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Morphometric evaluation of Maxillary sinus using Computed Tomography

Anuja G Deshmukh[1], Manjiri Joshi[2]

1. Associate Professor, Department of Anatomy,
2 Consultant Radiologist Nanded

Corresponding Author : Anuja G Deshmukh, Associate Professor, Anatomy 1 – A, Shree heights, Borban, Nanded – 431601
E mail: dr.anuja_n@rediffmail.com

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ABSTRACT

Introduction: Maxillary air sinus is the largest paranasal air sinus. It exhibits dimorphic features and remains intact in victims who are incinerated. Therefore it can be used for identification of individual and gender determination. CT is the most reliable method for measurement of maxillary sinus dimensions. This study has been carried out to check the accuracy and reliability of maxillary sinus in gender determination using morphometric parameters.

Materials and method: CT images of 100 healthy adults (54 males and 46 females) were subjected to the measurements of various dimensions. T test was used to find out the significant difference between male and females. P value was calculated. The statistical analysis was performed using word excel sheet windows 2007 and SPSS software version 21.0 was used for statistical analysis.

Result: Parameters were calculated on right and left maxillary sinus. Anteroposterior diameter, height and volumes on both sides were found to be more in males as compared to females and it was statistically significant. Width of the sinuses on both sides was also more in male than in female but was statistically nonsignificant.

Conclusion: The results of the present study and knowledge of anatomy of maxillary sinus as seen in CT scan will help in identification of individual, sex determination and minimizing the risk during surgery.

Keywords: Maxillary sinus, gender determination, morphometry.

Introduction

Paranasal sinuses are complex anatomical structures situated within frontal, maxilla, ethmoid and sphenoid bone and shows a significant inter individual variation. Maxillary air sinus is the largest paranasal sinus [1]. Maxillary sinuses are two spaces which are occupied with air and situated in Maxillary bone. It is a largest and first paranasal air sinus to develop [2]. It serves many functions such as to decrease the weight of skull, increases voice resonance, protect against the blows to face, insulation of eyes and roots of teeth against temperature fluctuations, humidification of inhaled air[3]. They can be in several sizes and shape. When fully developed it has a complex pyramidal shape. The tip is extended into Zygomatic process and occupy Zygomatic bone. Base is formed by alveolar process of first, second, third molars and root of Canine. It drains into middle meatus of nose at the posterior border of hiatus semilunaris. Maxillary sinuses appear at the end of second month of intrauterine life. They originates as invagination of nasal mucosa into maxilla. This unique development describes massive quantity of anatomical variation. Genetic diseases, infection and environmental factors can affect the size of sinus. At 12 to 13 years sinus floor is at the level of nasal floor, at 20 years completion of eruption of third molar pneumatisation of sinus ends and sinus reaches 5 mm inferior to nasal floor. It exhibits dimorphic feature therefore it can be used for identification of individual [4]. It has been reported that maxillary sinuses remain intact although skull and other bones may be disfigured in victims who are incinerated. Hence maxillary sinus can be used for identification [5]. The methods of measuring the dimensions of maxillary sinus have been changed from cadaveric skull measurement to computed tomography. The aim of this study was to estimate different dimensions of maxillary sinuses measured on Computed Tomography images and their relation to sex of individual.

Material and Methods

This study is an observational study in which CT images of 100 individuals of age group 20 to 60 years of either sex (male 54, female 46) who came for paranasal CT scan. The cases were collected from January 2017 to December 2019 who had complaints of headache, sinusitis without pathological findings in maxillary sinus, no history of trauma in whom CT scan as normal as diagnosed by radiologists. Maxillary sinus radiograph with obvious pathology or trauma, facial asymmetry or septal deviation, previously undergone surgical procedure with cleft palate with supernumerary teeth were excluded. All plates were examined on 16 sliced CT scan. All measurements of maxillary air sinus were done directly on DICOM image using electronic caliper inbuilt in DICOM viewer software. Volumes were calculated manually by using formula. The greatest measurement was taken after going through different slices in coronal and sagittal sections. Parameters measured on right and left maxillary sinus were as follows

- The anteroposterior (AP) diameter was measured on sagittal reconstructed image and was defined as longest distance from the most anterior point to the most posterior point.

