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Morphometry Of Maxillary Sinus and Its Clinical and Forensic Implications- A Ct Study

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ABSTRACT

Introduction: Maxillary sinus is the largest paranasal air sinus located within the maxilla beneath the cheeks and above the upper teeth ,They are shaped like pyramids and drain into the middle meatus of the nasal cavity. These sinuses are crucial for lightening the skull and for conditioning the air with adding moisture and warmth.

Material and Method: 355 individuals were taken for the study and were divided into four age groups 18-30 years, 31-40 years, 41-50 and 51-60 years. The measurements were recorded for right and left side maxillary sinus seperately.The cranio-caudal diameter, transverse diameter and anteroposterior diameter were measured statistical analysis was done.

Results: The largest proportion of participants belonged to the 18 to 30 age group, accounting for 29.9% of the overall cohort. Subsequent age categories exhibited relatively uniform distributions, with 24.8%, 22.5%, and 22.8% in the 31 to 40 years, 41 to 50 years, and 51 to 60 years age ranges, respectively. There was a statistically significant association between the mean of height, width and depth of the right and left maxillary sinus.

Conclusion: CT imaging offers critical insights into the size and shape of the maxillary sinuses across various age groups, making it an essential tool for age estimation. This information is highly valuable for clinicians, aiding them in surgical planning and decision-making

Keywords: *CT imaging, Maxillary Sinus, Morphometry*

1. INTRODUCTION

The maxillary sinuses are the largest of the paranasal sinuses, located within the maxillary bones, beneath the eyes, and above the upper teeth. They are pyramid-shaped, with their apex pointing towards the zygomatic bone and their base forming part of the lateral wall of the nasal cavity. These sinuses are lined with a mucous membrane and communicate with the nasal cavity through the ostium located in the middle meatus. Maxillary sinuses are clinically significant because they play a vital role in reducing the overall weight of the skull, humidifying and warming the inhaled air, and enhancing voice resonance. Pathological conditions affecting the maxillary sinuses, such as sinusitis, cysts, and tumors are common in clinical practice and may manifest with symptoms like facial pain, nasal congestion, and dental discomfort. Proper understanding of their anatomy is crucial for accurate diagnosis and management of sinus-related disorders. [1,2,3]

2. MATERIALS AND METHOD

The study was conducted in the Department of Anatomy, National Institute of Medical Sciences & Research, NIMS University, Jaipur, in collaboration with Department of Radio-Diagnosis, Era's Lucknow Medical Collage & Hospital, Era University, Lucknow.

STUDY DESIGN: Observational cross sectional study.

STUDY SUBJECTS:All adult patients consecutively referred for head and neck CT scans.

SAMPLE SIZE: 355

STUDY PERIOD: 2022-2024

INCLUSION CRITERIA :

- Subjects who were advised CT scan of head & neck region.
- Subjects between 18 to 60 years of age.

EXCLUSION CRITERIA:

- Subjects with CT scan showing abnormality of one or both maxillary sinuses.
- Subjects with congenital anomalies affecting the maxillofacial region, facial or paranasal sinus fractures, cleft palate, as well as those with ectopic or extra teeth, were excluded.
- Subjects with history of sinonasal surgery.
- Subjects unwilling to provide informed consent.
- Unclear or incomplete CT were rejected.

