

ORIGINAL RESEARCH

Dimensions of maxillary sinus in correlation to age by computed tomography (CT scan)

¹Jyotsna Kitchlu, ²Bonita Gupte, ³Apurab Gupta, ⁴Ashwani K. Sharma

¹Demonstrator, Department of Anatomy, AIIMS, Vijaypur, Jammu and Kashmir, India

²Demonstrator, Department of Anatomy, Government Medical College, Jammu, Jammu and Kashmir, India

³Assistant Professor, ⁴Associate Professor, Department of Anatomy, Government Medical College, Jammu, Jammu and Kashmir, India

Correspondence:

Apurab Gupta

Assistant Professor, Department of Anatomy, Government Medical College, Jammu, Jammu and Kashmir, India

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ABSTRACT

Background: Evaluation of maxillary sinus dimensions is important in correlation to age and gender by computed tomography. CT measurements of maxillary sinus are useful in age estimation and in clinical procedures.

Method: A morphometric analysis using Computed Tomography (CT scans) of the maxillary sinus of 118 individuals were taken for the study were divided into three age groups that is from 20-30 years, from 31-40 years and from 41-50 years and their measurements were recorded from right side maxillary sinus as well as from left side maxillary sinus. Maxillary sinus Cranio-caudal diameter, Transverse diameter, Antero-posterior diameter and volume were measured and then subjected to statistical evaluation in order to determine mean difference, t-value, p-value for evaluation.

Results: Similarly, there was a statistically significant association between the mean dimensions of height, width, depth, and volume of the right and left maxillary sinus, in the age group of 20-30years and in the age group of 31 - 40 years. In our investigations it was found that with the increase in age beyond 40 years, there was decrease in maxillary sinus dimensions and our other findings were similar to the previous reports.

Conclusion: CT images provide invaluable information on the dimensions of maxillary sinus in different age groups and hence the study proved vital in identifying age. It was of paramount importance for clinicians and top planning procedures by surgeons.

Keywords: CT scans, maxillary sinus, dimensions radiography.

INTRODUCTION

The paranasal sinuses are air filled pockets of bone surrounding the nasal cavity. Maxillary sinus is a pyramidal shaped pneumatic space that fills the body of maxilla. It is the largest bilateral air sinus that opens in the middle meatus of the nasal cavity. The growth of maxillary sinus after birth is biphasic, with rapid growth during the first 3 years and then again from the age of 7 to 12 years. Growth between 3 to 7 years of age occurs at a slower pace, and then again after the age of 12 years, growth slows until early adulthood¹. The maxillary sinuses reach their mature size at the age of about 20 years, when the permanent

teeth fully develop. The average dimensions of adult maxillary sinus are 33mm in height, 23-25 mm in width and 34 mm in the antero-posterior axis, the average volume is 15 ml².

The maxillary sinus evaluation by an otolaryngologist, including nasal endoscopy is important for all patients with a history of sinus disease as it may also be beneficial to fully evaluate patients with asthma, acid reflux and severe allergies because these conditions are often associated with chronic sinusitis and may predispose patients to infection and possible graft failure. The maxillary sinus is pneumatized in partial or complete edentulous patients and often requires grafting. So the visualization of maxillary sinus and its surrounding structures by various radiographic modalities are pivotal for proper diagnosis and treatment³. The maxillary sinus is a fundamental anatomical structure which is often involved in many oral, maxillofacial, otolaryngological and surgical procedures in the posterior maxilla. The invasion of maxillary sinus can occur during augmentation procedures and implant placement, when residual ridge height is reduced due to process of bone loss after tooth extractions in posterior maxilla. This is considered as a potential source of infection or irritation which can lead to inflammation of sinus membrane⁴.

In forensic science, the primary components of any skeletal analysis are age and sex determination. As most bones used for sex determination are recovered in incomplete state, it is often necessary to use bones that are recovered intact such as maxillary sinus. The maxillary sinus remains intact even when the skull and other bones are badly disfigured in victim who are incinerated⁵. CT scans are gold standard imaging modality in the identification of unknown remains as they provide an accurate assessment of the paranasal sinuses and craniofacial bones⁷ and are the most reliable imaging modality used to evaluate the Sino nasal cavities as they provide three-dimensional information and an accurate assessment of the paranasal air sinuses. Clinicians reviewing head and neck CT scans such as dentists, general medical practitioners, maxillofacial and ENT surgeons are vigilant of maxillary sinus measurements while interpreting CT scans of the maxilla and procedures should be followed up appropriately.

