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# Anthropometric evaluation of the maxillary sinus in subjects with complete dental system and complete edentulism based on gender, on cbct images

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## Abstract

**Introduction**: Today, it has been determined that women and men are different from each other in anatomical, physiological, and many other aspects. These differences can be useful in many cases, including identification. Considering that we are facing with increased rate of crimes and felonies, and there are different costly diagnostic methods in the field of identification, and few studies have been conducted in this field, as well as the limitation of 2D images and the complex structure of sinus, magnetic resonance imaging and computed tomography (gold standard) are used as the methods for depicting the true anatomy of sinus; However, their use has been limited due to high dose, lack of public access and high cost, and finally, since it seems that the loss of teeth is the only factor that can affect the dimensions of sinus, we decided to carry out a study with the aim of investigating the anthropometric analysis of maxillary sinus in subjects with complete dental system and complete edentulism based on gender, on CBCT images. **Materials and methods:** In this descriptive-analytical study, 70 patients (39 women and 31 men) were selected among available samples from the Maxillofacial Radiology of the Faculty of Dentistry of Khorasgan Azad University in Isfahan. The CBCT images were taken from samples with high resolution and voxel dimensions of 0.1 mm and with exposures of 85 kV and 21 to 35 mAh (according to patient's size) and were examined by SIDEXIS software with an accuracy of 0.01 mm. Finally, the obtained data were analyzed using SPSS ver.25 at two descriptive and inferential levels. **Findings**: in this study, 55.7% of the images were related to women and 44.3% were related to men. Also, 57.1% of them were related to dentate subjects and 42.9% were related to completely edentulous subjects. The gender had an impact on the cephalocaudal dimension (p-value = 0.017) and mediolateral dimension (p-value = 0.036), and is greater in men than women. Dental status had an impact on the orbital floor bone (p-value = 0.002), mediolateral dimension (p-value = 0.003), anteroposterior dimension of right maxillary sinus (p-value = 0.042) and soft tissue thickness (p-value = 0.042). These sizes are greater in dentate subjects than edentulous subjects. Gender had a significant effect on the volume of maxillary sinus (p-value = 0.021). Dental status had a significant effect on the volume of maxillary sinus (p-value = 0.022). The mean volume of maxillary sinus in men is higher than women, and in subjects with complete dental system is higher than subjects with complete edentulism. It is also higher in men in both groups of dentate and edentulous than women. **Discussion and conclusion:** Anthropometric analysis of the sinus by the CBCT not only helps in identification of corpses, but also provides us with useful information about the relationship between dental system and sinus dimensions.

**Keywords:** maxillary sinus, anthropometric, cbct images, gender

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## INTRODUCTION

In the present age, it has been found that men and women are different from each other in anatomical, physiological, and many other aspects. Therefore, these differences can be useful in many cases, including identification. In identification, the attempt is to obtain information about person's race, gender, height, age, occupation, and possibly the cause of death, which has made the identification of anonymous person to be very important in forensic science (Ciaffi et al. 2011). The identification of a living person and a fresh corpse is the same, and different methods are used to identify

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individuals, such as measuring and determining the physical characteristics of a person such as height and weight, the registration of symptoms, lesions, wounds, tattoos, person's dental ID, testing of major and minor blood groups, fingerprinting and genetic testing. DNA analysis is considered as the best method of identification. However, this method is costly and is also not usable in collective accidents (Parker et al. 2013, Caniglia et al. 2013). Fingerprinting can also only be used when fingerprints are found in the crime scene (Eshak et al. 2013). According to studies, superimposing the pre- and post-mortem radiographic plates is an acceptable method for identification among researchers (Patil et al. 2012, Banumathi et al. 2007), especially when there are no comparable DNA samples or fingerprints. The plates that have been used for this purpose have been the simple, MRI, and CT scan types (Uthman et al. 2012, Huang et al. 2010, Liu et al. 2009). Zheng et al. (2009) believed that in the future, CT scan along with other technologies of the day would be helpful in forensic medicine for analyzing the cause of death (Zheng et al. 2009). Examination of a specific anatomical area, that changes rarely after puberty (such as paranasal sinuses), can be helpful in identification using imaging techniques, and its structure does not change after age 20, unless very rare accidents, such as fractures or severe infections, change it (Ribeiro Fde 2000, Kirk et al. 2002). Therefore, the morphology of sinuses remains stable and consistent until old ages when the atrophic changes occur (Yoshino et al. 1987, Quatrehomme et al. 1996, Kullman et al. 1990, Harris et al. 1987). Da Silva et al. (2009) were able to identify the identity of an adult and anonymous man, who had died in a car accident, using pre- and post-mortem plates from frontal sinuses. In this study, the comparison of the outer margins of frontal sinus was suggested for identification (da Silva et al. 2009).