- The height (Ht)of sinus was measured on coronal reconstructed image and was defined as the longest distance from the lowest point of the sinus floor to the highest point of the sinus roof.
- The transverse diameter or width (W) was measured on coronal reconstructed image and was defined as the largest distance perpendicular from the medial wall of sinus to the outermost point of the lateral wall of the lateral process of the maxillary sinus,
- The volume (V) of maxillary air sinus on each side were calculated by using formula Volume = height X width X AP diameter X 0.52 (proven mathematical formula).

The statistical analysis was performed using word excel sheet windows 2007 and SPSS software version 21.0 was used for statistical analysis. Mean, Standard deviation and t value were calculated for each parameter in males and females. F value were calculated by F test to compare variants. P value was calculated. P value <0.05 was considered to be significant.

OBSERVATIONS AND RESULTS

In present study (Table 1)right AP diameter in males (37.18 ± 4.21) was more than females (35.26 ± 3.08) and it was found to be statistically significant (P < 0.05) while left AP diameter in males (37.35 ± 3.58) was found to be more than females (35.57 ± 3.49) which was statistically significant (P < 0.05).

Height of right maxillary sinus in males (36.15 ± 7.34) was more than females (33.79 ± 5.50) which was statistically significant (P< 0.05) and height of left maxillary sinus was more in males (36.68 ± 5.42) than females (34.52 ± 5.24) which was found to be statistically significant (P < 0.05).

Width of right maxillary sinus in males (24.76 ± 4.21) was more than in females (23.74 ± 3.64) which was found to be statistically nonsignificant (P > 0.05) while width of left maxillary sinus in males (25.21 ± 3.97) was also found to be more than in females (25.02 ± 3.64) which was also statistically nonsignificant (P > 0.05).

Volume of right maxillary sinus in males (12.89 ± 4.34) was more than in females (10.69 ± 3.29) which was found to be statistically significant (P < 0.05) while volume of left maxillary sinus in males (13.61 ± 3.82) was also more than in females (10.12 ± 2.76) which was statistically significant (P < 0.05).

Table no 1. Statistics of right and left side of Maxillary sinus

Parameters	Males (n=54) (Mean ± SD)	Females (n=46) (Mean ± SD)	P - value
Right AP diameter (mm)	37.18 ± 4.21	35.26 ± 3.08	0.008
Left AP diameter (mm)	37.35 ± 3.58	35.57 ± 3.49	0.003
Right Height (mm)	36.15 ± 7.34	33.79 ± 5.50	0.042
Left Height (mm)	36.68 ± 5.42	34.52 ± 5.24	0.045
Right Width (mm)	24.76 ± 4.21	23.74 ± 3.64	0.212
Left Width (mm)	25.21 ± 3.97	25.02 ± 3.64	0.192
Right Volume (cm3)	12.89 ± 4.34	10.69 ± 3.29	0.004
Left Volume (cm3)	13.61 ± 3.82	10.12 ± 2.76	0.001

By discriminant functional analysis it was found that anteroposterior diameter of maxillary sinus was the best discriminant parameter that could be used to study the sexual dimorphism. The accuracy rate of gender identification in male was 64.84 % and 67.85 % in females . Overall 66.34 % maxillary sinuses were sexed correctly. (Table 2)

Table 2. Number and Percentage of gender determination from both Maxillary sinus

Gender of Maxillary sinus	Percentage of maxillary sinus sexed correctly
Male	64.84 %
Female	67.85 %
Overall	66.34 %

Table 3. Comparison of maximum AP diameter of maxillary sinus with previous studies.