CT measurements of maxillary sinuses, that is length, width, height and volume may be useful for supporting gender determination in forensic anthropology and hence the study on dimensions of maxillary sinus in correlation to age and gender using CT scan is envisaged.

MATERIALS and METHODS

The study consisted of Computed Tomographic images of 118 patients, ranging from 20 to 50 years, the continuous variables were converted into categorical ones by distributing the individuals into 3 age groups:

1. 20 to 30 years
2. 31 to 40 years
3. 41 to 50 years

The wide age range was included in the study to provide applicable data of sinus identification in different age groups.

CRITERIA FOR PATIENT SELECTION

INCLUSION CRITERIA

Individuals undergoing CT scan for pathologies other than maxillary sinus, individuals with complaints of headache or with suspicion of sinusitis and images with good resolution.

Non-Contrast CT of Paranasal sinuses (PNS) were performed on either Siemens SOMATOM Definition Flash (256-slice) CT SCAN or Siemens SOMATOM Spirit (Dual slice) CT scan. All measurements of maxillary sinus dimensions (Antero posterior, width and height) were done on computer screen of workstation of CT machine. The sinus parameters were measured after identification and analysis of normal sinus parameters by an experienced radiologist.

EXCLUSION CRITERIA

Individuals with pathological conditions affecting the maxillary sinuses (Tumors, inflammation, residual root fragments, extrusion of endodontic filling materials), Facial Abnormalities, fractures of Maxilla or Facial Injuries, who have previously undergone surgical procedures of maxillofacial region, Cleft palate, ectopic and supernumerary teeth, missing teeth in maxillary posterior regions, with history of orthodontic treatment with metabolic diseases affecting bone tissue, with skeletal asymmetry, with congenital disorders, with craniofacial syndrome, and individuals less than 20 years of age, as maxillary sinus tends to stabilize after second decade of life.

The morphometric parameters of maxillary sinus were taken by CT scan images which was obtained by standard protocol made by the radiological society and were measured for right and left sides of the maxillary sinus Maxillary sinus Height (Crania-caudal diameter) (**Image-1**). Maxillary sinus Width (Transverse diameter) - (**Image-2**). Maxillary sinus Depth (Antero-posterior diameter) (**Image-3**).

Image 1 – Showing the Measurements of maximum Height (Crania caudal diameter) of Maxillary Sinus of right and left side by Computed Tomography Scan (Coronal view)



Image 2 – Showing the Measurements of maximum Width (Transverse diameter) of Maxillary Sinus of right and left side by Computed Tomography Scan (Axial view)

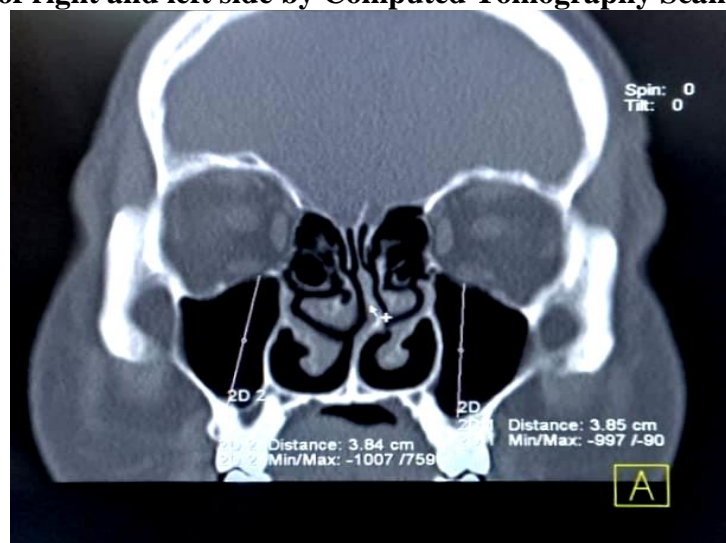
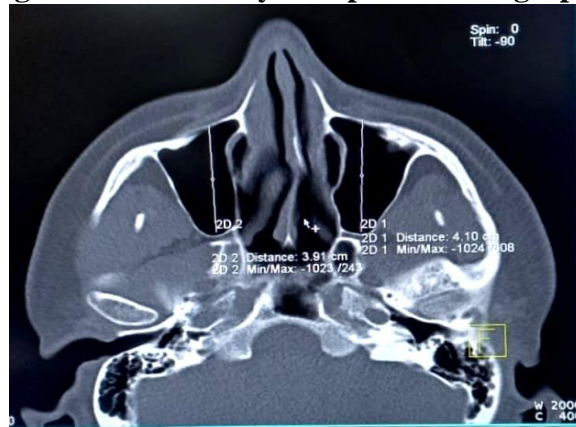


