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Original Research Article

MORPHOMETRIC STUDY OF MAXILLARY SINUSES IN NORMAL SUBJECTS BY USING COMPUTED TOMOGRAPHIC IMAGES

A.P. Mishra [1], Kuldeep Kumar *[2], C. S. Ramesh Babu [3].

[1] Professor and Head, Department of Radiology, Rama Medical University, Mandhana, Kanpur (U.P.), India.

*[2] Assistant Professor, Department of Anatomy, Govt.Medical College Kannauj(U.P.), India.

[3] Associate Professor, Department of Anatomy, Muzaffarnagar Medical College, Muzaffarnagar, (U.P.), India.

ABSTRACT

Introduction: Anatomical knowledge of maxillary sinus and its dimensions are Important during endoscopic sinus surgery.

Aim: The aim of our study was to measure bilaterally different Parameters of maxillary sinus[Antero-posterior diameter (APD), Transverse diameter (TD), Craniocaudal diameter (CCD)] in male and female subjects by computed tomography and their significant role during conduction of endoscopic sinus surgery and determination of sex of the individuals.

Materials and Methods: Cranial computed tomographic images of 67 normal subjects between the age groups of 21 to 70 years were taken in our study. The APD, TD and CCD of the maxillary sinuses were measured electronically. The axial and coronal sections were taken and examined.

Results: The mean Antero-posterior diameter, Transverse diameter, and Craniocaudal diameters of maxillary sinus in males on right side are 3.615 cm, 2.303cm, 3.328cm and on left side are 3.567cm, 2.264cm, 3.387 cm and in females on right side are 3.264cm, 2.059cm, 3.144cm and on left side are 3.188cm, 1.976cm and 2.925cm respectively. The discriminative analysis showed that the accuracy of maxillary sinus measurements (The ability of the size of maxillary sinus to identify gender) was 66.7% in females and 74.4% in males (overall accuracy = 71.6%).

Conclusion: The current study of CT guided morphometry of maxillary sinuses may be helpful for the Otolaryngologists during planning of the endoscopic sinus surgery and support to gender determination.

KEY WORDS: computed tomographic images, maxillary sinus, measurements.

Corresponding Author: Dr. Kuldeep Kumar, Assistant Professor, Department of Anatomy, Govt.Medical College Kannauj(U.P.), India. mob.no. 9794199741
E-Mail: drkuldeep15579@gmail.com

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INTRODUCTION

Maxillary sinuses are two air filled bony cavities situated in the body of maxilla on either side of nasal cavity and can be of different sizes and shapes. Their walls are thin. The apex is directed towards the zygomatic bone and base (medialwall) towards the lateral wall of nose while roof is formed by floor of the orbit and

floor by alveolar and palatine processes of the maxilla and the anterior wall is formed by the anterior surface of the maxilla covered by the cheek [1]. It drains into middle meatus (Hiatus semilunaris) of nose [2].

The maxillary sinuses appear at the end of second embryonic month. They extend to the roots of the permanent teeth when deciduous teeth fall off. The maxillary sinuses originate as invaginations of the nasal mucosa into maxillae [3].

The computed tomography (CT) provides significant anatomical information about the size of Maxillary sinus and hence it has been used to determine the anatomical variations of the nose and Para nasal sinuses [3].

Determination of gender is done through various body parts, the skull, the pelvis, the long bones with an epiphysis and a metaphysis in skeletons, the mastoid process, the foramen magnum and the paranasal sinuses. In explosions, warfare, and other mass disasters like aircraft crashes, the skull and other bones are badly disfigured, however it has been reported that maxillary sinuses remain intact [4]. The maxillary sinus varies greatly in size, shape, and position not only in different individuals but also in both sides of the same individual [5]. Various cadaveric and radiological studies have been carried out to identify the variations of the landmarks in nasal anatomy but the morphometric measurements vary considerably in cadaveric and CT studies [5-7].

The aim of the our study was to measure the maximum antero-posterior diameter, transverse diameter, craniocaudal diameter of the maxillary sinus in both axial and coronal computed tomographic images and assess significant difference found in the APD, TD, and CCD of the maxillary sinuses between males and females.

MATERIALS AND METHODS

The cranial computed tomographic study was conducted on 67 subjects (43 males and 24 females) between the age of 21 to 70 years, in the Department of Anatomy, Government Medical College Kannauj (UP) and study data taken from Radio diagnosis center of Rama Dental College and hospital, Kanpur. Subjects with history of previous surgery involving maxillary sinus, fractures around skull base affecting the sinus or any space occupying lesions involving maxillary sinus were excluded from the study.

