Ann Med Res

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Annals of Medical Research

journal page: www.annalsmedres.org

New approach to mastoid asymmetry

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ARTICLE INFO

Keywords:
Mastoid asymmetry
Chronic otomastoiditis
Computed tomography (CT)

Received: Aug 24, 2022
Accepted: Oct 20, 2022
Available Online: 22.10.2022

DOI:
10.5455/annalsmedres.2022.08.259

Abstract

Aim: To indicate the association between chronic otomastoiditis (COM) and the asymmetry in mastoid length and pneumatization.

Materials and Methods: 1.870 patients who underwent computed tomography (CT) imaging for various indications were retrospectively evaluated. Of the 1.870 patients, 67 were included in this study. Coronal and sagittal images of 67 patients were evaluated and 3D reconstructed.

Results: There was no significant difference in age or gender between right and left side hypopneumatization ($p>0.05$).Thevertical length difference between the tips of mastoids (VLBM) was significantly higher in patients with left hypopneumatized mastoid than the right ones ($p<0.001$). No significant association was found between chronic otomastoiditis (COM) and VLBM or hypopneumatization side. No correlation between VLBM and age was also found as well ($r= -0.012$ $p=0.926$).

Conclusion: No association is found between COM and the asymmetry in mastoid length or pneumatization. Therefore, we think that COM does not influence the development of mastoid pneumatization. The results of our study are in concordance with those of studies that indicate that mastoid pneumatization is mainly genetically determined.

Introduction

Temporal bone consists of five pneumatized regions, which are the middle ear region, mastoid region, perilabrynthine region, petrous apex region, and accessory region [1]. Accessory regions, including air cells, are the temporal bone's styloid, squamous, zygomatic and occipital parts [2]. Of the five pneumatized regions mastoid process is a common interest of oto-surgeons, neurosurgeons, and radiologists because of its clinical implications. It is an essential parameter to neurosurgeons for the localization of asterion, which is a surface landmark of the underlying transverse sinus and sigmoid sinus [3]. Also, mastoid air content protects vital structures in the temporal bone in any trauma [4].

The development of mastoid air cells begins in early gestational life. The antrum is the first mastoid air cell that begins to develop in 21-22 weeks of fetal life. Other air cells develop after birth and this process is completed around puberty by the development of the last air cells in the petrous apex [5]. The link between mastoid pneumatization and hereditary or acquired factors were examined in the previous studies [1]. As a general opinion accepted by the scientific community, symmetrical mastoid processes, either small or large, were considered evidence of hereditary theory, while asymmetrical mastoid processes were more linked to the environmental theory [6]. Mastoid asymmetry is a radiologic or morphologic implication of unilateral or bilateral unequal aeration of mastoid processes. In the present study, we aimed to assess the association between mastoid asymmetry and chronic otomastoiditis (COM). It is stil controversy for physicians if mastoid asymmetry is a consequence or a cause. The problem is that no sufficient result is obtained in the studies to date. We hypothesize studies with large sample size such as the present one will enlighten this controversy.

Materials and Methods

All procedures of the present study were approved by Ankara Yıldırım Beyazıt University Medical Faculty Clinical Research Ethics Committee (Decision number: 26379996/19). The temporal bone CT scans were obtained using a 256-slice CT device (Somatom Definition Flash, Siemens Healthcare, Forchheim, Germany) in the axial plane with a standard protocol of 512 × 512 matrix, 120 kV tube voltage, 400 mA current strength, 0.6 mm cross-sectional thickness, 0.3 mm cross-sectional spacing, and 6.19 sec acquisition time.

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One thousand eight hundred seventy patients who underwent CT imaging for various indications between January 2018 and January 2019 were retrospectively evaluated. Of the 1,870 patients, 67 were included in this study. In post hoc power analysis with >0.80 effect size, a of 0.05, two tails, and two groups, a total sample size of 67 cases given the power of 0.97. Coronal and sagittal images of 67 patients were evaluated and 3D reconstructed. (Fig1, Fig2, Fig3, Fig4, Fig5).

Patients with a history of head trauma, neoplasm, fracture in the temporal bone, previous ear and cranial surgery, and those younger than 18 were not included in this study. Patients with bilateral mastoid hypopneumatization and patients with asymmetrical mastoids with a difference of less than 5 mm of vertical length between tips of either mastoid processes were not included in the study.

Statistical analysis

All statistical analyses were performed via SPSS 25.0 (IBM SPSS Statistics 25 (Armonk, NY: IBM Corp.) program. In the statistical analysis, normal distribution was determined by Kolmogorov-Smirnov test. The Mann-Whitney U test was used to compare the continuous variables between the two groups. The Chi-square test estimated the differences between the categorical variables. The Spearman correlation was used for analyzing a correlation coefficient. A p-value <0.05 was considered statistically significant.