Image 3 – Showing the Measurements of maximum Depth (Antero Posterior diameter) of Maxillary Sinus of right and left side by Computed Tomography Scan (Axial view)



Maxillary sinus volume was calculated by the equation: Volume = (Width × Depth × height × 0.52), proven mathematical formula in which the maximum dimensions of maxillary air sinuses were taken that give approximate volume of each sinus.

A morphometric analysis using Computed Tomography (CT scans) of the maxillary sinus of 118 individuals were taken for the study. The study was conducted in the Postgraduate Department of Anatomy and Department of Radio diagnosis, Government Medical College Jammu. The males and females were divided into three age groups that is from 20-30 years from 31-40 years and from 41-50 years, and their measurements were recorded from right side maxillary sinus as well as from left side maxillary sinus. Maxillary sinus height (Cranio caudal diameter), width (Transverse diameter), depth (Antero posterior diameter) and volume were measured. A detailed statistical analysis was then done.

RESULTS

There is a statistically significant difference between the mean dimension of height, width, depth, and volume of the right and left side maxillary sinus 65 males and 53 females (**Table: 1 & 2**).

Similarly, there is a statistically significant association between the mean dimension of height, width, depth, and volume of the right and left maxillary sinus, in the age group of 20 – 30 years. (**Table: 1 & 2**).

Table: (1) Comparison of different measurements of Right Side Maxillary Sinus in the age group (20 – 30) years.

Variable	N	Mean	Standard Deviation	t-value	p-value
Height (cm)	50	3.44	0.36	3.870	0.000
Width (cm)	50	2.45	0.29	3.104	0.003
Depth (cm)	50	3.54	0.38	2.414	0.020
Volume (cm ³)	50	14.98	4.07	3.600	0.001

Table: (2) Comparison of different measurements of Left Side Maxillary in the age group (20 – 30) years.

Variable	N	Mean	Standard Deviation	t-value	p-value
Height (cm)	50	3.44	0.33	4.188	0.000
Width (cm)	50	2.45	0.32	1.594	0.118
Depth (cm)	50	3.57	0.32	2.256	0.028
Volume (cm ³)	50	15.20	3.99	2.721S	0.009

The right maxillary sinus dimensions including, in the age group of 31 - 40 years are enumerated in (**Table: 3**). There is a statistically insignificant correlation between the mean

dimension of height, width, depth, and volume of the right maxillary sinus with p-values 0.130, 0.081, 0.247 and 0.068 respectively.

Table: (3) Comparison of different measurements of Right Side Maxillary Sinus, in the age group (31 –40)years.

Variable	N	Mean	Standard Deviation	t-value	p-value
Height (cm)	37	3.55	0.41	1.553	0.130
Width (cm)	37	2.43	0.32	1.800	0.081
Depth (cm)	37	3.53	0.33	1.178	0.247
Volume (cm ³)	37	15.76	4.66	1.884	0.068

There is a statistically significant association between the mean dimension of height, depth, and volume of the left maxillary sinus in the age group of 31 - 40 years (**Table: 4**).

Table: (4) Comparison of different measurements of Left Side Maxillary Sinus between males and females in the age group (31 – 40) years.

Variable	N	Mean	Standard Deviation	t-value	p-value
Height (cm)	37	3.56	0.34	2.065	0.047
Width (cm)	37	2.41	0.30	1.231	0.227
Depth (cm)	37	3.54	0.29	2.495	0.018
Volume (cm ³)	37	15.53	3.74	2.384	0.023

The comparison of the right maxillary sinus dimensions between 16 males and 15 females, in the age group of 41 - 50 years are summarised in (**Table: 7**).

There is a statistically significant association in the mean dimension of height of the right maxillary sinus and statistically insignificant association between the mean dimension width, depth, and volume of the right maxillary sinus in 16 males and 15 females, in the age group of 41 - 50 years.