Mu. Henrich et al. (2015, Germany) conducted a study on CT scans of 276 patients in three groups of patients with complete dental system, partial and complete edentulism in order to identify the sexual identity in relation to the volume and surface area of maxillary sinus. The results of this study showed that there is a significant difference between the two genders in volume and surface area of maxillary sinus in all three groups of complete dental system, partially edentulous and complete edentulous, and the mean volume and surface area of sinus in men is greater. Therefore, gender determination using maxillary sinus analysis is possible even in the case of sinus pneumatization (Möhlhenrich et al. 2015). Considering that we are facing with increased rate of crimes and felonies, and there are different costly diagnostic methods in the field of identification, and few studies have been conducted in this field, as well as the limitation of 2D images and complex structure of sinus, magnetic resonance imaging and computed tomography (gold standard) are methods for depicting the true anatomy of sinus; however, their use has been limited due to high dose, lack of public access and high cost, and finally, since it seems that the loss of teeth is the only factor that can affect the dimensions of sinus, we decided to carry out a study with the aim of investigating the anthropometric analysis of maxillary sinus in subjects with complete dental system and complete edentulism based on gender on CBCT images.

## MATERIALS AND METHODS

In this descriptive-analytical and cross-sectional study, CBCT images of patients referred to the Maxillofacial Radiology department of the Faculty of Dentistry of Khorasgan Azad University in Isfahan, which included 70 subjects for both genders (39 females and 31 males) were studied. All of the images were reviewed by a radiologist. Also, patients with unclear images, patients under the age of 20, patients with sinus inflammatory diseases (such as sinusitis, sinus polyps, sinus mucositis due to periodontal disease, etc.), as well as patients with cysts and tumors inside the sinus (such as angioma, SCC, lymphoma, etc.), asymmetry, and history of fractures of the facial bones were excluded from the study. In this study, 70 patients (39 women and 31 men) from the available samples from the Maxillofacial Radiology of the Faculty of Dentistry of Khorasgan Azad University in Isfahan were selected. The CBCT images were taken from samples by radiography machine (Bensheim, Germany) with high resolution and voxel dimensions of 0.1 mm and with exposures of 85 kV and 21 to 35 mAh (according to patient's size), and were examined by SIDEXIS software with an accuracy of 0.01 mm. To prepare the images, the patient's head was positioned in the standard state through parallelizing the occlusal plan with the horizontal plan. The largest sinus dimensions were measured from different coronal and sagittal sections. The measured parameters in the left and right sides are as follows:

The largest anterior-posterior dimension of sinus which is the most anterior point in the anterior wall of the sinus up to most posterior point in its posterior wall in the sagittal section (**Fig. 1**) (Kullman et al. 1990).

The maximum height of sinus which is the distance between the lowest point in the sinus floor up to the highest point in its surface in the coronal section (**Fig. 2**) (Kullman et al. 1990).

The largest mediolateral dimension of sinus which is the distance between the outermost point in lateral wall up to the innermost point in its medial wall in the coronal section (**Fig. 3**) (Kullman et al. 1990).

The maxillary sinus volume in each side was calculated manually using the following formula: (Height × width × height × 0.52), this mathematical formula calculates the approximate volume of sinus using the greatest value of sinus dimensions.

