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Computed tomographic measurement of maxillary sinus dimensions and its association with age and gender in Rajshahi City

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Abstract: ***Background:*** A racial variation of paranasal sinus growth is observed with age and sex. ***Methods:*** This cross-sectional type of descriptive study was carried out in the Department of Anatomy, Rajshahi Medical College, Rajshahi over a period of 1 year among the apparently healthy people within the age of 11- 60 years. CT scan machine and Computer were used to gather data from 100 respondents by convenient sampling technique. ***Results:*** The height of the maxillary sinuses (both right and left) was observed to be significantly heterogeneous with maximum height being attained at 3rd decade and minimum at 6th decade of life ($p = 0.045$ and $p = 0.024$, respectively). While width of the left maxillary sinus was significantly greatest at 3rd decade, it is shortest at 2nd decade of life ($p = 0.037$) and depth of the left maxillary sinus was significantly greatest at 5th decade, it is shortest at 2nd decade of life ($p = 0.019$). Except width of the left maxillary sinus, all the dimensions were significantly greater in male than female ($p < 0.05$) and right sided all dimensions in both sexes were found to bear linear relationship with those of their left side. ***Conclusion:*** This study might help us in creating a database of our country people which provide an important role during maxillary sinus surgery.

Keywords: Maxillary Sinus Dimensions and Computed Tomographic Measurement.

Original Research Article

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Article at a glance:

Study Purpose: *The purpose of the study was to measure the normal dimensions (height, width and depth) of maxillary sinus in relation to age and gender by computed tomography in Rajshahi.*

Key findings: *All the dimensions except width of the left maxillary sinus were significantly greater in male than female. All the dimensions of right side in both sexes were found linear relationship with those of their left side.*

Newer findings: *Age demarcation of maximum and minimum height, width and depth of maxillary sinus were known.*

Abbreviations: *CT: Computed tomography Andr: correlation coefficient.*

INTRODUCTION

In our body, the maxillary sinus is the greatest paranasal sinus. It is located in the body of the maxilla and pyramidal in shape. The maximum portion of the lateral wall of the nasal cavity is formed by base of maxillary sinus and situated medially. The floor is formed by the part of the palatine process and alveolar process of the maxilla and lies below the nasal floor.[1] It is related to the first molar and second premolar teeth but may extend anteriorly to encompass the first premolar and sometimes the canine tooth and/or posteriorly to the third molar. Defects in the bone are common, most occurs overlying the roots. A major part of the floor of the orbit forms the roof of the sinus. The apex of the sinus which is laterally truncated and extends into the zygomatic process of the maxilla. It may reach the zygomatic bone where it forms the

zygomatic recess which is looked like a V-shaped shadow over the antrum on the radiography.[2] Facial surface of the maxilla forms the anterior wall and is grooved internally by canaliculus's. The posterior wall is formed by the infratemporal surface of the maxilla and contains alveolar canals.[3] Postero-superiorly at the maxillary hiatus, there is a large opening in the medial wall.

An incomplete septum divides the maxillary sinus. Being thinness of its walls, it is easy to spread thetumours from the maxillary sinus.[4] A tumour may push up the orbital floor, displace the eyeball, project into the nasal cavity, responsible for the nasal obstruction and bleeding.[5] Next to the pelvis, sex can be easily identified from the skull.[6,7] CT scan is an excellent imaging modality for evaluating the sino-nasal cavities as they provide three-dimensional scenario and give an accurate assessment of the paranasal air sinuses. Masri *et al*.[8] conducted a study on malays and found that maxillary sinus depth and height were larger in males than females in 21-30 years age category. Several studies on India and Turkey population found significant difference of the maxillary sinuses in terms of width, height and length between male and female.[6,9,10] So, maxillary sinuses represent a complex anatomical structure with significant inter and intra-individual variation. Thus, this study was done to find out the normal dimensions of maxillary sinus in our population by computed tomography and to see its relationship with age and gender.

