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Original Article:

Measurement of Different Dimension of Maxillary and Frontal Sinus Through Computed Tomography

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Abstract: The objective of the study was to estimate the normal upper and lower limit cut-off value of the different dimensions of maxillary and frontal sinuses, and also to determine the influence of gender on the obtained variables and to observe the effect of nasal septal deviation on maxillary sinus. The observational study was carried out and a total of 60 samples were collected from both males and females with the age group range from 20-50 years. Different dimensions of maxillary and frontal sinuses were measured and the volume was calculated. The mean of all the measured parameters in right and left maxillary sinus and frontal sinus shows the higher value in males as compared to females. The volumes of maxillary and frontal sinuses of both sides were significantly greater in males than females. All the measured dimensions were larger in males and also the volume of maxillary sinus was found to be larger in males. This study also showed that there was no effect of nasal septal deviation on the volume of maxillary sinus.
Key Words: Para nasal sinus, FESS, Computed tomography

Introduction:
The paranasal sinuses are air-filled spaces located within the bones of the skull and face. They are centred on the nasal cavity and have various functions, including lightening the weight of the head, humidifying and heating inhaled air, increasing the resonance of speech, and serving as a crumple zone to protect vital structures in the event of facial trauma. With the advent of multidetector computed tomography (MDCT), CT PNS has become the investigation of choice for the diagnosis of sinus diseases. Functional Endoscopic Sinus Surgery (FESS) is a common procedure which requires a meticulous assessment of the patient and a detailed radiological description of the anatomy and dimension in nose and PNS[1], hence imaging of paranasal sinuses prior to FESS has become mandatory. Multiplanar imaging offers precise information regarding the anatomy of the sinuses and its variations, which is an essential requisite before surgery. The success of FESS depends on adequate knowledge of the complicated anatomy of the paranasal sinuses, which is variable. It is important to recognize the clinical and surgical significance of these variations.
In a study conducted by Mohammad Adeel et al[2] where one or more types of anatomical variants were observed in 51.9% of the patients; the most frequent being the deviated nasal septum (26%) and the concha bullosa (18.2%.) In another study conducted by Perez-Pinas et al in Spain, it was concluded the population studied showed great anatomical variability, and a high percentage (67%) presented one or more anatomical variants. Discounting agger nasi air cells and asymmetry of both cavities of the sphenoidal sinus, which were present in all cases, the variations most often observed were deviation of the nasal septum, the presence of a concha bullosa, bony spurs of the nasal septum and Onodi air cells.(3) A good knowledge of the complex anatomy of the paranasal sinuses is crucial. This knowledge will provide an accurate assessment of the normal variants and pathological changes required for successful FESS. Although the anatomy of nasal cavity and paranasal sinuses differ significantly from patient to patient, certain distinct variations are found most frequently among the general population. The presence of anatomic variations must be noted in order to attain a full understanding of the individual patient as well as to develop an accurate diagnosis. Computed tomography scans serve as a critical 'roadmap' for FESS. A systematic evaluation of such scans, and an awareness of any anatomical variants that may modify one's surgical approach, allow one to pre-empt complications. The objective of this study was to estimate the normal upper and lower limit cut off value of the different dimensions of maxillary and frontal sinuses, also to determine the influence of gender on the obtained variables and to observe the effect of nasal septal deviation on maxillary sinus.

Materials and Methods
Approval was acquired from ethical committee, Kasturba Hospital and institution research committee, School of Allied Health Sciences. It is an observational study, carried out at

Department of Radio-diagnosis and Imaging, Kasturba Hospital, Manipal, Karnataka, using PHILIPS Brilliance 64-Slice Computed Tomography scan. The total data of 60 patients was collected from both the males and females of the age group range from 20-50 years, free from major injuries or trauma of facial bones. In all cases, systematic studies of the sinus region were performed in frontal or coronal and in horizontal scans. Investigation of anatomical variants was performed using a soft window and a bone density window.
In all cases, the existence of the septal deviation and septal angle was investigated. The direction of septal deviation was noted in coronal image, which shows the maximum deviation of septum clearly. Septal angle was measured in degrees by drawing a line from the superior insertion of the nasal septum at the crista galli to the inferior insertion of the septum at maxillary crest and another line from the superior insertion of the nasal septum at the crista galli to the maximally deviated point of the convex nasal septum. For right and left frontal sinus and maxillary sinus, cranio-caudal diameter, antero-posterior diameter and width of the sinus was measured in millimetres (Figure 1).

All the above parameters were collected and tabulated and the volume for both right and left frontal sinus and maxillary sinus was calculated using formula (cranio-caudal diameter X antero-posterior diameter X width of the sinus). The measured and calculated parameters were statistically analysed using SPSS 20 where the mean and the range were calculated to estimate the normal upper and lower limit cut-off value. To determine the influence of gender, student t-test was used for the normally distributed variables and for the variables which were not normally distributed, non-parametric Mann-Whitney test was used.

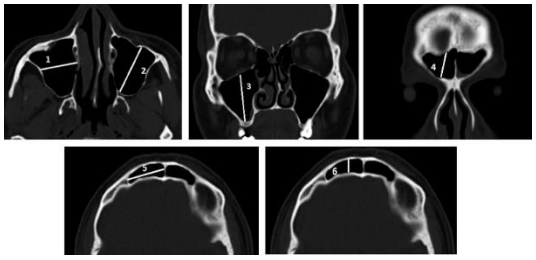

Figure 1: CT axial and coronal image showing the measurement of different dimension. (1) Width of maxillary sinus (2) antero-posterior diameter of maxillary sinus (3) cranio-caudal diameter of maxillary sinus (4) cranio-caudal diameter of frontal sinus (5) Width of frontal sinus (6)antero-posterior diameter of frontal sinus.