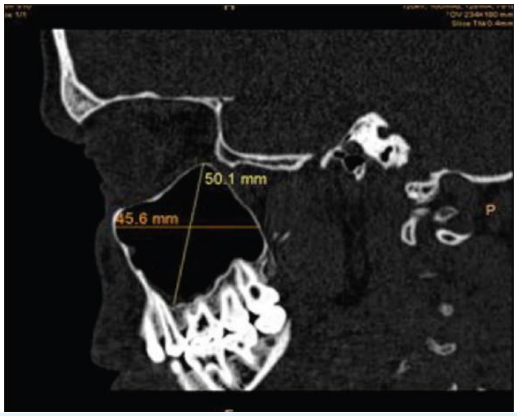


**Fig. 1.** The posterior dimension in the sagittal plane

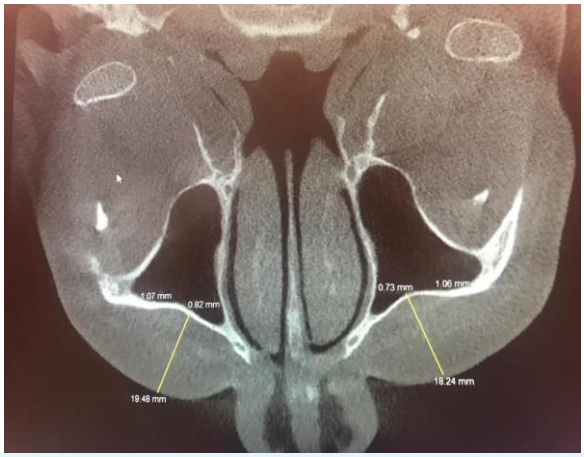


**Fig. 2.** The maximum height in the coronal plane

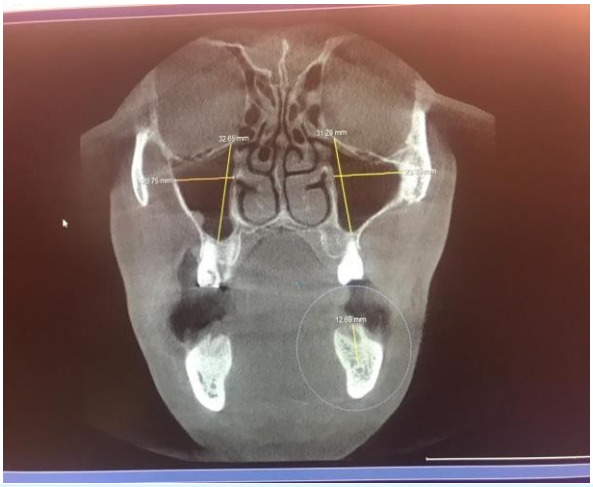

**Fig. 3.** The maximum width in the coronal plane

The mean thickness of the anterior wall of sinus in the canine fossa region in the axial plane (**Fig. 4**) (Harris et al. 1987).

The mean thickness of the orbital floor bone in the coronal plane (**Fig. 5**) (Harris et al. 1987).

The mean thickness of the skin soft tissue up to the anterior wall of the maxillary sinus in the canine fossa

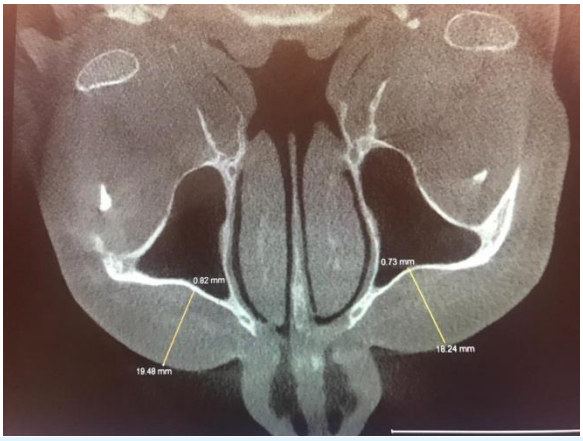


**Fig. 4.** Thickness of the anterior wall of sinus and skin in the canine fossa region


**Fig. 5.** Canine Fossa Area Thickness

region in the axial plane (Harris et al. 1987). The mean thickness of the anterior-medial wall of maxillary sinus in the dental region 6 in the axial plane. Finally, all of the images were examined by a maxillofacial radiologist. The Kolmogorov-Smirnov test was used to evaluate the normality of data, t-test and two-way analysis of variance to evaluate the mean differences, and non-parametric Wilcoxon and Kruskal-Wallis test to evaluate the means. The tests were analyzed at a significance level of 0.05. Finally, the obtained data were analyzed using SPSS ver.25 software.