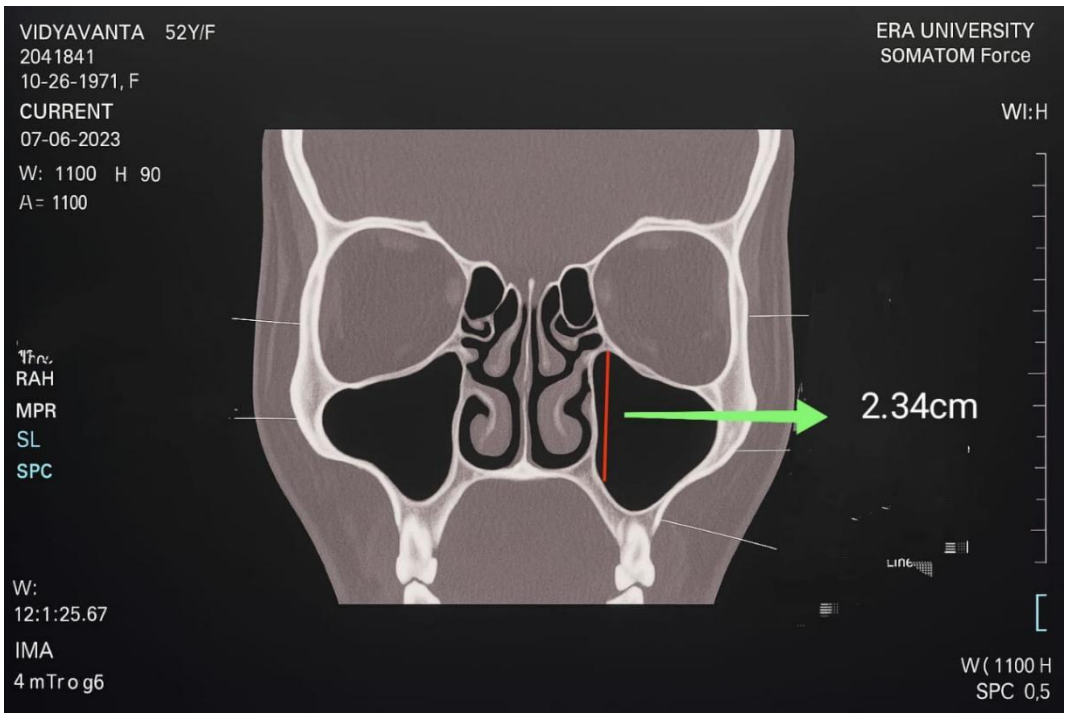
METHOD OF COLLECTION OF DATA:

MEASUREMENTS:-

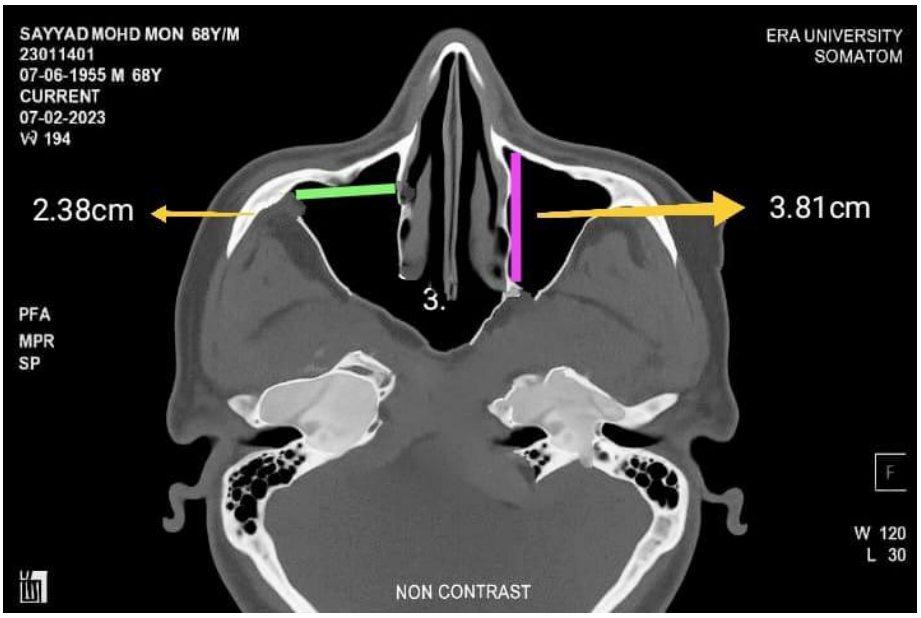
- The anteroposterior (APD) and transverse (TD) diameters were obtained using axial sections, while the craniocaudal (CCD) diameter was evaluated in coronal sections.[4].
- The anteroposterior dimension was measured along the inner bony surface of the sinus.[4]
- The maximum transverse dimension was determined by measuring from the inner bony wall's medial to lateral sides of the sinus.[4]

The craniocaudal dimension was calculated from the roof to the floor of the sinus.[4]

Fig: 1- CT Image showing Cranio-caudal diameter (CCD) in coronal section



Fig; 2- CT Image showing Antero-posterior diameter (APD) and Transverse diameter (TD) in axial section



3. RESULTS

The maxillary sinus of 355 subjects was studied 29.9 % were in 18-30 years age group.