Antero-posterior diameter (APD), Transverse diameter (TD), Cranio-caudal diameter (CCD) were measured electronically with a computed tomography machine (model Somatom Emotion, Max.kvp130, max. mA / Max. mAs 180 and ID- G-XL-95033). The maximum Antero-posterior diameter (APD) and Transverse diameter (TD) are measured in axial sections (Figure A) and Cranio-caudal diameter (CCD) is measured in coronal sections (Figure B). The axial and coronal sections were taken at the interval of 1.5 mm.

In coronal images maximum Cranio-caudal diameter was measured from roof to bottom of the sinus and in axial images, maximum anterio-posterior diameter measured from anterior and posterior inner bony walls of the sinus and maximum transverse diameter by medial and lateral inner bony walls of sinus. Discriminative analysis was done to detect gender by using data obtained from CT scans. A significant difference was found in Antero-posterior diameter, Transverse diameter and Cranio-caudal diameter of sinuses between males and females.

RESULTS

In our study, the mean parameters of the maxillary sinuses of the females were found to be smaller in comparison to males as given in table 1 and the accuracy rate of gender identification from right and left maxillary sinus measurements together was 66.7% in females and 74.4% in males, with a mean of 71.6% as given in table 2.

DISCUSSION

In the past many researchers worked on morphomeric study of maxillary sinuses by various radiological techniques but more accurate measurements of various parameters of maxillary sinuses obtained by computed tomography images and their significant role in sinus surgery and determination of gender. In our study all the parameters of the maxillary

sinus in females are less than that of the males. The mean Antero-posterior diameter, Transverse diameter and Craniocaudal diameter of Maxillary sinus in males on

Right side were 3.615 cm, 2.303cm, 3.328cm and on left side were 3.567cm, 2.264cm, 3.387 cm respectively. The same parameters in females on right side were 3.264cm, 2.059cm, 3.144cm and on left side were 3.188cm, 1.976cm and 2.925cm respectively (Table – 1).

Table 1: Shows the distribution of the mean, standard deviation and P value of the Antero-Posterior diameter, Transverse diameter and Cranio-caudal diameter of the maxillary Sinuses according to gender.

Maxillary sinus	Male(n= 43)		Female(n= 24)		P value
	Mean	Std. deviation	Mean	Std. deviation	
Right APD	3.615 cm	0.3696	3.264 cm	0.4464	0.001
Left APD	3.566 cm	0.3315	3.188 cm	0.4877	0.004
Right TD	2.30 cm	0.3675	2.059cm	0.3448	0.01
Left TD	2.26 cm	0.4052	1.976 cm	0.3595	0.005
Right CCD	3.32 8cm	0.4808	3.144 cm	0.4419	0.14
Left CCD	3.387cm	0.4471	2.952 cm	0.5511	0.0008

We found that all parameters of right maxillary sinus in male is slightly higher than left sinus except left craniocaudal diameter which is slightly higher than right craniocaudal diameter. The same parameters in females on right side of the sinus is slightly higher than left side of the sinus. The size difference between right and left sinuses are given in table 1 and have their significant role during performing endoscopic sinus surgery and determination of gender. The average dimensions of the adult sinus are 2.5–3.5 cm wide, 3.6–4.5 cm tall, and 3.8–4.5 cm deep [8]. During adulthood, their shape and size change, especially due to loss of teeth. It has been reported that genetic diseases, post infections, and environmental factors can also affect the sizes of maxillary sinuses [9].

Maxillary sinus anatomy is complex and rather variable from person to person. Significant differences in structure between the two sides may also exist in the same person [10,11]. The anatomy of the maxillary ostia should be well understood by an endoscopic sinus surgeon in order to perform the middle meatal antrostomy [12].

The dimensions of the maxillary sinus could be used for determination of gender [13].

CT measurements of maxillary sinuses, that is, the length, the width, and the height may be useful to support gender determination in forensic medicine; therefore, dimensions of maxillary sinus together with other bones can be used for gender determination when the whole skeleton is not available for more accurate results [4].

Detailed knowledge of the anatomy of the sinuses is critical for performing procedures such as functional endoscopic sinus surgery [10,11]. The comparative data of our study with that of Kiruba et al [14], Tambawala et al [15] and Ahmed . et al [16] and Souza et al [17] are given in Table 3.

Table 2: showing Gender determination from measurements of both maxillary Sinuses together.

Gender (real)	Gender (predicted)	
	Male	Female
Male(43)	32(74.4%)	16(66.7%)
Female(24)	11(25.6%)	8(33.3%)
Total	43	24

Table 3: Showing comparative differences of parameters of our study with that of Kiruba et al [14], Tambawala et al [15], Ahmed. et al[16] and Souza et al [17].