Table: (5) Comparison of different measurements of Right Side Maxillary Sinus in the age group (41 – 50) years.

Variable	N	Mean	Standard Deviation	t-value	p-value
Height (cm)	31	3.36	0.33	2.355	0.026
Width (cm)	31	2.31	0.25	0.123	0.903
Depth (cm)	31	3.42	0.34	0.974	0.338
Volume (cm ³)	31	13.49	2.96	1.769	0.090

The comparison of the left maxillary sinus dimensions comprising 16 males and 15 females, in the age group of 41 - 50 years are summarised in (**Table: 5**).

There is a statistically significant association observed in the mean dimension of height of the left maxillary sinus and insignificant difference between the mean dimensions of the width, depth and volume of the left maxillary sinus in the age group of 41 - 50 years.

Table: (6) Comparison of different measurements of Left Side Maxillary Sinus between males and females in the age group (41 – 50) years.

Height (cm)	31	3.30	0.30	2.330	0.027
Width (cm)	31	2.35	0.26	1.039	0.307
Depth (cm)	31	3.45	0.28	1.071	0.293
Volume (cm ³)	31	13.50	2.87	0.866	0.394

The comparative studies of different measurements of maxillary sinus between right and left sides of males and females including 118 subjects, in the age group of 20 - 50 years were conducted. The standard deviation of height, width, depth, and volume of right maxillary sinus are 0.41, 0.31, 0.37 and 4.51 respectively. The standard deviation of height, width, depth, and volume of left maxillary sinus are 0.38, 0.31, 0.33 and 4.02 respectively.

The t-values are 0.324, 0.083, -0.571 and 0.054 and the p-values 0.746, 0.934, 0.569 and 0.957 which are all statistically insignificant.

Our studies show that with the increase in age beyond 40 years there is decrease in measure dimensions and size of maxillary sinus.

DISCUSSION

Statistically significant difference was observed between the mean dimensions of height, width, depth, and volume of either side of maxillary sinus of males and females CT scans. Similarly, there was a statistically significant association between the mean dimensions of height, width, depth, and volume of the right and left maxillary sinus, in the age group of 20-30 years and in the age group of 31 - 40 years. There was a statistically significant association in dimension of height of the right maxillary sinus and statistically insignificant association in dimensions of width, depth, and volume of the right maxillary sinus in males and females, in the age group of 41 - 50 years. There was a statistically significant association in dimension of height and volume of the left maxillary sinus and insignificant difference in dimensions of the width in the age group of 41 - 50 years. In our investigations it was found that with the increase in age beyond 40 years, there was decrease in maxillary sinus dimensions and our other findings were similar to the previous reports.^{9,10,11,12}

Height MS: Comparison of different measurements of right side maxillary sinus in the age group (31 – 40) years showed insignificant results, but left side maxillary sinus in the age group (31 – 40) years with t- value 2.065 and p- value 0.047 which was significant. In the age group 41 - 50 years' right side maxillary sinus, height with t- value 2.355 and p- value 0.026 which is significant. Also on the left side of maxillary sinus, height with t- value 2.330 and p- value 0.027 was recorded which is significant.

In our study the maxillary sinus mean height is comparable to the studies done by other authors.^{9,10,11,12}

WIDTH

Comparison of measurements of width of right and left side maxillary sinus between in the age group 20 -30 years, 31 –40 years and 41-50 years showed that in the age group of 20 -30 years the width on the right side of maxillary sinus was bigger than others with the mean value of with t –value 3.104 and p- value 0.003.

VOLUME

The maximum increase in maxillary sinus volume was observed in the age group of 21-25²The left maxillary sinus volume was more than right sinus volume in the age group 21-25 years. These observations are in agreement with our studies in which there is **Increase** in sinus volume between 20-30 yrs. and also in 51-60 yrs. and thereafter it decreases.

A significant correlation in maxillary sinus height, width and depth of right and left sides, involving both the genders in the age groups 31 – 40 years and 41 – 50 years¹³. The differences observed are attributed to ethnic groups and geographical barriers^{14,15}

CONCLUSION

CT images provide invaluable information on the dimensions of maxillary sinus in different age groups and hence the study proved vital in identifying age. It was of paramount importance for clinicians and to planning procedures by surgeons.

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CONFLICT OF INTEREST

None

ETHICAL APPROVAL

Approved by Govt. Medical College Jammu Institutional Ethics Committee.

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