## FINDINGS

In this study, the maxillary sinus was analyzed in people with complete dental system and complete edentulism based on gender in CBCT images in patients referred to the Maxillofacial Radiology Department of the Faculty of Dentistry of Khorasgan Azad University in Isfahan. In this study, 70 images, including 39 images of women (55.7%) and 31 images of men (44.3%), were examined. Of the 70 images, 40 (57.1%) were related to dentate subjects and 30 (42.9%) were related to completely edentulous subjects. First, the normal distribution of the research variables (the thickness of

**Table 1.** Comparison of the mean variables of the study on right and left sides

| p-value | Mean ± standard deviation | |
|---|---|---|
| 0.581 | 0.0 ± 821.294 | Left Orbital Floor |
| | 0.0 ± 821.294 | Right orbital floor |
| 0.33 | 33.6±98.75 | Left cephalodal dimensions |
| 0.371 | 22.4±1.98 | Left Mediolateral Dimensions |
| | 215±61.22 | Straight Mediolateral Dimensions |
| 0.032 | 32.6±38.38 | Left Antropostrior Dimensions |
| | 33.5±58.9 | Right Antropostrior Dimensions |
| 0.983 | 0.0 ± 764.208 | The thickness of the anterior left wall |
| | 0.0 ± 765.231 | The thickness of the anterior wall is straight |
| 0.386 | 14.3 ± 56.25 | Soft soft tissue thickness |
| | 14.3 ± 35.12 | Right soft tissue thickness |
| 0.388 | 1.0 ± 38.805 | Left antimodal wall thickness 6 |
| | 1.0 ± 38.807 | Anthromedial wall thickness 6 right |

**Table 2.** Two-way analysis of variance of gender and dental condition in examination of orbital floor variable

| Gender * Dental Condition | Number | Mean ± standard Deviation | Dental condition | Gender |
|---|---|---|---|---|
| p-value=0.665 | 19 | 0.0 ± 729.245 | Toothless | man |
| | 12 | 0.0 ± 967.261 | With teeth | |
| | 31 | 0.0 ± 821.247 | Total | |
| | 11 | 0.667 ± 0.220 | Toothless | woman |
| | 28 | 0.859 ± 0.264 | With teeth | |
| | 39 | 0.808 ± 0.263 | Total | |
| | 30 | 0.810 ± 0.234 | Toothless | Total |
| | 40 | 0.892 ± 0.265 | With teeth | |
| | 70 | 0.814 ± 0.266 | Total | |
| | | | p-value= 0.002 | p-value= 0.223 |

**Table 3.** Two-way analysis of variance and dental status in the evaluation of cephalocaudal dimension

| Gender * Dental Condition | Number | Mean ± standard Deviation | Dental condition | Gender |
|---|---|---|---|---|
| p-value=0.477 | 19 | 34.4 ± 65.78 | Toothless | man |
| | 12 | 37.7 ± 99.7 | With teeth | |
| | 31 | 35.6 ± 94.18 | Total | |
| | 11 | 32.065 ± 0.32 | Toothless | woman |
| | 28 | 32.265 ± 0.79 | With teeth | |
| | 39 | 32.925 ± 0.62 | Total | |
| | 30 | 32.705 ± 0.06 | Toothless | Total |
| | 40 | 32.686 ± 0.32 | With teeth | |
| | 70 | 32.626 ± 0.02 | Total | |
| | | | p-value=0.135 | p-value=0.017 |

the left and right orbital floor, right and left cephalocaudal dimension, right and left mediolateral dimension, the thickness of right and left anterior wall, the thickness of right and left soft tissue, the thickness of right and left anteromedial 6, and maxillary sinus volume) was examined using the Kolmogorov-Smirnov test, in which the significance level obtained for all variables was

**Table 4.** The gender and dental status in evaluation of mediolateral dimension

| Gender * Dental Condition | Number | Mean ± standard Deviation | Dental condition | Gender |
|---|---|---|---|---|
| p-value=0.923 | 19 | 21.3 ± 12.83 | Toothless | man |
| | 12 | 24.5 ± 79.06 | With teeth | |
| | 31 | 22.4 ± 54.64 | Total | |
| | 11 | 18.76 ± 3.92 | Toothless | woman |
| | 28 | 22.21 ± 4.85 | With teeth | |
| | 39 | 21.24 ± 4.82 | Total | |
| | 30 | 20.26 ± 3.97 | Toothless | Total |
| | 40 | 22.985 ± 0.00 | With teeth | |
| | 70 | 21.81 ± 4.75 | Total | |
| | | | p-value=0.003 | p-value=0.036 |

greater than 0.05 except for the thickness of the anteromedial 6 (right and left p=0.004).