Table 1: Age wise distribution of patients

Age Interval	n = 355	%
18 – 30 years	106	29.9%
31 – 40 years	88	24.8%
41 – 50 years	80	22.5%
51 – 60 years	81	22.8%

Table 2: Frequency distribution of patients according to antero-posterior diameter of right and left maxillary sinus

Antero-posterior diameter	Right Side		Left Side	
	n	%	n	%
1.50 - 2.00 cms	10	2.8%	10	2.8%
2.01 - 2.50 cms	149	42.0%	135	38.0%
2.51 - 3.00 cms	81	22.8%	79	22.3%
3.01 - 3.50 cms	85	23.9%	94	26.5%
3.51 - 4.00 cms	22	6.2%	22	6.2%
>4.00cm	8	2.3%	15	4.2%

Table 3 Frequency distribution of patients according to transverse diameter of right &left maxillary sinus

Transverse diameter	Right Side		Left Side	
	n	%	n	%
≤ 2.00 cms	44	12.4%	28	7.9%
2.01-2.50 cms	113	31.8%	100	28.2%
2.51-3.00 cms	92	25.9%	64	18.0%
3.01-3.50 cms	71	20.0%	97	27.3%
3.51-4.00 cms	17	4.8%	45	12.7%
>4.00 cms	18	5.1%	21	5.9%

Table 4: Frequency distribution of patients according to Craniocaudal diameter of right & left maxillary sinus

Craniocaudal diameter	Right Side		Left Side	
	n	%	n	%
≤ 2.00 cms	10	2.8%	12	3.4%
2.01-2.50 cms	60	16.9%	43	12.1%
2.51-3.00 cms	94	26.5%	72	20.3%
3.01-3.50 cms	94	26.5%	125	35.2%
3.51-4.00 cms	69	19.4%	69	19.4%
4.00-4.50 cms	21	5.9%	48	13.5%
>4.50 cms	7	2.0%	9	2.5%

Table 5: Comparing diameter and dimension of maxillary sinus between right and left side by using t-test

Variables	Right(in cms)	Left(in cms)	t - test	P - Value	Significance
Anteroposterior	2.69 ± 0.56	2.80 ± 0.6	-2.449	0.01458	All are significant
Transverse	2.79 ± 1.21	2.98 ± 1.18	-2.187	0.02910	
Craniocaudal	3.06 ± 0.77	3.18 ± 0.78	-1.976	0.04852	

Age Comparison between male (39.33 ± 12.7) and female (38.75 ± 12.45) subjects reveals a non-significant difference, with a t-test value of 0.431 and a p-value of 0.66708. This suggests that there is no significant difference between male and female participants with respect to the age in the study cohort.

4. DISCUSSION

The importance of bilateral symmetry and asymmetry in maxillary sinus dimensions cannot be overstated, as unilateral variations may impact clinical assessments, treatment strategies, and surgical interventions. This underscores the necessity for a comprehensive investigation that considers the morphometric intricacies of both the right and left sides.

Jovanic S. et. al 1984 found that the maturation of maxillary sinuses correlates with the full development of permanent teeth, typically achieved around the age of 20 years. Adult maxillary sinuses are reported to have average dimensions ranging from

2.5–3.5 cm in width, 3.6–4.5 cm in height, and 3.8–4.5 cm in depth, constituting an estimated volume of approximately 12–15 cm, This is at par with Van den Bergh JP et al. 2000, and Cordioli G et. al., 2001. Notably, the preeminent representation within the 18 to 30 age group, comprising 29.9% of the total cohort, suggests a deliberate emphasis on investigating developmental aspects or anatomical variations during early adulthood. [5,6,7]

Moreover, the subsequent age categories, spanning 31 to 40 years, 41 to 50years, and 51 to 60years, demonstrate relatively uniform distributions of 24.8%, 22.5%, and 22.8%, respectively. The development and size of the maxillary sinuses have been extensively studied, with various researchers presenting differing conclusions. According to Değermenci M et al., the maxillary sinus achieves its full size by the age of 16years. On the other hand, Ariji Y et al. and Baweja S et al. provide alternative perspectives on age-related changes in sinus dimensions. Ariji Y et al. report that maxillary sinuses continue to grow until around age 20 years, after which a gradual reduction is observed. In contrast, Baweja S et al. suggest that this growth may extend up to 25 years before a decline is noted. [8,9,10]

A pivotal facet of this discourse is the assessment of maxillary sinus volume, as conducted by Ariji Y et al. using CT scans. Their findings suggest a noteworthy observation: beyond the age of 20, the volume of the maxillary sinus appears to decrease. This aligns with the notion that age-related changes in maxillary sinus dimensions are not uniform across the lifespan, featuring growth phases followed by periods of reduction.

