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The effect of anatomical variations of concha bullosa on maxillary sinus volume using Cone Beam Computed Tomography (CBCT) imaging

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ABSTRACT

Background and Objective: Concha Bullosa (CB) is called partial or total pneumatisation of the middle turbinate and is the most common anatomic variation of the ostiomeatal complex region. CB is a Pneumatisation of the middle turbinate and is the most common anatomical variation in the ostiomeatal complex. It is divided into lamellar, bulbous, and extensive types. Some studies demonstrated prevalence between 14% and 53%. CB can be small, medium, or large and cause nasal cavity obstruction. Although it usually remains asymptomatic, a large concha bullosa can occasionally compromise drainage of the sinuses, resulting in chronic paranasal sinus disorders.

Materials and Methods: The study group included 200 CBCT images and a total of 400 maxillary sinuses, which were retrospectively selected from the records in the CBCT archive. Maxillary sinus volume of all CBCT images was calculated using NNT Viewer version 10.1 software. Maxillary sinus volume differences were evaluated by comparing the bilateral sinus volumes in patients with CB and without CB. Statistical analyses were performed using SPSS software and a p-value <0.05 was considered statistically significant.

Results: 54.2% of men and 48.2% of women had Concha Bullosa. There was no statistically significant relationship between gender and concha bullosa (p>0.05). The volume of the right and left sinus in men was larger than the volume of the right and left sinus in women and the difference in the average volume was statistically significant (p<0.05). The volume of the maxillary sinus on the side with concha bullosa was less than the side without concha bullosa, but there was no statistically significant difference in the volume of the right and left sinus in people with or without concha bullosa (p>0.05). Among the people with concha bullosa, 42 people (42%) had Extensive, 20 people (20%) had lamellar and 38 people (38%) had bulbous. The volume of the right and left sinus was higher in the extensive type, followed by the volume of the lamellar type, and the smallest volume was obtained for the bulbous type. There was no significant difference between the average of these volumes on the right side and the left side (p>0.05).

Conclusion: The findings show that the volume of the maxillary sinuses is smaller on the side with CB. In addition, Extensive is the most common type and no significant difference was found between the volume of maxillary sinuses in CB types on the right and left side.

Key words: maxillary sinus volume, concha bullosa, cone-beam computed tomographys

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INTRODUCTION

Maxillary sinuses are the first paranasal sinuses to develop. They are air-filled spaces that surround the upper jaw bone bilaterally. Maxillary sinuses develop in the 2nd month of intrauterine life; a depression is created in the lateral wall of the nasal

cavity in the middle sinus and the sinus expands laterally inside the body of the maxillary bone [1, 2].

Is created in the lateral wall of the nasal cavity in the middle meatus, and the sinus develops laterally inside the body of the maxillary bone [1, 2]. A rudimentary sinus measuring 4 mm x 4 mm x 7 mm or an average of approximately 6 cm^3 -8 cm^3 is present at birth, with its longest dimension in the anterior-posterior axis [3]. After birth, the ventilation of the sinuses into the alveolar appendages leads to the draping of the floor of the maxillary sinus on the premolar root and molar teeth. The imaging view of the floor of the maxillary sinus is a thin, radiopaque, and clear line [1]. In adults, the dimensions of the sinus are approximately 33 mm in height, 33 mm in width, and 34 mm in the anteroposterior axis. The average volume of a developed maxillary sinus is approximately 15 ml to 20 ml [2]. This sinus continues to grow between the ages of 12 and 15 and reaches its adult size at the age of 15 [4].

The annual growth of the maxillary sinus is estimated to be 2 mm vertically and 3 mm in the anteroposterior axis. In most cases, maxillary sinuses grow symmetrically, although sometimes unilateral or bilateral sinus hypoplasia is also seen [3]. Concha Bullosa (CB) is a Pneumatization of the middle turbinate. It is the most common anatomic variation in the ostiomeatal complex [5, 6]. The causes of pneumatization remain unclear, although Nasal Septum Deviation (NSD) and mouth breathing are known predisposing factors for CB [7]. Some studies have shown that the middle turbinate is more pneumatized because it is affected by airflow [6]. CB is classified into Extensive, Bulbous, or Lamellar type. It is assumed that the bulbous and extensive type at the tip of the turbinate, near the middle meatus, affects the formation of maxillary sinus volume [7, 8]. Although concha bullosa is usually asymptomatic, a large concha bullosa may sometimes interfere with sinus drainage. The concha bullosa air cavity is covered with the same epithelium as the nasal cavity. These cells can cause inflammation, resulting in chronic disorders in the paranasal sinuses [9].