METHODS

This was a cross-sectional type of descriptive study at the Department of Anatomy with collaboration of Department of Radiology and Imaging, Rajshahi Medical College Hospital, Rajshahi from January 2018 to December 2018 to measure the normal dimensions of maxillary sinus in relation to age and gender by computed tomography in Rajshahi. The 100 apparently healthy people within the age of 11- 60 years who were residing in Rajshahi included in this study by convenient sampling technique. Prior to the commencement of the study approval was taken from the Ethical Review Committee (ERC) and before taking images, the consent of the subjects was taken and then a proper history taking (name, age, sex, other systemic disease) was performed. After history taking age of the respondents were confirmed by matching with NID card over phone.

All metallic materials were removed from the respondents before entering into CT scan room. The respondents were instructed for no movement and their position was supine without any contrast medium or sedation and head was fixed by head bags. Normal scoring was reported by radiologist in case of all respondents. In this study, CT scan machine was Philips, Ingenuity core 64 slices, Model 2016, 120kV, scanning at 5mm slice thickness that was used in Radiology Department of Rajshahi Medical College and hospital. The different dimensions (height, width and depth) of maxillary sinus were taken after going through different slices in axial and coronal sections. These measurements were directly taken from computer provided with electronic caliper and recorded in the data sheet. All statistical analysis was done by SPSS software, version 24. ANOVA test was used to compare right and left maxillary sinus height, width and depth with age and sex. Pearson's correlation was used to assess maxillary sinus height, width and depth between the right and left side. A p-value < 0.05 was considered statistically significant for all tests.

RESULTS

The height of both right and left maxillary sinuses was observed to be significantly heterogeneous with maximum height being observed at 3rddecade and minimum at 6thdecade of life ($p = 0.045$ and $p = 0.024$, respectively). While width of the left maxillary sinus was significantly greatest at 3rd decade, it is shortest at 2nd decade of life ($p = 0.037$) and depth of the left maxillary sinus was significantly greatest at 5th decade, it is shortest at 2nd decade of life ($p = 0.019$) (Table-01).

Table 1: Dimensions of maxillary sinuses among different age groups (n=100)

Dimensions of maxillary sinuses in mm	Age group (years)					p-value
	11 – 20	21 – 30	31 – 40	41 – 50	51 – 60	
Right maxillary sinuses						
Height	33.0±4.9	36.3±5.5	35.3±4.1	33.9±3.7	32.7±2.8	0.045
Width	22.9±3.6	25.3±3.4	25.7±3.9	24.4±2.4	24.4±3.5	0.107
Depth	35.8±2.8	37.5±2.9	37.3±2.5	37.6±1.8	37.3±2.1	0.141
Left maxillary sinuses						
Height	34.9±4.9	37.4±5.1	34.5±4.2	34.3±3.3	32.9±3.5	0.024
Width	23.4±3.2	26.4±3.2	25.3±3.5	24.2±2.7	24.3±3.1	0.037
Depth	35.7±3.2	37.9±2.5	37.2±2.4	38.3±1.9	37.2±2.5	0.019

Data were analyzed using **ANOVA statistics** and were presented as **mean ± SD**

Height of the right maxillary sinus was influenced by age ($p < 0.05$) whereas width and depth in the same side was not influenced by age ($p = 0.107$ and $p = 0.141$, respectively) (Table-02).

Table 2: Comparison of dimensions of maxillary sinuses among different age groups in right maxillary sinus (n=100)

Dimensions of maxillary sinuses in mm	Age group (years)	Frequency	Mean±SD	Minimum	Maximum	p-value
Right Maxillary sinus height in mm	11-20	20	33.03±4.98	26.20	43.60	0.045
	21-30	20	36.37±5.50	24.00	45.50	
	31-40	20	35.30±4.18	29.00	43.10	
	41-50	20	33.89±3.75	25.10	39.30	
	51-60	20	32.71±2.80	29.00	39.60	
	Total	100	34.26±4.48	24.00	45.50	
Right maxillary sinus width in mm	11-20	20	22.98±3.59	15.00	30.40	0.107
	21-30	20	25.32±3.40	18.80	30.80	
	31-40	20	25.78±3.91	19.20	31.30	
	41-50	20	24.41±2.46	20.80	29.60	
	51-60	20	24.45±3.58	19.10	30.00	
	Total	100	24.59±3.49	15.00	31.30	
Right maxillary sinus depth in mm	11-20	20	35.83±2.88	28.40	40.60	0.141
	21-30	20	37.53±2.97	33.20	41.90	
	31-40	20	37.31±2.57	33.80	42.80	
	41-50	20	37.69±1.81	33.50	40.40	
	51-60	20	37.30±2.11	33.40	40.50	
	Total	100	37.13±2.55	28.40	42.80	