SN	Our study Mean (in cm)		Kiruba et al [14], mean (in mm)		Tambawala et al [15], mean (in mm)		Ahmed et al [16] Mean (in mm)		Souza et al [17] (cm)	
Parameters	male	female	male	female	male	female	male	female	male	female
RightAPD(depth)	3.615	3.264	40.053	36.675	40.22	35.66	35.9	34.58	3.86	3.72
LeftAPD(depth)	3.567	3.188	39.736	37.433	39.59	35.12	36.63	35.6	3.9	3.71
RightTD(width)	2.303	2.059	27.858	26.693	29.78	23.8	25.74	22.54	2.7	2.49
LeftTD(width)	2.264cm	1.976	28.212	26.787	29.75	23.61	25.36	21.53	2.64	2.38
RightCCD(height)	3.144	3.179	39.951	36.825	39.71	30.29	32.86	29.16	3.43	3.23
LeftCCD (height)	2.925	2.87	39.683	37.125	39.67	30.64	33.13	29.25	3.46	3.21

Figure A: Showing the Antero-posterior diameter (APD) and Transverse diameter (TD) of maxillary sinus as measured on computed tomography image in axial section.

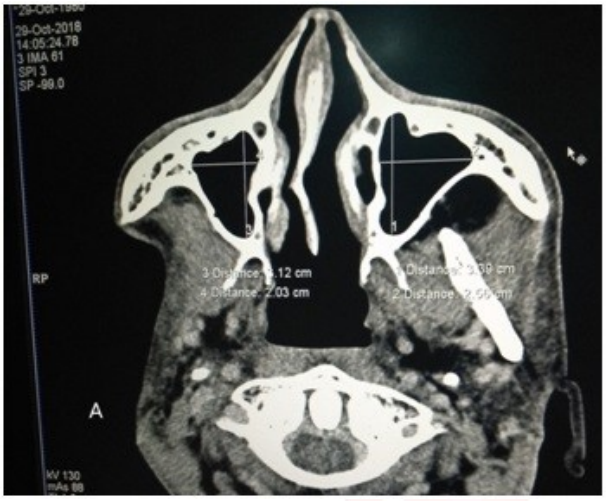

Figure B: Showing the Craniocaudal diameter (CCD)of maxillary sinus as measured on computed tomography image in coronal section.

It has been reported that the maxillary sinuses are significantly larger in males than in

Females [18-20]. The left maxillary sinus has been reported to be larger than the right sinus in both genders. In the study of Lee Fernandes [18] (2004), about gender determination from measurements of the maxillary sinuses, it has been noted that maxillary sinuses were larger in males than in females and that the accuracy rate was 79.0%.

According to Hacer Yasar T et al [4] the determination of gender based on measurements of maxillary sinus was found to be accurate in 69.4% in females and 69.2% in males.

In the present study, the measurements of the maxillary sinuses of females were lower than those of males. The estimation rate of gender was detected in male 74.4% and female 67.7% where as mean was 71.6%. Johnson et al [21] found the depth and width of maxillary sinus in males on right and left side as 36, 35 and 25, 25 mm while in females as 35, 34 and 23, 23 mm while in our study, we got 40, 39.7 and 27.8, 28.2 in males and in females 36.6, 37.4 and 26.6, 26.7 mm. Uthman et al [13] found that the maxillary sinus height was the best discriminant parameter that could be used to study sexual dimorphism with an overall accuracy of 71.6%. They found using multivariate analysis, 74.4% of male sinuses and 73.3% of female sinuses were sexed correctly and the overall percentage for sexing maxillary sinuses correctly was 73.9%. According to Fernandes [22],

gender determination from measurement of the maxillary sinuses was 79.0% while in our study, it was 71.6%. We advise that the depth, the width, and the height of the maxillary sinuses together with other bones can be used for gender determination when the complete skeleton is not available. This information can also be useful for ENT surgeons while performing surgery in this region.

CONCLUSION

Variability in the morphology of the maxillary sinus has practical significance during surgical procedures conducted by maxillofacial surgeons or otolaryngologists. The knowledge about the variations in the lateral wall of the nasal cavity is also crucial during the endoscopic interventions and for functional endoscopic sinus surgeries. In our study all mean parameters of female maxillary sinus are smaller than male maxillary sinus and the accuracy rate of gender identification from the right and left maxillary sinus measurements together was 66.7% in females and 74.4% in males, with a mean of 71.6%.

Conflicts of Interests: **None**

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