Many studies have reported the prevalence of CB between 14% and 53% [10]. CB can be small, medium, or large and cause nasal cavity obstruction. Ventilation of the upper part of the lamina attachment turbinate is usually called partial ventilation of the turbinate. This condition rarely causes nasal obstruction [3]. It is believed that ostiomeatal obstruction, which impairs ventilation and mucociliary clearance of the sinuses, exposes patients to sinus diseases [10]. CBCT is increasingly used as a cost-effective and more accurate method than CT to diagnose sinus disorders, anatomical abnormalities, and pathological conditions of the sinonasal complex due to its low radiation dose, greater simplicity, and higher resolution [7, 11]. In addition, CBCT images for the nose and paranasal sinuses have several advantages over Computed Tomography (CT), including high quality for bone fracture detection, multiplanar reformation, faster scanning time, and a cheaper device [12]. Linear dimensions of maxillary sinuses have been investigated in several studies. However, volumetric research has received less emphasis [13]. Accordingly, the purpose of the present study is to determine the relationship between CB and volume changes in the maxillary sinus using CBCT.

METHODS AND MATERIALS

This study is descriptive-analytical and retrospective research that uses Cone Beam Computed Tomography (CBCT) images of the maxillary sinus in three axial, coronal, and sagittal planes on 200 patients referred to a private maxillofacial radiology clinic in Ahvaz County between 2020-2022. The study group included 200 CBCT images of people who visited a specialized radiology clinic in Ahvaz for different reasons between 2020-2022. The inclusion criteria of the samples included the optimal quality of the images, the availability of information on the age and gender of the patients, and the coverage of the maxillary sinuses and the nasal cavity. Patients with a history of surgery, pathology, mid-facial trauma, or sinusitis, as well as patients under 15 years of age, were excluded from the study. The sample size for the two groups was determined to be 134 cases (67 cases with concha bullosa and 67 cases without concha bullosa). However, we included all the information in the archives of a private maxillofacial radiology clinic in Ahvaz

County between 2020-2022 for analysis. Finally, 210 samples were collected, of which 2 patients were excluded from the studied samples due to lack of complete coverage of the maxillary sinus image and 8 patients due to lack of complete information. Finally, 200 patients (400 maxillary sinus samples) were studied.

In this study, images were prepared by Italy, Verona, QR, and NewTom Giano devices with FOV 11 x 8 High resolution with exposure conditions kvp=90 and time 9 seconds and saved with NNT viewer version 10.1 software and are archived. The images were viewed in a semi-dark room on a (14-inch Asus LED flat-screen monitor) with a resolution of 1920 x 1080. In this study, the medical mode of the software, NNT viewer (QR, Verona, Italy) was used to calculate the volume of two-sided sinuses. It should be noted that the patients' images were examined in the volume obtained, not in the study. All patients were examined for the presence or absence of concha bullosa. At first, the name, age, and sex of each patient were written in the specified tables.