Results

One thousand eight hundred seventy patients were examined, out of which 47% were male and 53% were female. Among these, 67 (3.58 %) with unilateral hypopneumatized mastoids were subsequently enrolled to study. (Fig1, Fig2) All 67 patients had mastoid asymmetry, which was indicated by at least 5mm vertical length difference between the tips of either mastoids (VLBM). (Figure 1).

The mean age of 67 patients enrolled in the study was 43.21±13.42 years (range:17-84 years), among whom 37(%55.2) were females, and 30 (44.8%) were males (Table1).

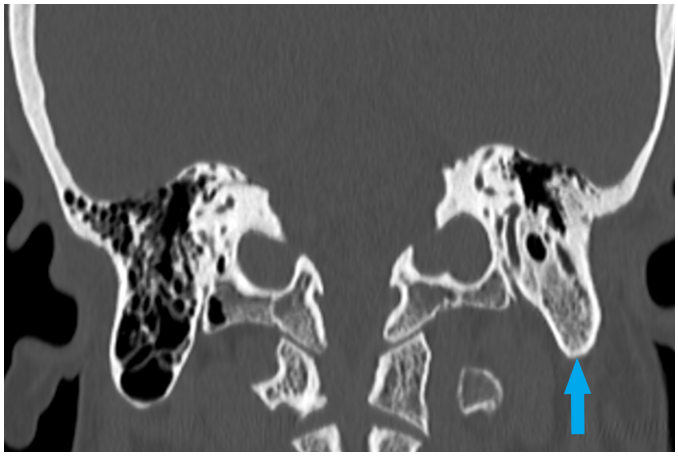

Figure 1. Coronal MDCT image of temporal bone Left hypopneumatized mastoid bone leading cranial asymmetry (with no chronic mastoiditis) (blue arrow).

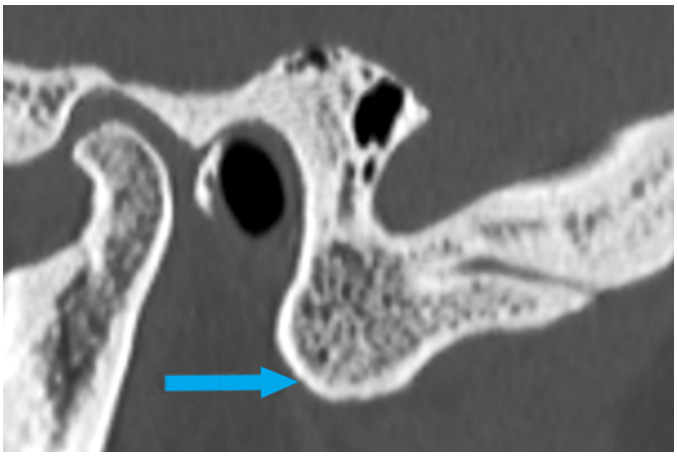

Figure 2. Sagittal MDCT image of temporal bone Left hypopneumatized mastoid bone (with no chronic mastoiditis) (blue arrow).

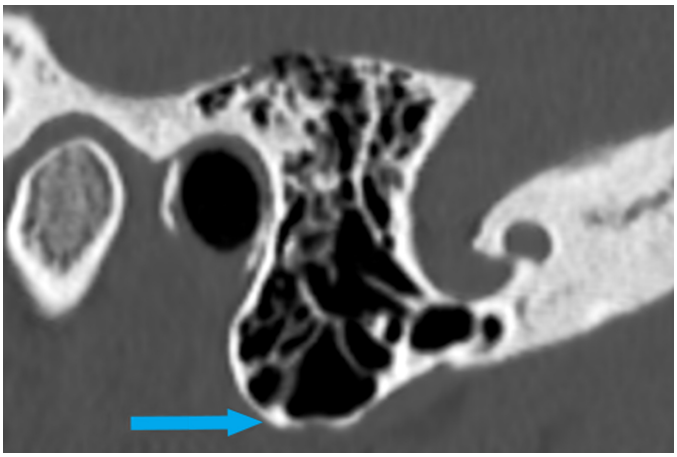

Figure 3. Sagittal MDCT image of temporal bone Normopneumotized right mastoid bone (blue arrow).