Results

The results of different dimensions measured are given in Table 1. The mean and standard deviations of all the maxillary and frontal sinuses show higher value in males as compared to females. The results also showed that the volume of maxillary and frontal sinuses of both sides were significantly greater in males than females.

Table 1: Mean, Standard deviation and range for the measured values of different dimension of maxillary and frontal sinus for male and female

	Male		Female	
	Mean ± SD	**Range**	**Mean ± SD**	**Range**
Maxillary sinus (Right) in mm				
Cranio-Caudal Diameter	35.7 ± 6.0	22 - 45.9	31.4 ± 2.7	24.9 – 38.3
A-P diameter	34.6 ± 4.7	24.1 - 43.1	31.4 ± 5.0	11.8 – 37.5
Width of the sinus	31.4 ± 5.4	20.9 – 39	30.3 ±4.6	21 – 40.1
Maxillary sinus (Left) in mm				
Cranio-Caudal Diameter	38.7 ± 4.3	27 – 46.5	30.6 ± 3.0	22.1 – 36.3
A-P diameter	34.6 ± 4.5	25.1 – 41	31.6 ± 4.6	12 – 37.5
Width of the sinus	30.9 ± 5.7	19.5 – 39.2	30.2 ± 3.6	23.6 – 37.8
Frontal Sinus (Right) in mm				
Cranio-Caudal Diameter	25.6 ± 5	12.9 – 36.5	20.8 ± 5.8	8.8 – 34.6
A-P diameter	8.8 ± 2.0	6 – 15	5.2 ± 1.1	3 - 8
Width of the sinus	26.2 ± 5.0	17.2 – 43.7	19.4 ± 7.1	5.4 – 39.8
Frontal Sinus (left) in mm				
Cranio-Caudal Diameter	25.0 ± 7.4	12 – 38.7	21.1 ± 6.4	9.7 – 38.3
A-P diameter	7.8 ± 1.8	5.3 – 12	5.9 ± 1.3	3 – 8.9
Width of the sinus	24.7 ± 6.7	13.1 – 40.6	23.2 ± 6.1	11.3 – 33.6

Table 2: The influence of gender in maxillary and frontal sinus volume

	Male	**Female**	**Mean diff.**	**P-value**
	Mean ± SD	**Mean ± SD**		
Maxillary sinus volume				
Right	39045.9 ± 10977.5	30348.1 ± 9044.5	8697.8	0.002
Left	42248.4 ± 13279.5	29524 ± 7050.2	12724.4	0.001
Frontal sinus volume				
Right	6099.1 ± 2508.6	2165.1 ± 1214.9	3934	0.001
Left	5368.4 ± 3449.1	3061.3 ± 1831.9	2307.1	0.004

Discussion

This study has shown that CT is a very reliable modality for obtaining the measurement for different dimensions of paranasal sinuses. The surgical management of paranasal sinus disease has evolved over the years. Prolonged hospital stays were common due to extensive external approaches and have been replaced by a minimally invasive procedure called endoscopic sinus surgery (ESS). Literature has reported the outcome using endoscopic sinus surgery as very successful.[4] However due to the anatomical relation of paranasal sinus to skull base and orbits, it becomes a complicated procedure until the different dimension of the sinuses are known.

Measurement of different dimensions of PNS and anatomical variation of these sinuses were studied by many authors.[2,3,5] Pernilla S et al., reported that the mean value of different measured dimensions was not correlated with age and the mean value for the cranio-Caudal diameter and antero-posterior diameter of both right and left maxillary and frontal sinus were larger in males than females. She also reported that there is no significant difference between right and left side of maxillary and frontal sinus.[5] Also in a study preformed by Mehmet Emirzeoglu et al., found that there is no significant difference between right and left side of the measured sinuses.[6] Similar result was found in the present study where all the measured sinus parameters were found to be larger in males than females and also no significant difference between right and left maxillary and frontal sinus.

There are many studies performed which evaluate the volume of maxillary sinus [5,7-9] and frontal sinus.[5,6,9] Some authors measured the volume using dry skulls,[9] MRI,[10] and CT scan. In most of the studies performed, the authors reported that there is gender difference where the measured volume of maxillary sinus is larger in males than females. However in a study performed by Y Ariji et al., there was no statistically significant difference between gender[7] and also in a study performed by Kawarai Y et al., similar result was found except for frontal sinus which showed larger sinus in males compared to females.[11] The present study showed that the volume of both maxillary and frontal sinus were significantly larger in males as compared to females (p- value 0.001).

A few authors also reported that the measurement of sinus volume can be done manually and automatically using dedicated software. Pernilla S et al.,[5] compared the result between manual and automatic process and found that automatically computed data were 14-17% higher than the manually calculated volumes. In the present study manual method was considered to measure the volume of maxillary and frontal sinus.

The effect of nasal septum deviation was reported in many studies. In the study conducted by Dong Hee Lee et al.,[8] there was no statistically significant difference of maxillary sinus volume between the deviated and contra lateral side. A study conducted by Zeliha K G et al.,[12] found similar result supporting Dong Her lee et al. In our study also there was no statistically significant difference between the deviated and contralateral side.

Conclusion

For the success of Functional Endoscopic Sinus Surgery (FESS) a good knowledge of the complex anatomy of the paranasal sinuses is crucial. The normal limit for different dimensions of frontal sinus and maxillary sinus helps us to understand the anatomical variation. All the measured dimensions were larger in males and also the volume of maxillary sinus was found to be larger in males. This study also showed that there is no effect of nasal septal deviation on the volume of maxillary sinus.

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