Measurements were performed in patients who had two complete maxillary sinuses covered and the same nose was clearly defined. In the axial image of the patient, the target area was selected at the section where the maxillary sinus and the nasal cavity were distinct, and then restorations were made in other planes (coronal, sagittal). That is the height of the sinus on the images of the coronal view from the lowest point of the floor to the highest point of the roof of the sinus, the width of the maxillary sinus on the images of the coronal plane as the longest horizontal distance from the inner wall of the sinus to the outermost point of the lateral wall of the maxillary sinus and in the anterior-posterior dimension of the sinus It was also marked as the longest anteroposterior distance from the most anterior point to the most posterior point in the sagittal plane. After selecting the limits of the maxillary sinus in all 3 views, this sinus turned green, which was used as a guide for correct measurement. Finally, the final calculation was conducted when the maxillary sinus was fully covered in all three views. In this part software settings were such that only the air density measurement was done by the computer (Hounsfield unit -1000 to unit-4000). After doing this, write down the Total Volume from the Analyze volume statistics part and save the results. This process was performed for both sinuses in each patient. Finally, the maxillary sinus volume on both planes was used for further analysis. Then, the presence or absence of concha bullosa in the middle turbinate was examined in the nasal cavity. The samples were classified based on the classification of Kalaiarasi et al. which divided Concha bullosa into three types: Lamellar, Bulbous, Extensive/Large, and were marked in the information form, as follows [8]:

- (Lamellar): The vertical lamella of middle turbinate was pneumatized.
- (Bulbous): The lower part of the middle turbinate was pneumatized.
- (Extensive/Large): The vertical lamella and the lower part of the middle turbinate were pneumatized.

The data of this study was collected in the form of a census of the total Cone Beam Computed Tomography (CBCT) images of the maxillary sinuses as the volume in 200 patients who, according to the inclusion criteria, were selected from the archives of a private maxillofacial radiology clinic in Ahvaz during the years 2020-2022. The NNT Viewer v10.1 was used to view the data. Descriptive statistics (mean, standard deviation) were used to analyse the statistical indicators and describe the variables. Shapiro-Wilk test to assess the normality of the data.

It was used to measure the relationship between variables if the data were normal. The independent t-test was used to compare the means if the data were normal, and the Mann-Whitney test was used if the data were not normal. ANOVA test (analysis of variance) was used to compare the levels of variables. In addition, data analysis was conducted using SPSS Statistics 23.0. In all tests, a P-value of less than 0.05 was considered. This study has been registered with the code 297.1401 IR.AJUMS.REC in the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences. This study was conducted on the images in the archives of a private maxillofacial radiology clinic in Ahvaz. The principles of protection and hygiene were observed when preparing radiographs.

RESULTS

In this research, 200 people with an average age of 29.96 years ± 8.94 years were investigated, of which 59 people (29.5%) were men and 141 people (70.5%) were women. Almost half of the audience) 100 people (were with concha bullosa and the other half were without concha bullosa. Among the people with concha bullosa, 27 people (27%) had right concha bullosa, 31 people (31%) had left concha bullosa, and 42 people (42%) had both right and left concha bullosa. We used the chi-square test to check the presence or absence of concha bullosa according to gender. In total, 54.2% of men and 48.2% of women had concha bullosa (Table 1). There was no statistically significant relationship between gender and concha bullosa (p>0.05).

Tab. 1. Evaluation of the presence or absence of concha bullosa according to gender

Variable		Concha bullosa		p-value
		Yes	No	
Gender	Men	32 (54.2)	27(45.8)	0.438
	Woman	68(48.2)	73(51.8)	

Almost 25% of men had concha bullosa on the right side, 28.1% on the left side, and 46.9% on both sides (Table 2). For women, 26.5% had concha bullosa on the right side, 32.4% on the left side, and 41.2% on both sides. In other words, in both women and men, the prevalence of concha bullosa on both sides is more than on the left side and more than on the right side, but there was no statistically significant relationship between gender and the type of concha bullosa (p>0.05).

Tab. 2. Concha bullosa side evaluation according to gender

Variable		Concha bullosa			P-value
		Left	Right	Both sides	
Gender	Man	9(28.1)	8(25)	15(46/9)	0.857
	Woman	22(32.4)	18(26.5)	28(41.2)	

The volume of the right sinus in men was 14.23 cm^3, which was larger than the volume of the right sinus in women (12.41 cm^3) (Table 3). The difference between average volumes was statistically significant (p<0.05). In addition, the volume of the left sinus in men and women was 14.38 cm^3 and 12.35 cm^3, respectively, and this difference is statistically significant (p<0.05). It should be noted that according to the findings of the research, the maxillary sinus was larger on the left side in men and on the right side in women, but this difference was not significant.