**Table 1** shows the mean indices measured.

**Table 2** shows the gender and dental status in examination of the orbital floor based on the two-way analysis of variance. Based on this table, the gender and dentate status had no significant effect on the thickness of the orbital floor bone (P>0.05). The mean sizes of orbital floor thickness had no significant difference in different age categories (p-value = 135.0).

**Table 3** shows the gender and dental status in the evaluation of the cephalocaudal dimension variable. According to this table, the mean cephalocaudal dimension in edentulous men is higher than that of dentate women. However, the dental status (edentulous or dentate) had no significant effect on cephalocaudal dimension (p-value = 135.0). Also, the mean cephalocaudal dimension had no signifcant difference in different age categories (p = 0.687).

According to **Table 4**, the mean mediolateral dimension in edentulous men was higher than edentulous women, in dentate men was higher than dentate women, in dentate men was higher than edentulous men, and in dentate women was higher than edentulous women. In addition, the mean sizes of mediolateral dimension had no significant difference in different age categories (p = 0.047).

**Table 5** compares the gender and dental status with anteroposterior dimension of maxillary sinus. The multivariate analysis of variance showed that gender had no significant effect on the size of anteroposterior dimension of the maxillary sinus (right and left) (p-value = 0.11; p-value = 118). In other words, the mean anteroposterior dimension of the maxillary sinus is the same in men and women. Also, the dental status (dentate or edentulous) had no significant effect on the anteroposterior dimension of the maxillary sinus (p-value = 108). The mean sizes of anteroposterior dimension of the maxillary sinus had no significant difference in different age categories (left side, p = 0.654 and right side, p = 0.261).

**Table 5.** Multivariable analysis of variance of gender and dental status in the anteroposterior dimension of the maxillary sinus

| Gender * Dental Condition | Number | Mean ± standard deviation related to the right | Mean ± standard deviation related to the left | Dental condition | Gender |
|---|---|---|---|---|---|
| Left side p-value=0.685 | 19 | 33.4 ± 20.83 | 32.6 ± 11.67 | Toothless | man |
| | 12 | 36.8 ± 6.84 | 35.6 ± 41.46 | With teeth | |
| | 31 | 34.6 ± 31.5 | 33.6 ± 39.68 | Total | |
| | 11 | 30.61 ± 3.97 | 30.5 ± 15.30 | Toothless | woman |
| | 28 | 33.94 ± 5.64 | 32.6 ± 13.39 | With teeth | |
| | 39 | 33.5 ± 0.39 | 31.6 ± 57.10 | Total | |
| Right side p-value= 0.876 | 30 | 32.25 ± 4.63 | 31.3 ± 39.83 | Toothless | Total |
| | 40 | 34.6 ± 57.57 | 33.6 ± 12.5 | With teeth | |
| | 70 | 33.58 ± 5.90 | 32.6 ± 38.38 | Total | |
| | | | | p-value = 0.108 | Left side p-value =0.111 |
| | | | | p-value = 0.042 | Right side p-value =0.118 |

**Table 6.** Two-way analysis of variance showed that gender had no significant effect on the anterior wall thickness

| Gender * Dental Condition | Number | Mean ± standard Deviation | Dental condition | Gender |
|---|---|---|---|---|
| p-value=0.182 | 19 | 0.0 ± 79.27 | Toothless | man |
| | 12 | 0.0 ± 73.14 | With teeth | |
| | 31 | 0.0 ± 77.22 | Total | |
| | 11 | 0.70 ± 0.10 | Toothless | woman |
| | 28 | 0.78 ± 0.17 | With teeth | |
| | 39 | 0.76 ± 0.16 | Total | |
| | 30 | 0.75 ± 0.22 | Toothless | Total |
| | 40 | 0.76 ± 0.16 | With teeth | |
| | 70 | 0.76 ± 0.19 | Total | |
| | | | p-value = 0.801 | p-value = 0.682 |

**Table 7.** Two-way analysis of variance of gender and dental status with soft tissue thickness

| Gender * Dental Condition | Number | Mean ± standard Deviation | Dental condition | Gender |
|---|---|---|---|---|
| p-value=0.043 | 19 | 15.2 ± 68.91 | Toothless | man |
| | 12 | 12.2 ± 59.33 | With teeth | |
| | 31 | 14.3 ± 49.7 | Total | |
| | 11 | 14.3 ± 44.97 | Toothless | woman |
| | 28 | 14.43 ± 2.65 | With teeth | |
| | 39 | 14.433 ± 0.2 | Total | |
| | 30 | 15.232 ± 3.33 | Toothless | Total |
| | 40 | 13.882 ± 2.67 | With teeth | |
| | 70 | 14.463 ± 0.2 | Total | |
| | | | p-value=0.042 | p-value=0.69 |