Study	Males		Females	
	Right	Left	Right	Left
Sharma S K et al9 (2014)	34.89 ± 3.256	35.03± 3.559	**33.20** ± 2.943	**33.58** ± 2.915
Sauza A D et al10 (2016)	**38.6** ± 4.5	**39.0** ± 3.6	**37.2** ± 2.1	**37.1** ± 3.0
Deepak Bhusal et al 4 (2017)	**37.31** ± 4.62	**37.74** ± 3.59	**36.15** ± 3.92	**35.57** ± 3.50
Present study	**37.18** ± 4.21	**37.35** ± 3.58	**35.26** ± 3.08	**35.57** ± 3.49

Table 4. Comparison of maximum height of maxillary sinus with previous studies.

Study	Males		Females	
	Right	Left	Right	Left
Ahmad A Masri et al (2013)11	**37.4± 4.8**	**38.1** ± 8.7	**33.7**±4.3	**31.8**±9.4
Sharma S K et al9 (2014)	36.07 ± 6.123	**36.72** ± 5.651	**34.51** ± 4.032	**34.63** ± 4.414
Laxmi N kiruba et al(2014)12	**39.95** ± 7.21	**39.68** ± 7.26	**36.82** ± 5.50	**37.12** ± 5.50
Present study	**36.15** ± 7.34	**36.68** ± 5.42	**33.79** ± 5.50	**34.52** ± 5.24

Table 5. Comparison of width of maxillary sinus with previous studies.

Study	Males		Females	
	Right	Left	Right	Left
Ahmad A Masri et al (2013)11	31.7± 3.6	**30.9± 6.2**	**28.7± 5**	**27.6± 3.9**
Laxmi N kiruba et al(2014)12	**27.85± 4.04**	**28.21± 3.95**	**26.69± 3.53**	**26.78± 3.68**
Sharma S K et al9 (2014)	24.33± 4.26	**24.93 ±4.84**	**23.39± 3.80**	**23.88±3.89**
Present study	**24.76± 4.21**	**25.21 ± 3.97**	**23.74 ±3.64**	**25.02 ± 3.64**

Table 6. Comparison of volume of maxillary sinus with previous studies.

Study	Males		Females	
	Right	Left	Right	Left
Ahmad A Masri et al (2013)11	20.3 ± 5.85	19.2± 8.7	14.9± 6.28	14.1± 5.5

Sharma S K et al9 (2014)	15.84± 5.85	16.45 ±6.14	13.65± 3.92	14.18 ±4.67
Deepak Bhusal et al 4 (2017)	12.95 ±4.48	13.26 ± 3.94	10.59± 3.37	10.16± 2.92
Present study	12.89± 4.3	13.61± 3.88	10.69± 3.29	10.12± 2.76

Table 7. Comparison of discriminant function analysis of maxillary sinus with previous studies.

Study	Males	Females	overall
Laxmi N kiruba et al(2014)12	69.5%	63%	55.1%
Sharma S K et al9 (2014)	65.16%	68.9%	67.03%
Present study	64.84 %	67.85 %	66.34 %

DISCUSSION

The paranasal sinuses are complex anatomical structures with a significant individual variation. The use of computed tomography instead of plain radiography in the workup of paranasal sinuses pathology was recommended in the beginning of the 1990[6]. Since then CT has become mandatory in the preoperative workup of sinus surgery. In addition CT has become an essential aid in navigation during the functional endoscopic sinus surgery (FESS). Identification on skeletal and decomposing human remains is one of the most difficult skill in forensic medicine. Sex determination is also one of the important problem in identification. When skeleton exists completely the sex can be determined with hundred % accuracy. Sex estimation can be accomplished using either morphological or metric methodology [7]. Maxillary sinus exhibits dimorphic features and hence used for identification of individual [8].

As shown in table no 3, 4, 5, 6, and 7, the findings of present study were compared with previous studies and found to be correlated with their study. These parameters may be used for gender determination in forensic medicine and criminal investigations when other method of sexing are not conclusive. It will also help to the physician for diagnosing diseases of maxillary sinus and surgical interventions.

CONCLUSION

The results of the present study showed that anatomical variation exist between genders.It was found that all the dimensions were higher in males as compared to females and this difference was statistically significant except width of maxillary sinus. By discriminant functional analysisit was found that AP diameter of the maxillary sinus was the best parameter to study the sexual dimorphism with an overall accuracy of 66.34 %.

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