Tab. 3. Measurement of maxillary sinus volume according to gender

Variable		Left sinus	Right sinus
		Standard deviation ± Mean	Standard deviation ± Mean
Gender	Man	14.38 4 ± .77	14.23 4 ± .55
	Woman	12.35 3 ± .51	12.41 7 ± .7
p-value		0.0003**	0.004*

* Independent t-test, **Mann-Witney

The volume of the maxillary sinus on the side with concha bullosa is less than the side without concha bullosa (Table 4), but there is no statistically significant difference in the volume of the right and left sinus in people with or without concha bullosa (p>0.05).

Tab. 4. Measurement of maxillary sinus in people with or without concha bullosa

Variable		Left sinus	Right sinus
		Standard deviation ± Mean	Standard deviation ± Mean
Concha bullosa	Yes	12.93 4 ± .0.6	12.62 4 4 ± .21
	No	13 3 ± .99	13.29 8 ± .12
P-value*		0.586	0.817

*Mann-Witney test

The volume of the maxillary sinus on the side with concha bullosa is less than the side without concha bullosa, but there is no statistically significant difference in the volume of the right and left sinus in men with or without concha bullosa (p>0.05) (Table 5).

Tab. 5. Assessment of maxillary sinus volume in men with or without concha bullosa

Variable		Left sinus	Right sinus
		Standard deviation ± Mean	Standard deviation ± Mean
Concha bullosa	Yes	14.35 5 ± .13	14.04 4 ± .88
	No	14.55 4 ± .34	14.47 4 ± .19
P-value *		0.871	0.719

* Independent t-test

Moreover, the volume of the maxillary sinus on the side with concha bullosa is less than the side without concha bullosa, but there is no statistically significant difference in the volume of the right and left sinus in women with or without concha bullosa (p>0.05) (Table 6).

Tab. 6. Assessment of maxillary sinus volume in women with or without concha bullosa

Variable		Left sinus	Right sinus
		Standard deviation ± Mean	Standard deviation ± Mean
Concha bullosa	Yes	12.26 3 ± .27	11.94 3 ± .71
	No	12.43 3 ±.34	12.85 9 ± .14
P-value *		0.771*	0.853**

* Independent t-test *Mann-Witney test

According to the results of Table 7, there is no statistically significant difference in the average volume of the right and left maxillary sinuses of men with concha bullosa on both sides (p>0.05).

Tab. 7. Assessment of maxillary sinus volume in men with concha bullosa on both sides

Variable		Left sinus	Right sinus
		Standard deviation ± Mean	Standard deviation ± Mean
Concha bullosa	Right	12.87 3 ± .98	12.13 3 ± .94
	Left	12.43 3 ± .34	15.71 3 ± .7
Both sides		14.87 5 ± .74	14.19 6 ± 0.9
P-value *		0.611	0.305

* One-way ANOVA

According to the results of Table 8, there is no statistically significant difference in the average volume of the right and left maxillary sinuses of women with concha bullosa on both sides (p>0.05).

Tab. 8. Assessment of maxillary sinus volume in women with concha bullosa on both sides

Variable		Left sinus	Right sinus
		Standard deviation ± Mean	Standard deviation ± Mean
Concha bullosa	Right	12.78 3 ± .98	12.34 4 ± .05
	Left	12.68 3 ± .39	12.20 4 ± .0.2
Both sides		11.58 3 ± .27	11.45 3 ± 0.26
P-value *		0.267	0.675

* One-way ANOVA

Among the people with concha bullosa, 42 people (42%) had extensive, 20 people (20%) had lamellar, and 38 people (38%) had bulbous. The chi-square test was used to investigate the type of concha bullosa according to the genus. In total, 43.8% of men were in the bulbous type and 35.3% of women were in the extensive type, in both women and men, the lamellar form was the lowest type (Table 9). There was no statistically significant relationship between gender and concha bullosa type (p>0.05).