Our comprehensive morphometric analysis, compared with Kiruba et al. (2014), Tambawala et al. (2015), Ahmed et al. (2015), and Souza et al. (2016), enriches the understanding of morphometric nuances. This not only enhances the academic discourse on maxillary sinus morphology but also has potential implications in forensic and surgical contexts.[11,12,13,14,]

Comprehensive comparison of the diameter and dimensions of the maxillary sinus between the right and left sides, utilizing the t-test for statistical analysis. The mean values with standard deviation, t-test statistics, p-values, and significance indicators contribute to unraveling the asymmetry or symmetry in various morphometric parameters, providing a nuanced understanding of lateral variations in the maxillary sinus.

The anteroposterior dimension on the right side (2.69 ± 0.56) is statistically significantly different from that on the left side (2.80 ± 0.6) with a t-test value of -2.449 and a p-value of 0.01458. This signifies a notable lateral difference, with the left side exhibiting a slightly larger anteroposterior dimension compared to the right.

The transverse dimension on the right side (2.79 ± 1.21) is statistically significantly different from that on the left side (2.98 ± 1.18) with a t-test value of -2.187 and a p-value of 0.02910. This indicates a significant lateral difference in the transverse dimension, suggesting potential asymmetry in the maxillary sinus.

The craniocaudal dimension on the right side (3.06 ± 0.77) is statistically significantly different from that on the left side (3.18 ± 0.78) with a t-test value of -1.976 and a p-value of 0.04852. This implies a significant lateral difference in the vertical dimension, suggesting asymmetry in the maxillary sinus.

Comparing these findings with existing literature, Uthman et al. (2011) and Teke et al. (2007) reported significant gender-based variations in the maximum depth of the maxillary sinus, with males exhibiting greater dimensions than females. Muthukumaravel N. et al. (2016) also observed significant gender-based differences in the maximum width of the maxillary sinus. These comparative analyses contribute to a more profound understanding of lateral asymmetry in the maxillary sinus, highlighting the need for individualized considerations in clinical and surgical approaches.

5. CONCLUSION

This study provides an in-depth analysis of the morphometric characteristics of the maxillary sinus, revealing both lateral asymmetries and gender similarities. The examination of anatomical measurements across various dimensions—antero-posterior, transverse and cranio-caudal highlights significant variations between the right and left sides of the maxillary sinus, with the left side generally showing larger dimensions. This asymmetry underscores the need for further research into anatomical variations and their potential clinical implications. These findings emphasize the importance of considering individual anatomical differences in clinical assessments and research. Overall, the study offers valuable insights into the complex anatomy of the maxillary sinus, providing a foundation for understanding its variations and guiding future research, particularly in personalized approaches to sinus-related health and treatment.

Clinical Relevance [Sinusitis] - Inflammation or infection of the maxillary sinuses, known as maxillary sinusitis, can cause symptoms such as facial pain, pressure, nasal congestion, and discharge. Chronic sinusitis can result from persistent infections, allergies, or structural abnormalities that obstruct sinus drainage. Dental Implications The proximity of the maxillary sinus to the upper teeth means that dental infections or procedures (such as tooth extractions or implants) can sometimes affect the sinuses. Oroantral fistulas, which are abnormal connections between the oral cavity and the maxillary sinus, can occur after dental extractions. Surgical Considerations: Procedures such as sinus lifts (augmentation of the sinus floor) are performed to allow for the placement of dental implants. Functional endoscopic sinus surgery (FESS) is a common procedure to improve sinus drainage and treat chronic sinusitis. Tumors and Cysts: The maxillary sinus can be the site of various benign and malignant tumors, as well as cysts. These conditions may require surgical intervention for diagnosis and

treatment.

