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## Sexual Dimorphism by Analysis of Maxillary Sinus Dimensions in a Sample of Egyptian Population Using Cone Beam Computed Tomography

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### ABSTRACT

**Purpose:** To assess maxillary sinuses dimensions and the volume using Cone Beam Computed Tomography .Explore whether these parameters can be used to gender determination. **Material and methods:** Left and Right maxillary sinus images were obtained for one hundred Egyptian patients divided into three age groups and different parameters (length, width, height, perimeter, Area, and volume) were measured and calculated. Mean value and standard deviation of left and right sides of maxillary sinuses measurements were evaluated and compared. The data was directed to statistical analysis using independent t and (ANOVA) test. **Results:** Comparison maxillary sinus (MS) dimensions ( length, width, Height, Perimeter, Area and Volume) between male and female with in same age groups. Showed higher mean values in males. However, this difference showed a statistical significance in height only in all three age groups. **Conclusion:** Maxillary sinus height can be used as a support in forensic medicine for sex identification.

### INTRODUCTION

Skeleton has always helped in genomic, anthropological, odontological and forensic research of living and non- living individual<sup>(1)</sup>.As sex identification from bones is essential in forensic studies for establishing identity in cases of disfigured bodies, various morpho-metric principles have been laid down for several bones for sex identification in earlier studies<sup>(2)</sup>.Skull bones and pelvis have been widely used in

### KEYWORDS

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forensic determination. The first step of forensic is to estimate the difference in morpho-metric features to identify an individual, and a lot of studies report that there exist differences in the skull and other bones of male and female, in addition to different age groups<sup>(1)</sup>. Therefore, sex identification are not easily achievable tasks. So became important to use denser bone e.g. the maxillary sinus<sup>(3)</sup>.

The maxillary sinus is the greatest of paranasal sinuses. The sinus starts to grow at 10 weeks of embryonic life and has an opening in the middle nasal meatus of the nasal cavity<sup>(4)</sup>. At birth it begins as a pea size and continues to grow after eruption of deciduous teeth and grows again with eruption permanent teeth and with the third molars complete eruption, the sinus pneumatization ends<sup>(4)</sup>.

Numerous shapes of maxillary sinus (MS) are triangular, leaf, scapular, and kidney shaped. It has been revealed that triangular sinuses are the most shared shape in females and males. It differs widely in size, shape, and site not only between different individuals but also between both sides of the same individuals<sup>(4)</sup>.

It has been revealed that Maxillary sinuses continue undamaged despite the skull and other bones getting badly damaged in victims who are burned. Hence, maxillary sinuses can be used for gender identification<sup>(5)</sup>.

Sinus radiography has been used for determination of unknown and identification of sex. It has been reported that Cone beam computed tomography are brilliant imaging modality in the determination of unknown victims as they provide a precise evaluation of the paranasal sinuses and maxillofacial bones. Maxillary sinuses dimensions and volume can be measured by using CBCT and it may be valuable for supporting sex identification in forensic science<sup>(4)</sup>.

Cone Beam Computed Tomography can visualize and provide accurate details about structures of

complex anatomy and teeth, since it is categorized by fast volumetric image achievement with low level radiation dose and high resolution. These benefits of Cone Beam Computed Tomography make it a dependable tool for gender identification<sup>(6)</sup>.

## MATERIAL AND METHODS

This study was a retrospective study. It encompassed of CBCT images of one hundred Egyptian patients who were referred to Radiology center. Their ages went between 20 to 50 years.

They were divided into 3 groups.

**Group 1:** Included CBCT of patients between 20-30 years old(16 male -16 female).

**Group 2:** Included CBCT of patients between 31-40 years old(17male-17 female).

**Group 3:** Included CBCT of patients between 41-50 years old(17male -17female).

### Exclusion criteria

CBCT images that were not covering the full extent of the sinus were not included.

CBCT images with destructive maxillary sinus from trauma, cleft or congenital craniofacial abnormalities or any previous surgery were excluded.

### Inclusion criteria

Only high quality reconstructed CBCT images of bilateral maxillary sinuses were selected.

CBCT images with inflamed lining of the sinus were involved in this study.

CBCT images were made using a planmecamapromax 3D mid machine (Asentajankatu 6 FIN-00880 Helsinki, Finland). The Digital Image Communication in Medicine (DICOM) Romexis viewer (4.5.0.R) software was used to analyze the reconstructed image sections.

The maxillary sinus were measured in Three-dimensions way:

- 1- The length dimension were estimated as the longest distance antero-posteriorly from the greatest anterior point to the greatest posterior point on axial section.
- 2- The width were estimated as the longest distance from the medial wall of the sinus to the utmost point of the lateral wall of the maxillary sinus on axial section.
- 3- The height were measured on the coronal view as the longest distance from the deepest point of the sinus floor to the highest point of the sinus roof. .

Also the following were calculated

$$\text{Volume mm}^3 = (\text{height} \times \text{length} \times \text{width} \times 0.5).$$

$$\text{Area mm}^2 = \text{length} \times \text{width}.$$

$$\text{Perimeter mm}^2 = 2 \text{ length} \times 2 \text{ width}.$$

#### Statistical analysis:

Values were subjected as mean  $\pm$  standard deviation. Since data were normally distributed therefore, independent t test was used for comparison between two groups . One method analysis of variance (ANOVA) test was used to compare more than two groups.

P < 0.05 was considered significant. Statistical analysis was made with SPSS 18.0 (Statistical Package for Scientific Studies, SPSS, Inc., Chicago, IL, USA) for Windows.