Tab. 9. Review of different forms of concha bullosa according to gender

Form					p-value
Variable		Bulbous	Lamellar	Extensive	
Gender	Men	14 (43.8)	6(18.8)	12 (37.5)	0.714
	Women	24(35.3)	14(20.6)	30(44.1)	

The volume of the right and left sinuses respectively in the extensive type was higher. Then, the volume of the bulbous type, and the smallest volume was obtained for the lamellar type (Table 10). Based on the statistical analysis, no significant difference was found between the average of these volumes on the right and left sides. (p>0.05).

Tab. 10. Assess the volume of the maxillary sinus according to the type of concha bullosa

Variable		Left sinus	Right sinus
		Standard deviation ± Mean	Standard deviation ± Mean
Concha Bullosa genus	Extensive	13.73 4 ± .80	13.24 4 ± .53
	Lamellar	11.09 2 ± .99	10.55 3 ± .0.99
Bulbous		12.99 3 ± .38	12.86 3 ± 0.76
P-value		0.057*	0.054*

* One-way ANOVA

DISCUSSION

This study aimed to investigate whether concha bullosa affects the volume of the maxillary sinuses. Does this disrupt drainage and predispose a person to chronic sinusitis? Therefore, 200 CBCTs were examined and measured. In total, 141 people were women and 59 were men. All of them were over 15 years old to ensure the development of the maxillary sinus.

Raghdaa et al. conducted a study to determine the effect of Concha Bullosa (CB) and Nasal Septal Deviation (NSD) on the volume of maxillary sinuses in Egypt [14]. Therefore, 70 CBCT scans were analyzed. 140 maxillary sinuses were examined. The subjects were between 20 years-60 years old. The total volume of the maxillary sinus was 13.08 cubic centimetres ± 4.98 cubic centimetres. The total volume of the maxillary sinus was 13.08 cm^3 ± 4.98 cm^3. The measurements in this study were similar to those in our study. The results of this study showed that the two anatomical changes of CB and NSD do not affect the average volume of maxillary sinuses. The results also showed that the presence of concha bullosa does not affect the average volume of the maxillary sinuses. Senol et al, 2023 used MDCT images of 73 patients (35 women and 38 men) aged between 25 and 58 years in Turkey. Turbinate pneumatization (upper, middle, or lower) was observed in 75.3% of cases. The number of patients with turbinate pneumatization on the right side was 19.2%, the number of patients with turbinate pneumatization on the left side was 20.5%, and the number of bilateral pneumatization was 35.6%, while no significant correlation was found between turbinate pneumatization and maxillary sinus volume. In addition, it was found that men had higher maxillary sinus volume compared to women. In our study, 100 out of 200 people had concha bullosa. The results of both studies were similar despite the difference in the number of samples and the difference in the imaging modality. Thus, in both studies, the prevalence of concha bullosa was higher on the left side and more than on the right side, respectively. There was no significant relationship between concha bullosa and sinus volume.

Kar et al. conducted a study in Turkey [6]. This study included 3133 patients including 1534 women (48.96%) and 1599 men (51.03%). The age range of the patients was between 12 and 85 years and the average age was 57.25 years. The middle turbinate concha bullosa was diagnosed in 44.74% of cases. Of these, 99.54% had bilateral CB. In our study, most cases of concha bullosa were bilateral. The lamellar type of concha bullosa was diagnosed in 575 patients (41.01%), bulbous type in 363 (25.89%), and extensive type in 464 (33.09%). The prevalence of different types of concha bullosa was not consistent with our study, because their study showed the prevalence of the lamellar type as the dominant type, while in our study the lowest prevalence was related to the lamellar type, which can be related to racial differences. In our study, people under 15 years of age were excluded from the study due to a lack of maxillary sinus development. Zakariaee et al. conducted a descriptive-analytical study on 135 patients in Iran [13]. CBCT images were checked by Digimizer to measure the volume of maxillary sinuses. The results showed that the average volume of the right and left maxillary sinuses was not significantly different in the presence or absence of concha bullosa. These results are consistent with the results of the present study, despite the difference in the number of samples and the difference in the software [15].