Forensic Relevance:

Sinus radiography is a valuable tool for identifying human remains and determining factors such as sex and ancestry. Computed tomography (CT) scans are a highly effective imaging method for assessing the nasal and paranasal cavities. They offer precise evaluation of the paranasal sinuses, craniofacial bones, and the degree of air-filled spaces (pneumatization).Sexual dimorphism, which refers to the systematic differences in shape or size between males and females of the same species, is observable in maxillary sinuses across various species. In forensic investigations, CT imaging provides several benefits, including high-resolution skeletal imaging, cost-effectiveness, portability, reduced metal artifacts, and ease of use.

Personal Identification:

By matching specific features of the maxillary sinuses (e.g., shape, size dimension) on remains with pre-mortem data(e.g., radiographs, study casts), forensic scientists can aid in personal identication

REFERENCES

[1] Barnes L. Diseases of the nasal cavity, paranasal sinuses, and nasopharynx. InSurgical pathology of the head and neck 2019 Jan 15 (pp. 353-432). CRC Press.

[2] Whyte A, Boeddinghaus R. The maxillary sinus: physiology, development and imaging anatomy. Dentomaxillofacial Radiology. 2019 Dec 1;48(8):20190205.

[3] Teke HY, Duran S, Canturk N, Canturk G. Determination of gender by measuring the size of the maxillary sinuses in computerized tomography scans. Surgical and radiologic anatomy. 2007 Feb;29:9-13.

[4] Mishra AP, Kumar K, Babu CR. Morphometric study of maxillary sinuses in normal subjects by using computed tomographic images. International Journal of Anatomy and Research. 2020;8(2.2):7505-9.

[5] 1984 Jan 1;118(2):122-8.

[6] Van Den Bergh JP, Ten Bruggenkate CM, Disch FJ, Tuinzing DB. Anatomical aspects of sinus floor elevations. Clinical Oral Implants Research: Treatment Rationale. 2000 Jun;11(3):256-65.

[7] Cordioli G, Mazzocco C, Schepers E, Brugnolo E, Majzoub Z. Maxillary sinus floor augmentation using bioactive glass granules and autogenous bone with simultaneous implant placement: clinical and histological findings. Clinical oral implants research. 2001 Jun;12(3):270-8.

[8] Degermenci M, Ertekin T, Ülger H, Acer N, Coskun A. The age-related development of maxillary sinus in children. Journal of Craniofacial Surgery. 2016 Jan 1;27(1):e38-44.

[9] Ariji Y, Kuroki T, Moriguchi S, Ariji E, Kanda S. Age changes in the volume of the human maxillary sinus: a study using computed tomography. Dentomaxillofacial radiology. 1994 Aug 1;23(3):163-8.

[10] Sonia Baweja SB, Asha Dixit AD, Saurabh Baweja SB. Study of age related changes of maxillary air sinus from its anteroposterior, transverse and vertical dimensions using Computerized Tomographic (CT) scan.

[11] Kiruba LN, Gupta C, Kumar S, Antony SD. A study of morphometric evaluation of the maxillary sinuses in normal subjects using computer tomography images. Archives of medicine and health sciences. 2014 Jan 1;2(1):12-5.

[12] Tambawala SS, Karjodkar FR, Sansare K, Prakash N. Sexual dimorphism of maxillary sinus using cone beam computed tomography. Egyptian journal of forensic sciences. 2016 Jun 1;6(2):120-5.

[13] ELAMIN AA, AcAr T, KAjoAK S, IDRIS SA, MALIK BA, AYAD CE. Volumetric Measurement of the Maxillary Sinuses in Normal Sudanese using Computed Tomography: A Retrospective Study. Journal of Clinical & Diagnostic Research. 2021 May 1;15(5).

[14] Souza AD, Rajagopal KV, Ankolekar VH, Souza AS, Kotian SR. Anatomy of maxillary sinus and its ostium: A radiological study using computed tomography. Chrismed journal of health and research. 2016 Jan 1;3(1):37-40.

[15] Brook I. Sinusitis of odontogenic origin. Otolaryngology—Head and Neck Surgery. 2006 Sep;135(3):349-55. Nimigean VR, Nimigean V, Maru N, Andressakis D, Balatsouras DG, Danielidis V. The maxillary sinus and its endodontic implications: clinical study and review. B ENT. 2006 Jan 1;4:167..