## RESULTS

**Table (1):** Comparison between human Egyptian males and females regarding mean value of height in both sides of maxillary sinus (independent t test)

	20-30years		31-40 years		41-50 years	
	Males	Females	Males	Females	Males	Females
<b>Mean of right and left</b>	38.26	31.82	38.97	36.00	36.36	32.92
<b>Std. Dev.</b>	2.89	4.55	4.3	3.9	4.36	3.85
<b>Std. error</b>	0.7	1.14	1.04	0.98	1.07	0.96
<b>Mean difference</b>	6.44		2.97		3.44	
<b>C.I. of difference</b>	3.75 to 9.13		0.49 to 5.89		.51 to 6.37	
<b>t</b>	4.55		2.07		2.39	
<b>P</b>	<0.0001*		0.047*		0.022*	

Significance level= P<0.05, \*significant. C.I. of difference= 95% confidence interval of this difference  
t=independent test.

**Table (2):** Comparison between left and right sides of maxillary sinus regarding width (mm) in human Egyptian females and males (independent t test)

	Females						Males					
	20-30years		31-40 years		41-50 years		20-30years		31-40 years		41-50 years	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
<b>Mean</b>	23.36	23.52	24.75	25.34	22.81	23.81	25.96	26.37	25.33	25.66	24.09	24.08
<b>Std.Dev.</b>	3.09	3.01	4.59	2.85	4.87	4.00	3.32	4.00	3.93	4.79	4.54	4.41
<b>Std. error</b>	0.77	0.75	1.15	0.71	1.22	1	0.81	0.97	0.95	1.16	1.1	1.07
<b>Mean difference</b>	0.16		0.59		1		0.41		0.33		0.01	
<b>C.I. of difference</b>	2.36 to 2.04		3.35 to 2.17		-4.22 to 2.22		2.98 to 2.16		3.39 to 2.73		3.12 to 3.14	
<b>t</b>	0.15		0.43		0.63		0.33		0.22		0.007	
<b>P</b>	0.88ns		0.67ns		0.53ns		0.75ns		0.83ns		0.99ns	

Significance level:  $P < 0.05$ , ns= non-significant. C.I. of difference=95% confidence interval of this difference. t=independent test.

**Table (3):** Comparison of perimeter between different human Egyptian age groups (mean of both sides of maxillary sinus), (ANOVA test)

	Males			Females		
	20-30 years	31-40 years	41-50 years	20-30 years	31-40 years	41-50 years
<b>Mean of right&amp; left sides perimeter</b>	131.61	126.23	119.88	117.39	121.58	117.88
<b>Std. Dev.</b>	15.00	15.71	12.62	11.01	14.48	13.68
<b>F</b>	2.78			0.486		
<b>P</b>	0.07ns			0.62ns		

Significance level=  $p < 0.05$ , ns=non-significant. F=ANOVA test

## DISCUSSION

In the present study comparison between human Egyptian males and females within the same age groups of maxillary sinus (MS) dimensions (length, width, Height, Perimeter, Area, Volume) were performed. Higher mean values were recorded in males compared with females. Height was statistically significant in 20 to 30years group ( $p < 0.0001$ ), the in the 31 to 40 years group ( $p = 0.047$ ) and the 41 to 50 years group ( $p = 0.022$ ). Thus height of the MS was the differentiation parameter which could be used to

sex determination with an overall accuracy. The results achieved in this study were in agreement with several pervious studies <sup>(7-9)</sup>.

On the other hand, our results In contrast with another study that concluded The group of female revealed greater values were statistically significant for left MS width where left side MS width can be used to identify sex<sup>(6)</sup>. Also another study stated that The left MS width was the differentiation parameter <sup>(10)</sup>.

In this study Comparison between the right and left side of maxillary sinus dimensions (width, length, Height, Perimeter, Area, Volume) within the same gender and same age group it revealed that it was difference between right and left maxillary sinus (MS) whether (higher mean value was recorded in left side or higher mean value was recorded in right side). The difference was statistically significant only in males In the 20-30 years age group in height where as a higher mean value was recorded in left side with a significant difference ( $p=0.026$ ). Another study Concluded that comparison maxillary sinus volume between left and right sides were not statistically significant<sup>(11)</sup>. In addition to another study reported that The right MS has been reported to be greater than the left MS in both sexes<sup>(4)</sup>.

A Comparison between age groups (mean of both sides) maxillary sinus dimensions (length, width, Height, Perimeter, Area and Volume) in both male and female revealed that there was not statistically significant difference. This might be due to this age groups between (20-50) years old (in middle age population), the pneumatization of the sinus ends with the complete eruption of the third molars at age of twenty<sup>(4)</sup> before age changes factors as bone changes (bone resorption) occur.

Since this agreement with study that evaluated age-correlated changes in bone architecture. Revealed that (over age of 65) bone changes begin to occur as in the cortical bone, there was a little amount of Volkmann's and Haversian channels and nearly all osteoblasts were hollow. In the cancellous bone the trabeculae were thin, allowing ample medullary space, frequently engaged by adipocytes and fat cells<sup>(12)</sup>, also another study confirmed the result of previous study, especially in the explanation of age-correlated changes in the trabecular bone in humans over 50 years<sup>(13)</sup>.

## CONCLUSION

The present study concluded that given a cranium of unknown origin, sex identification can be achieved using maxillary sinus dimensions through CBCT.

The maxillary sinus height is the most dependable differentiate parameter that could be used for the determination of gender identification.

The use of CBCT has the reliability, usability and accuracy for assessing maxillary sinus dimensions in the field of forensic science.

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