Data were analyzed using **ANOVA statistics** and were presented as **mean ± SD**

All the dimensions of the left maxillary sinus such as height, width and depth were influenced by age ($p = 0.024$, $p = 0.037$ and $p = 0.019$, respectively) (Table-03).

Table 3: Comparison of dimensions of maxillary sinuses among different age groups in left maxillary sinus (n=100)

Dimensions of maxillary sinuses in mm	Age Group (Years)	Frequency	Mean±SD	Minimum	Maximum	p-value
Left maxillary sinus height in mm	11-20	20	34.93±4.90	27.20	45.10	0.024
	21-30	20	37.46±5.17	26.40	46.90	
	31-40	20	34.48±4.26	29.00	43.70	
	41-50	20	34.28±3.33	26.90	40.00	

	51-60	20	32.94±3.48	27.30	41.50	
	Total	100	34.82±4.46	26.40	46.90	
Left maxillary sinus width in mm	11-20	20	23.42±3.27	17.10	28.40	0.037
	21-30	20	26.43±3.27	20.70	32.20	
	31-40	20	25.32±3.54	19.10	30.00	
	41-50	20	24.18±2.75	21.40	30.30	
	51-60	20	24.32±3.07	19.50	30.30	
	Total	100	24.73±3.29	17.10	32.20	
Left maxillary sinus Depth in mm	11-20	20	35.70±3.23	29.70	40.40	0.019
	21-30	20	37.97±2.53	32.90	41.80	
	31-40	20	37.18±2.41	31.30	41.20	
	41-50	20	38.33±1.97	34.20	43.70	
	51-60	20	37.20±2.51	33.30	41.50	
	Total	100	37.28±2.67	29.70	43.70	

Data were analyzed using **ANOVA statistics** and were presented as **mean ± SD**

The means of different dimensions of maxillary sinuses were different in male and female and the result was statistically significant ($p<0.05$) except the width of left maxillary sinus (Table-04).

Table 4: Comparison of different dimensions of maxillary sinuses between sexes (Male=50, Female=50)

Dimensions of maxillary sinuses in mm	Sex	Mean ± SD	t-value	df	p-value
Right Maxillary Sinus Height in mm	Male	35.2± 4.7	2.14	98	0.035
	Female	33.3± 4.0	2.14	95.19	
Left Maxillary Sinus Height in mm	Male	35.9 ±4.8	2.53	98	0.013
	Female	33.7± 3.7	2.53	92.30	
Right Maxillary Sinus Width in mm	Male	25.2± 3.5	1.98	98	0.050
	Female	23.9 ±3.4	1.98	97.94	
Left Maxillary Sinus Width in mm	Male	25.2± 3.2	1.58	98	0.117
	Female	24.2± 3.3	1.58	97.74	
Right Maxillary Sinus Depth in mm	Male	37.7± 2.5	2.43	98	0.017
	Female	36.5± 2.4	2.43	97.97	
Left Maxillary Sinus Depth in mm	Male	37.9 ±2.4	2.41	98	0.018
	Female	36.6 ±2.8	2.41	95.35	

Data were analyzed using **ANOVA statistics** and were presented as **mean ± SD**

The parameters of maxillary sinus dimension of right side of male were found to bear linear relationship with those of their left side as indicated by p-value < 0.05 for each correlation (Table-05).