Lee J. et al., investigated the effect of concha bullosa on maxillary sinus volume in Korea and retrospectively reviewed 209 PNS CT paranasal sinuses [6]. The results showed that the volume of the maxillary sinus (on the right and left side) was significantly larger in men compared to women, and the volume of the maxillary sinus was not related to concha bullosa. We also found that the volume of the maxillary sinuses in men was larger than in women, and this difference was statistically significant despite the difference in the imaging modality in the findings of the study. Tassoker et al. conducted a study in Turkey with the aim of the effect of concha bullosa on the volume of the maxillary sinus [5]. They examined 55 patients and 110 maxillary sinuses by CBCT imaging. Then, the volume of sinuses was calculated by Materialise Mimics. This study showed that impacted teeth, nasal septum deviation, concavity, and age had no effect on maxillary sinus volume, but gender had an effect on maxillary sinus volume so the average sinus volume was higher in men than women. Our findings regarding the effect of concha bullosa and gender on maxillary sinus volume are consistent with the results of this study despite the difference in the number of samples and the difference in the used software. Al-Rawi et al. investigated the effect of Conca bullosa on maxillary sinus volume on 106 CBCTs in the UAE [7]. They measured maxillary sinus volume using Dolphin 11.8 premium. Concha bullosa was detected in 37.7% of

samples. In total, 20.7% of the samples had single unilateral CB and 16.6% had single bilateral CB. CB was significantly associated with higher maxillary sinus volume on the affected side. In our study, there were more cases of bilateral concha bullosa. In addition, the maxillary sinus volume on the side with concha bullosa was less than the opposite side. All these cases were inconsistent with the above study. The difference in the number of samples, different races, and different software used may be one of the reasons for this discrepancy [16].

Kalabalik et al. studied 252 patients using cone beam computed tomography retrospectively in Turkey [11]. All CBCT images were imported into 3D modeling software (MIMICS 3D) to calculate maxillary sinus volume. The results showed that the average volume of the maxillary sinus in men was significantly higher than that of women, and the volume of the maxillary sinus decreased with increasing age. In this study, there was no significant correlation between the volume of the maxillary sinus and concha bullosa. The results were similar despite the difference in the software used. Karatas et al. 45 conducted a study in Turkey to investigate the volumetric relationship between concha bullosa and paranasal sinuses. CT images of 509 adult patients were reviewed retrospectively. There was a moderate positive correlation between the volume of the concha bullosa and the volume of the paranasal sinus. The maxillary sinus volume was larger in men, which was consistent with the results of our study.

El-Din et al. examined the nasal cavity and paranasal sinuses in MDCT of 879 patients in Egypt [17]. They found the prevalence of concha bullosa to be 55%, while in another study by Sogono et al., this figure was 37% [18]. The prevalence of concha bullosa was the same in men and women. (p=0.912). In our study, the prevalence of concha bullosa was almost uniformly higher in men, which was not statistically significant. The prevalence of bilateral CB was higher compared to unilateral cases and there was a statistically significant difference (p=0.041). This result was consistent with our study. In our study, the number of cases with bilateral concha bullosa was more than unilateral, but this difference was not significant. Kalaiarasi et al. found the prevalence of concha bullosa in three forms, extensive bulbous and lamellar, 49.5%, 28.3%, and 22%, respectively. El-Din et al. reported the highest prevalence of the extensive type at 44% [8, 17]. Shams et al reported the prevalence of the extensive type as 36.5% and the prevalence of bulbous and lamellar types as 32.7% and 30.8%, respectively [19]. These studies are consistent with our study and the most common form was extensive in all cases.

CONCLUSION

The findings of the study show that the volume of maxillary sinuses in men was significantly higher than in women. In addition, the volume of this sinus on the side with CB was less than the opposite side, although this difference was not significant. Extensive was the most common type of concha bullosa and lamellar was the least type in our study population. There was no significant difference in the volume of the maxillary sinus in different types of concha bullosa. It is recommended to conduct other studies with a larger sample size in this direction.