**Table 6** compares the gender and dental status with the anterior wall thickness. Two-way analysis of variance showed that gender had no significant effect on the anterior wall thickness (p-value = 682). Also, dental status (dentate or edentulous) had no significant effect on the anterior wall thickness (p-value = 0.801). The mean sizes of anterior wall thickness had no significant difference in different age categories (p = 0.363).

In the evaluation of gender and dental status with soft tissue thickness, shown in **Table 7**, it was determined

**Table 8.** Kruskal-Wallis test on the thickness of anteromedial wall of the maxillary sinus in dental region 6

| Number | Mean ± standard Deviation | Dental condition | Gender |
|---|---|---|---|
| 19 | 1.0 ± 22.69 | Toothless | man |
| 12 | 1.0 ± 42.58 | With teeth | |
| 31 | 1.0 ± 29.65 | Total | |
| 11 | 1.0 ± 53.91 | Toothless | woman |
| 28 | 1.43 ± 0.83 | With teeth | |
| 39 | 1.46 ± 0.84 | Total | |
| 30 | 1.33 ± 0.78 | Toothless | Total |
| 40 | 1.0 ± 43.57 | With teeth | |
| 70 | 1.39 ± 0.76 | Total | |
| | | p-value=0.156 | p-value=0.226 |

**Table 9.** Two-way analysis of variance of gender and dental status in the evaluation of volume variable

| Gender * Dental Condition | Number | Mean ± standard Deviation | Dental condition | Gender |
|---|---|---|---|---|
| p-value=0.853 | 19 | 120.418 ± 33.88 | Toothless | man |
| | 12 | 1814.946 ± 88.57 | With teeth | |
| | 31 | 950.41350 ± 0.31 | Toothless | woman |
| | 11 | 1302.15602 ± 0.97 | With teeth | |
| | | | p-value=0.020 | p-value=0.021 |

that the mean soft tissue thickness in edentulous men was higher than edentulous women, and in dentate men is lower than dentate women. Also, the mean sizes of soft tissue thickness had no significant difference in different age categories (p = 0.317).

According to **Table 8**, the mean thickness of the anteromedial wall of maxillary sinus in dental region 6 in edentulous men is lower than edentulous women, and in dentate men is lower than dentate women.

The mean thickness of the anteromedial wall of the maxillary sinus in dental region 6 had no significant difference in both genders and in two groups of dentate and edentulous. This index had also no significant difference in different age groups (p = 0.861).

The mean volume of maxillary sinus in women was 1202.562 ± 95.44 (2484.87-255.55) and in men was 1450.48 ± 721.26 (3438.18 – 475.92), which had no statistically significant difference (P=0.111). In the analysis of gender and dental status in the evaluation of variable of volume according to **Table 9**, it was determined that gender had a significant effect on the volume of maxillary sinus (p-value = 0.021). The dental status (dentate and edentulous) had a significant effect on the volume of maxillary sinus (p-value = 0.02). However, the mean size of maxillary sinus volume had no significant difference in different age categories (p=0.110).

## DISCUSSION AND CONCLUSION

This study is conducted with the aim of anthropometric analysis of maxillary sinus in both sides in subjects with complete edentulism for identification of

sexual identity using the CBCT images. This study followed a different secondary objective, which is the association between the mean volume of sinus in people with complete dental system and complete edentulism by considering gender.

In the field of anthropometric study of maxillary sinus, no study was found except for a study by Parnilla (Suresh et al. 2014, Asif 2020, John and Oluwafemi 2019). However, this study has been conducted on the investigation of dimension and thickness of maxillary and frontal sinus walls. In this study, we also decided to use these for the purpose we pursued in our research.

In this study, gender had a significant effect on the size of the cephalocaudal dimension of sinus. In other words, the mean cephalocaudal dimension in edentulous men was higher than edentulous women, and in dentate men was higher than dentate women. However, dental status (dentate and edentulous) had no significant effect on the cephalocaudal dimension of sinus.