Table 5: Correlation of maxillary sinus parameters in male for both side (n=50)

Maxillary sinus	Correlation coefficient (r)	p-value
Height right and left	0.763	< 0.001***
Width right and left	0.777	< 0.001***
Depth right and left	0.677	< 0.001***

* Significant at 0.05 level; **Significant at 0.01 level; ***Significant at 0.001

All the parameters of maxillary sinus dimension of right side of female were observed to bear linear relationship with those of their left side as evidenced by p-value< 0.05 for each correlation (Table-06).

Table 6: Correlation of maxillary sinus parameters in female for both side (n=50)

Maxillary sinus	Correlation coefficient (r)	p-value
Height right and left	0.796	< 0.001***
Width right and left	0.684	< 0.001***
Depth right and left	0.646	< 0.001***

* Significant at 0.05 level; **Significant at 0.01 level; ***Significant at 0.001

DISCUSSION AND CONCLUSIONS

The results of this study were statistically analyzed and compared between sexes and among different age groups. Comparative discussion of results was given with previous researchers as mentioned below. In the present study, significant differences were found in most maxillary sinus measurements between males and females. For these two explanations can be offered. First, according to Enlow[11] males need to have correspondingly bigger lungs to support their relatively more massive muscles and body organs. Second, the males need a larger airway which begins with the nose and nasopharynx. In other words, physiological changes in nasal cavity size and shape occur as a direct result of respiration-related needs such as warming and humidifying inhaled air. Maxillary sinus increases in size as it occupies the remaining space within the nasomaxillary complex.[8]

Dimensions of maxillary sinuses in males and females by height, width and depth of right and left side revealed that the mean height of maxillary sinus of Rajshahi people was in consistent with Muthukumaravel and Manjunath [12] for female group and Jehan *et al.*[9] for male group. These result was smaller than Uthman *et al.*[13], Attia *et al.*[14] and Teke *et al.*[6]. But larger than Ahmed *et al.*[15] and Hameed *et al.*[16]. It was found that sinus width of Rajshahi people in consistent with Attia *et al.*[14], Muthukumaravel and Manjunath[12], Jehan *et al.*[9] for female group and Sahlstrand *et al.*[17]. It was smaller than Teke *et al.*[6] and Kiruba *et al.*[10].

Kiruba *et al.*[10] and Uthman *et al.*[13] had found greater depth in case of male, in female their values had similarities with the present study. Teke *et al.*[6] had found greater depth in both male and female than the measured values of present study. The present study was found greater values for depth in male and female than Muthukumaravel and Manjunath[12] and Jehan *et al.*[9]. According to result achieved in current study, the overall mean dimension for each parameter was statistically greater for males compared with females which was consistent with Jehan *et al.*[9], Kiruba *et al.*[10], Teke *et al.*[6], Attia *et al.*[14] and Uthman *et al.*[13]. The greater mean dimensions in males might be explained due to sex specific differences in energy intake, nutrition, body composition and genetics as also stated by previous researcher.[6]

All the parameters of both maxillary sinuses (Height, Width and Depth) of right side were in a linear relationship with those of their left side in both male and female ($p < 0.001$). Ahmed *et al.*[15] had found significant differences in correlation in width and depth parameters between the right and left side in females only.[9,17] From the result of the present study, it could be concluded that all the dimensions of maxillary sinus except width of left sinus were significantly greater in male than those of female. There were some limitations of the study. The study was conducted only in a center with small sample size. So, the study result might not reflect the exact scenarios of the whole country. The estimated measurement was based on the mean dimension of different age groups for only one time rather than on the measurement of an individual for the different period of age.

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Authors contributions

SA, ZF, RM, ABMR: Concept and design, data acquisition, interpretation, drafting and final approval. DHMFR and MAHP: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

Declarations

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Conflict of interest: Authors declared no conflict of interest.

Ethical approval: Ethical approval of the study was obtained from the Ethical Review Committee, Rajshahi Medical College, Rajshahi. Informed consent was taken from all participants. All the study methodology was carried out following the relevant ethical guidelines and regulations.

Consent for publication: Taken.

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