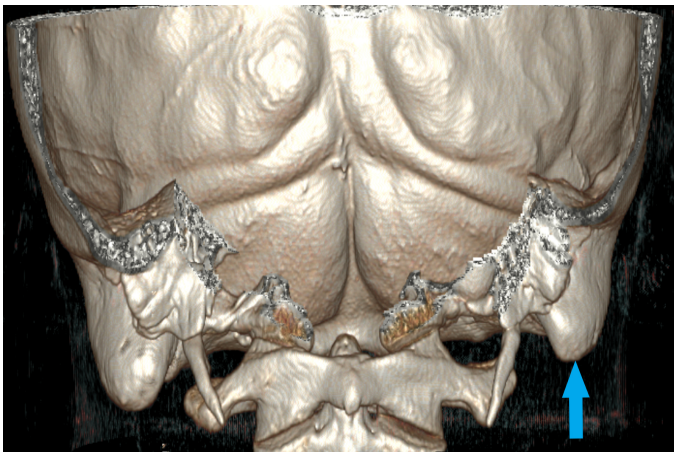

Figure 4. Anteroposterior 3D MDCT image. Left hypopneumatized mastoid process (blue arrow).

When the side of the hypopneumatization according to the genders and age was examined, there was no significant difference between the right and left sides (p>0.05).VLBM was significantly higher in patients with a left hypopneu-

Table 1. Demographic information and comparison of hypopneumatization between right and left sides among genders.

	Total (n=67)	R-hypopneumatization (n=28)	L- hypopneumatiza-tion (n=39)	p
Female, n(%)	37 (55.2%)	15 (53.6%)	22 (56.4%)	0.818
Male, n(%)	30 (44.8%)	13 (46.4%)	17 (43.6%)	
Age, mean±sD	43.21±13.42	44.61±11.17	42.2±14.88	0.377
VLBM (mm), mean±sD	7.1±1.45	6.37±1.01	7.63±1.51	<0.001*

R; right, L; left, *p<0.05 statistically significant difference, VLBM; vertical length between mastoid tips.

Table 2. The comparison of choronic otomastoiditis (COM) and hypopneumatization of mastoid bone.

	Total (n=67)	with COM (n=37)	without COM (n=30)	p
R-hypopneumatization, n(%)	28 (41.8%)	16 (43.2%)	12 (40%)	0.789
L-hypopneumatization, n(%)	39 (58.2%)	21 (56.8%)	18 (60%)	
VLBM (mm), mean±sD	7.1±1.45	7.18±1.63	7.01±1.22	0.925

R; right, L; left, *p<0.05 statistically significant difference, VLBM; vertical length between mastoid tips.

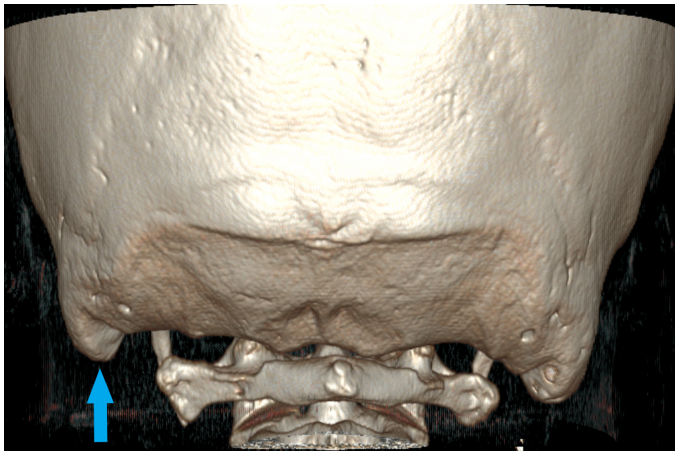

Figure 5. Posteroanterior 3D MDCT image. Left hypopneumatized mastoid process (blue arrow).

matized mastoid than the patients with a right hypopneumatized mastoid (p<0.001) (Table1).
The association between COM and VLBM was examined as well. 37 (%55.2) of 67 patients had COM. The mean value of VLBM of the patients without COM was 7.01±1.22 and of the patients with COM was 7.18±1.63 mm (p=0.925). No significant correlation was found between COM and VLBM (p>0.05) (Table 2).
No correlation between VLBM and age was found as well. (r= -0.012 p=0.926).

Discussion

Many scientists have studied the mastoid process, a downward pneumatized temporal bone projection [5,7]. It has been an interest of otosurgeons and neurosurgeons because of the assumption that less pneumatized mastoid cells accompany COM [5,8]. Our aim in this study was to to indicate the association between COM and the asymmetry in mastoid length and pneumatization. We found no significant association between COM and VLBM or hypopneumatization side. No correlation between VLBM and age was also found as well. Also there was no significant difference in age or gender between right and left side hypopneumatization in the present study.