In other words, the mean cephalocaudal dimension of sinus in dentate and edentulous

individuals is the same, which challenges the idea that with loss of teeth, the sinus floor is pneumatized to the alveolar region. Also, according to Sam, the expansion of the maxillary sinus floor is basically related to teeth eruption (Peter et al. 2011). Therefore, in an edentulous individual, this is the process of alveolar erosion which reduces the sinus floor distance from the ridge crests surface, rather than lowering sinus.

In our study, the mean mediolateral dimension of sinus in edentulous men is higher than edentulous women, and in dentate men is higher than dentate women, therefore, the gender superiority in edentulous groups is also in male gender, which is generally due to greater facial dimensions in men, which means that gender has a significant effect on the size of the mediolateral dimension of sinus. This result is consistent with the results of studies by Jasem (Jasim and Al-Taei 2013) and Soroush (Pernilla et al. 2011). The mean mediolateral dimension of sinus in dentate subjects is higher than edentulous individuals, which indicates the effect of mastication function on the transverse dimensions of maxillary sinus. On the other hand, the mean anteroposterior dimension of maxillary sinus in men and women is the same. However, the mean anteroposterior dimension of maxillary sinus was higher in dentate subjects, which is probably due to reduced bone density in completely edentulous subjects in old ages, and the difference that generally exist in the left and right sinuses in each person and in this dimension is due to the lack complete symmetry on both sides of the face and masseter function in the side where the person predominantly uses for chewing. In a study by Dr. Tambawala (Tambawala et al. 2015, Podymova et al. 2019) on comparison of the maxillary sinus dimension in both groups of men and women, all of the above dimensions in women were significantly lower than men, however, in a similar study by Sasuki (Ekizoglu et al.), no difference was observed in sinus dimensions between men and women.

The results of the present study showed that gender had a significant effect on the maxillary sinus volume, in other words, the mean volume of maxillary sinus is different in me and women, which is consistent with the results of the studies by Mu Hendrich (Suresh et al. 2014), Akizaglo (Ekizoglu et al.), Vidya (Vidya et al. 2013), Jasim (Jasim and Al-Taei 2013), and Soroush (Pernilla et al. 2011). The dental status (dentate and edentulous) had also a significant effect on the volume of maxillary sinus. In other words, the mean volume of maxillary sinus in dentate subjects is higher than edentulous subjects, which according to the results obtained from the previous section, the mediolateral and anteroposterior dimensions of sinus in individuals with complete dental system is larger than individuals with complete edentulism, and, consequently, the difference is more in the volume.

## REFERENCES

Asif M (2020) Natural Anti-Quorum Sensing agents againstPseudomonas aeruginosa. Journal of Chemical Reviews 2(1): 57-69.

Banumathi A, Vijayakumari B, Geetha A, Shanmugavadivu N, Raju S (2007) Performance analysis of various techniques applied in human identification using dental X-rays. J Med Syst 31(3): 210-8.

Caniglia R, Fabbri E, Mastrogiuseppe L, Randi E (2013) Who is who? Identification of livestock predators using forensic genetic approaches. Forensic Sci Int Genet 7(3): 397-404.

Ciaffi R, Gibelli D,Cattaneo C (2011) Forensic radiology and personal identification of unidentified bodies: a review Radiol Med 116(6): 960-8.

da Silva RF, Prado FB, Caputo IG, Devito KL, Botelho Tde L, Daruge Júnior E (2009) The forensic importance of frontal sinus radiographs. JForensic Leg Med 16(1):18-23.

Ekizoglu O, Inci E, Hocaoglu E, Sayin I, Kayhan FT, Can IO The use of maxillary sinus dimensions in gender determination: a thin-slice multidetector

Eshak GA, Zaher JF, Hasan EI, El-Azeem Ewis AA (2013) Sex identification from fingertip features in Egyptian population. J Forensic Leg Med 20(1): 46-50.

Harris AM, Wood RE, Nortjé CJ, Thomas CJ (1987) The frontal sinus: forensic fingerprint? A pilot study.The Journal of forensic odonto-stomatology 07/ 5(1): 9-15.

Huang Y, Xu Z, Zhang JB, Zhang HX, Deng ZH (2010) Morphological classification of frontal sinuses on digital X-ray films and its forensic identification indexes. Fa Yi Xue Za Zhi 26(3): 173-6,180.

