Mastoid pneumatization was defined visually as formation of air cells in mastoids.

In addition to the above three variables, the mastoid cell volume was also determined. This volume is defined as the volume of the air cells of aditus and antrum in the mastoid bone. This volume was calculated directly and automatically using three diameters (two coronal diameters and one axial diameter) by the software. This calculation method is called DMPVR (three-dimensional multi-planar volume rendering).

Data collection: A data collection form that was designed by the researchers was used to collect different variables. This form was completed based on the information in patient files. The data collection form included different variables such as age, gender, clinical symptoms, history of disease, degree of deviation of nasal septum, presence or absence of mastoid pneumatization, volume of mastoid cells and chronic otitis media.

Statistical analysis: Descriptive indicators such as mean, standard deviation, frequency and percent were used to describe the variables. To compare the frequency of qualitative variables between three groups of NSD (mild, moderate and severe), Chi-square test or Fischer's exact test was used. Analysis of variance (ANOVA) was used to compare the mean age of the three groups while $p<0.05$ was considered significant.

Ethics: Due to the fact that the CT scan was done on patients who were referred to the imaging center by the ears, nose, and throat specialists and no intervention was done on patients, there was no need for a written consent.

Results

The age range of patients was 18 – 72 years with an average of 39.6±14.07 years. 45 patients (60%) were male and 30 patients (40%) were female. 45 patients (60%) had symptoms of paranasal sinuses. In 49 patients (65.3%), the NSD was to the right and in 26 patients (34.7%), it was to the left. The NSD angle was 4.5 to 23 degrees in patients with an average of 12.27 ± 5.39 degrees. 25 patients (33.3%) had mild NSD, 25 patients (33.3%) had moderate NSD and 25 patients (33.3%) had severe NSD.

Patients in the three groups of NSD (mild, moderate and severe) had no significant difference in age, gender, frequency of symptoms of sinus disease and NSD direction (Table 1). Mastoid pneumatization was observed in 73 patients (97.3%).

The direction of mastoid pneumatization was two-way in 74 patients (98.7%) and one-way (1.7%) in one patient. 26 patients (34.7%) had chronic otitis media. The prevalence of mastoid pneumatization was not significantly different between the three groups of NSD. However, there was a significant difference in the frequency of chronic otitis media in the three groups.

The prevalence of chronic otitis media in the group with severe NSD was higher than those with mild and moderate NSD (Table 2). In the groups with moderate and severe NSD, the volume of mastoid air cells on the side with nasal septum deviation was less than the volume of these cells in the opposite side in more than three-fourths of the patients (Table 2).

Table 1. Comparison of age, gender, disease symptoms and direction of nasal septum deviation in patients with nasal septum deviation based on severity of septum deviation (25 patients)

Severity of nasal septum deviation Property	Mild N(%)	Moderate N(%)	Severe N(%)	P-value
Age (year) Mean±SD	42.28±13.58	39.44±11.41	37.08±16.78	0.289
Gender				
Male	13(52%)	15(60%)	17(68%)	0.513
Female	12(48%)	10(40%)	8(32%)	
Symptoms of the disease				
With	19(76%)	12(48%)	14(56%)	0.115
Without	6(24%)	13(52%)	11(44%)	
Deviation direction				
right	18(72%)	14(56%)	17(68%)	0.465
Left	7(28%)	11(44%)	8(32%)	

Table 2. Comparison of the frequency of mastoid pneumatization, chronic otitis media, and the difference in the volume of mastoid air cells in the deviation side and the opposite side in patients with nasal septum deviation based on the severity of nasal deviation (25 patients)

Group \ Severity of nasal septum deviation	Mild N(%)	Moderate N(%)	Severe N(%)	P-value
Mastoid pneumatization	25(100)	25(100)	23(92)	0.128
Chronic otitis media	4(16)	9(36)	13(52)	0.028
The volume of the mastoid cells on the side of the septum deviation is lower than the opposite side	12(48)	19(76)	20(80)	0.03

Discussion

Based on the results of this study, there was no significant difference in the frequency of mastoid pneumatization between the three groups of mild, moderate and severe NSD. However, chronic otitis was more common in patients with severe NSD than in the other two groups. Although the presence of mastoid pneumatization did not significantly correlate with NSD severity alone, patients with moderate and severe NSD had lower air cell volume in the deviation side. Although several studies have been conducted on the relationship between NSD and sinus diseases, limited studies have been conducted on the effect of NSD on mastoid pneumatization and the volume of air cells. One study reported that the prevalence of chronic otitis media on the NSD side was significantly higher than the opposite side. In this study, the frequency of chronic otitis media was assessed separately in each NSD group (mild, moderate and severe) (2).

However, in the present study, we did not use intra-group comparisons. Instead of this method, inter-group comparison of the frequency of chronic otitis was performed. In addition, the results of the mentioned study indicated that the mastoid air cell volume on the NSD side was significantly lower than the opposite side, which is consistent with the results of the present study. The researchers concluded that severe NSD was associated with the volume of air cells, and it might be better to do NSD corrective surgery before examining tympanoplasty for patients with chronic otitis media (2). The results of the present study confirmed these findings, especially in patients with severe NSD, who had higher incidence of chronic otitis media than those with mild and moderate NSD. It seems that examining the effect of NSD corrective surgery on the frequency of chronic otitis media and the possible increase in air cells volume in the deviation side is a significant issue for future interventional studies. Another study on 59 children and adolescents showed results similar to the present study; the volume of mastoid air cells in the side with NSD was lower than the opposite side, although this difference was not statistically significant. Moreover, there was no correlation between the volume of mastoid air cells and the severity of NSD in the side of the deviation and the opposite side (9). In another study on the association between NSD and pathological changes in mastoid, it was shown that mastoiditis is mainly observed on the NSD side (13). The effect of NSD on the volume of mastoid air cells has also been examined in previous studies. One of these studies has shown that the volume of total ethmoid cells in NSD side decreases with an increase in the degree of deviation in comparison with the opposite side, and it can be said that nasal septal deviation affects the volume of the ethmoid cells (14). In addition to ethmoid, another anatomical structure that have been considered in the studies were maxillary sinus. In another study, the size of the maxillary sinus of the NSD was different from the opposite side (15). In this study, CT scan was used to examine the relationship between NSD and chronic otitis media, as well as pneumatization and the volume of the air cells. CT scan is a gold standard for evaluating these anatomical structures.

Awareness of various anatomical deviations for surgeons and radiologists is essential to avoid possible complications and to improve the success of therapeutic strategies (16). Furthermore, CT scan images can be used to reconstruct axial designs for data collection. It is both quick and less costly than the MRI, which provides more information about soft tissue than the bone (17). Based on the results, chronic otitis was more common in patients with severe NSD than in the mild and moderate NSD groups. In addition, the majority of patients with moderate and severe NSD had lower mastoid volume in the side with deviation compared to the opposite side (without deviation), although there was no difference in the frequency of mastoid pneumatization between different NSD intensities. These results can help

physicians who treat patients with chronic otitis media and NSD to consider corrective surgery in cases of severe NSD. Furthermore, the study of these patients should not be limited to observing the presence or absence of pneumatization, and the volume of mastoid air cells should be compared on both sides of the patient.

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