Çalışkan et al. measured the dimensions of 58 mastoid processes on dry skulls of unknown sex. Measurements of 18 mastoid processes were taken on hemi skulls [7]. They found the vertical length of the mastoid process greater on the right side. Flohr et al researched 151 mastoid processes consisting of 52 bilaterally examined crania [9]. In our opinion, such studies on dry materials serve limited information due to unclear demographic data and unilateral materials. Unknown sex, age, and trauma exposure damage are limitations of such dry material studies. Since 18 of the measured structures were unilateral, the study of Caliskan et al. does not provide further information on the right-left difference. Unknown demographic data of the aforementioned studies provides insufficient data to evaluate age and gender-related differences as well [7,9].

Paiva Las et al. took measurements on the mastoid process of 60 dry skulls, each of which had clear demographic information. They presented gender specific morphological features of the mastoid process. They indicated overlapping of the right and left area values was 60% and 51.67% respectively, between the male and female skulls [10]. In our opinion, the high rate of overlapping values is due to their study's lack of mastoid asymmetry evaluation. Smaller or greater values of individuals with asymmetrical mastoid processes influence the measurement of all series. We think volumetric and morphologic studies should be carried out on living populations. The present study provides proper morphological measurements, demographic information, and information on the volumetric asymmetry between the right and left sides. Paired anatomical features in the body should be evaluated bilaterally in the volumetric and morphometric studies aim to present a paired structure as an indicator of sex or any disease since asymmetry may affect the outcomes. We found that 3.58 % of the study population had asymmetric mastoids. Besides, no correlation was found between age and mastoid size in our study, which consists of the adult population either with or without COM. However the hyponeumatized smaller mastoid process was more significant on the left side. The data of the present study improves on those of the aforementioned studies.

The degree of mastoid pneumatization varies among individuals. Many studies are encountered in the literature examining what affects the mastoid volume. Sethi et al. claimed that mastoid pneumatization is under the influence of genetic factors, skull size, and height of an individual [1]. Ertugrul et al. found that degree of mastoid pneumatization was higher in patients with Huschke's foramen, which is a bony dehiscence interconnecting the external auditory canal and temporomandibular joint [8]. Kim et al. showed the hypertrophic mastoid process in patients with congenital muscular torticollis. Moreover, they demonstrated that the volumetric asymmetry increased with age [11]. Lee et al measured the volume of the mastoid air cells by a 3D reconstruction CT and reported that the adult mastoid loses volume with age [12]. Aldeyelu et al. published that the mastoid volume, which is an implication of pneumatization, differs among populations, ages, and sex [13]. Yılmaz et al. measured mastoid height and detected no significant difference as the result of a comparison of right-left side values according to sex [14]. Chatterjee et al. published that the normal measurement of mastoid air cell system in Indian people is the same as that of Western people in both sexes [15]. Literature is rich in papers discussing the hereditary factors resulting from mastoid volume differences. In the present study, we aimed to indicate if there is a link between mastoid volume and COM which is an acquired and preventable cause of mastoid asymmetry, and contribute to the relevant literature.

Since the mastoid and tympanic cavities are of common embryological origin and have anatomical continuity, any infection in one will occur clinically in the other. There are studies in the literature discussing insufficient mastoid aeration as a cause or a consequence of COM [16-21]. There is a controversy about whether mastoid hypopneumatization is a genetically based variation or whether it is the consequence of an environmental factor. While Voltanen et al. and Roy et al. report that otitis media and its long-standing process influence mastoid pneumatization, Sade et al. reported no link between these two conditions [16,17,21]. We found no association between COM and mastoid size in the present study. Our study supports those studies which report mastoid pneumatization is genetically determined. Whether the cause or the consequence, hypopneumatized mastoid is an important prognostic factor of ear surgery for patients with COM.

Present study was carried on adults. Because it is a retrospective study long term follow-up of patients with COM and effects of disease duration on mastoid asymmetry were not documented. These are the limitations of our work. However this study provides base for future prospective studies with long-term follow-up in patients with COM beginning in childhood.

Conclusion

There is no association between COM and the asymmetry in mastoid length or pneumatization. Based on the results of the present study, we disagree with the widely accepted views that argue that mastoid pneumatization is the result of COM. Our study concurs with studies that indicate that mastoid pneumatization is mainly genetically determined. In conclusion, regardless of its cause mastoid asymmetry has clinically significant consequences and should be evaluated radiologically before ear and cranial surgeries.

Ethics approval

Approved by Ankara Yıldırım Beyazıt University Medical Faculty Clinical Research Ethics Committee (Decision number: 26379996/19).

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