Jasim HH, Al-Taei JA (2013) Computed tomographic measurement of maxillary sinus volume and dimension in correlation to the age and gender (comparative study among individuals with dentate and edentulous maxilla). Journal of Baghdad College of Dentistry 25(1): 87-93.

John A, Oluwafemi RA (2019) Hematology and Serum Biochemical Indices of Growing Rabbits Fed Diet Supplemented with Different Level of Indigofera Zollingeriana Leaf Meal. Progress in Chemical and Biochemical Research: 170-177.

Kirk NJ, Wood RE, Goldstein M (2002) Skeletal identification using the frontal sinus region: a retrospective study of 39 cases. Forensic Sci 47(2): 318-23.

Kullman L, Eklund B, Grundin R (1990) Value of the frontal sinus in identification of unknown persons J Forensic Odontostomatol 8(1): 3-10.

Liu NG, Zou DH, Xu JR, Zhao HL, Zheng J, Chen YJ (2009) Comparison between application of imaging techniques and autopsy in the identification of injury manner. Fa Yi Xue Za Zhi 25(4): 254-9.

Möhlhenrich SC, Heussen N, Peters F, Steiner T, Hölzle F, Modabber A (2015) Is the Maxillary Sinus Really Suitable in Sex Determination? A Three-Dimensional Analysis of Maxillary Sinus Volume and Surface Depending on Sex and Dentition. Journal of Craniofacial Surgery 26(8): 723-6.

Parker LS, London AJ, Aronson JD (2013) Incidental findings in the use of DNA to identify human remains: an ethical assessment. Forensic Sci Int Genet 7(2): 221-9.

Patil N, Karjodkar FR, Sontakke S, Sansare K, Salvi R (2012) Uniqueness of radiographic patterns of the frontal sinus for personal identification. Imaging Sci Dent 42(4): 213-7.

Pernilla SJ, Magnus J, Anita S, Kasim AK (2011) Computed tomographic measurement of different dimensions of maxillary and frontal sinuses. Journal of BMC Medical Imaging 11: 8.

Peter M, Hugh S,Curtin D (2011) Head and Neck Imaging. Elsevier 2011, 978-0-323-05355-60.

Podymova LS, Gots EV, Rozhnov AA, Kovaleva NV, Podymov NA, Novitskaya LY, ... Ovchinnikov AA (2019) Reflection, Self-Actualization and Creativity Peculiarities of Socio and Psychologically Maladjusted Students. Journal of Environmental Treatment Techniques 7(4): 548-554.

Quatrehomme G, Fronty P, Sapanet M, Grévin G, Bailet P, Ollier A (1996) Identification by frontal sinus pattern in forensic anthropology. Forensic Sci Int 83(2): 147-53.

Ribeiro Fde A (2000) Standardized measurements of radiographic films of the frontal sinuses: an aid to identifying unknown persons. Ear Nose Throat J 79(1): 26-8, 30, 32-3.

Suresh KS, Massarat J, Anil K (2014) Measurements of maxillary sinus volume and dimensions by computed tomography scan for gender determination. Journal of the Anatomical Society of India 36:442.

Suresh KS, Massarat J, Anil K (2014) Measurements of maxillary sinus volume and dimensions by computed tomography scan for gender determination. Journal of the Anatomical Society of India 36:442.

Tambawala SS, Karjodkar FR, Sansare K, Prakash N (2015) Sexual dimorphism of maxillary sinus using cone beam computed tomography.Egypt J Forensic Sci 6(2): 20-25.

Uthman AT,Al-Rawi NH, Al-Naaimi AS, Tawfeeq AS, Suhail EH (2010) Evaluation of frontal sinus and skull measurements using spiral CT scanning: an aid in unknown person identification. Forensic Sci Int 197(1-3): 124.e 1-7.

Vidya C, Shamasundar N, Manjunatha B, Raichurkar K (2013) Evaluation of size and volume of maxillary sinus to determine gender by 3D computerized tomography scan method using dry skulls of South Indian origin. International Journal of Current Research and Review 5(3): 97

Yoshino M, Miyasaka S, Sato H, Seta S (1987) Classification system of frontal sinus patterns by radiography. Its application to identification of unknown skeletal remains. Forensic Sci Int 34(4): 289-99.

Zheng J, Liu NG, Chen YJ (2009) The application of computed tomography (CT) in postmortem examination. Fa Yi Xue Za Zhi 25(4): 286-9.