REFERENCES

1. Mallya S, Lam E. White and Pharoah's Oral radiology E-book: principles and interpretation: second South Asia Edition E-Book. Elsevier India; 2019.
2. Miloro M, Ghali GE, Larsen P, Waite P. Peterson's Principles of Oral and Maxillofacial Surgery (volume 2). People's Med Publ House-USA; 2012.
3. Som PM, Curtin HD. Head and Neck Imaging: Expert Consult-Online and Print. Elsevier Health Sci,; 2011.
4. Aşantoğrol F, Coşgunarslan A. The effect of anatomical variations of the sinonasal region on maxillary sinus volume and dimensions: a three-dimensional study. Braz J Otorhinolaryngol. 2023;88:118-127.
5. Tassoker M, Magat G, Lale B, Gulec M, Ozcan S, et al. Is the maxillary sinus volume affected by concha bullosa, nasal septal deviation, and impacted teeth? A CBCT study. Eur Arch Oto-Rhino-Laryngol. 2020;277:227-233.
6. Lee J, Park SM, Cha SW, Moon JS, Kim MS. Does Nasal Septal Deviation and Concha Bullosa Have Effect on Maxillary Sinus Volume and Maxillary Sinusitis?: A Retrospective Study. J Korean Soc Radiol. 2020;81:298-304.
7. Al-Rawi NH, Uthman AT, Abdulhameed E, Al Nuaimi AS, Seraj Z. Concha bullosa, nasal septal deviation, and their impacts on maxillary sinus volume among Emirati people: A cone-beam computed tomography study. Imaging Sci Dent. 2019;49:45-51.
8. Kalaiarasi R, Ramakrishnan V, Poyyamoli S. Anatomical variations of the middle turbinate concha bullosa and its relationship with chronic sinusitis: a prospective radiologic study. Int Arch Otorhinolaryngol. 2018;22:297-302.
9. Al-Sebeih KH, Bu-Abbas MH. Concha bullosa mucocele and mucopyocele: a series of 4 cases. Ear Nose Throat J. 2014;93:28-31.
10. Bahemmat N, Hadian H. The frequency of nasal septal deviation and concha bullosa and their relationship with

maxillary sinusitis based on CBCT finding. Int J Med Res Health Sci. 2016;5:152-156.

11. Kalabalık F, Tarım Ertaş E. Investigation of maxillary sinus volume relationships with nasal septal deviation, concha bullosa, and impacted or missing teeth using cone-beam computed tomography. Oral Radiol. 2019;35:287-295.
12. Anbiaee N, Khodabakhsh R, Bagherpour A. Relationship between anatomical variations of sinonasal area and maxillary sinus pneumatization. Iran J Otorhinolaryngol. 2019;31:229.
13. Jubari A. Z., Torkzadeh A. Relationship between maxillary sinus volume and nasal septal deviation concha bullosa and infundibulum size using cone-beam computed tomography (CBCT). Capian J Dent Res. 2022;11:46-53.
14. Senol D, Oner S, Secgin Y, Oner Z, Toy S. Analysis of the effects of total pneumatized turbinate volume on septum deviation, maxillary sinus volume, and maxillopalatal parameters: A multidetector computerized tomography study. J Anatomical Society India. 2023;72:8-14.
15. Kar M, Altıntaş M. The incidence of concha bullosa: a retrospective radiologic study. Eur Arch Otorhinolaryngol. 2023;280:731-735.
16. Demir UL, Akca ME, Ozpar R, Albayrak C, Hakyemez B. Anatomical correlation between existence of concha bullosa and maxillary sinus volume. Surg Radiol Anat. 2015;37:1093-1098.
17. El-Din WA, Madani GA, Fattah IO, Mahmoud E, Essawy AS. Prevalence of the anatomical variations of concha bullosa and its relation with sinusitis among Saudi population: a computed tomography scan study. Anat Cell Biol. 2021;54:193-201.
18. Sogono PG, Songco CG. Prevalence of nasal septal deviation, concha bullosa, and infundibular size and their association with maxillary sinusitis by computed tomography in Filipinos with paranasal sinus disease. J Otolaryngol Facial Plast Surg. 2019;5:1-6.
19. Shams N, Shams B, Sajadi Z. Evaluation of the Prevalence of Concha Bullosa in Cone-Beam Computed Tomography Images. Avicenna J Dent Res. 2020;12:93-96.