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Volumetric measurement of maxillary sinus volume by MDCT

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Abstract
Background: An in-depth knowledge of the physiology of the upper respiratory tract, as well as the developmental, clinical, and imaging anatomy of the maxillary sinus-in particular its relationship to the dentition, nose, and ethmoid and frontal sinuses-is necessary for appreciating the maxillary sinus's part in both health and disease. To this end, this study sought to validate MDCT as a volumetric tool for assessing maxillary sinus size.
Material and methods: The volume of the maxillary sinuses was evaluated by using MDCT in 140 patients. CT head pictures were viewed via DICOM viewing software, and an internal electronic calliper was used to measure the sinuses. The data was analysed using a t-test for independent samples and a discriminant function analysis.
Results: Over the course of this study, 140 adults took part. Right maxillary sinus mean estimated volumes ranged from 13.89 cm^3 in patients aged 18-30 years, 15.87 cm^3 in patients aged 31-40 years, 16.56 cm^3 in patients aged 41-50 years, 15.88 cm^3 in Patients aged 51-60 years, and 16.45 cm^3 in patients aged 60 and over. The mean value of estimated volumes of the right maxillary sinus was greatest in the age group 41–50, and lowest in the age group 18–30. Patients between the ages of 18 and 30 had left maxillary sinus volumes of 13.70 cm^3, those between 31 and 40 had 15.82 cm^3, those between 41 and 50 had 16.50 cm^3, those between 51 and 60 had 15.52 cm^3, and those above 60 had 15.90 cm^3. There was a significant difference between the estimated right maxillary sinus volumes for those aged 18-30 and those aged 41-50.
Conclusion: The present study concluded that MDCT volumetric analysis of maxillary sinus may be useful for identification of the paranasal sinuses and adjacent structures.

Keywords: Maxillary sinus, MDCT, volumetric measurement

Introduction
The paranasal sinuses that make up the maxillary sinuses are the largest in the head [1, 2]. The forensic medical field and the dentistry and maxillofacial fields may both benefit from an understanding of maxillary sinus anatomy. The maxillary sinuses begin to form in the third month of foetal development as an evagination of the epithelium of the lateral wall of the nasal fossa [3]. The volume of this pyramidal-shaped structure typically measures 15 cc, but this value may vary with age, gender, ethnicity, and tooth loss or absence [4, 5]. Different imaging methods have revolutionised dentistry and medical diagnosis in recent decades, and accurate identification of linear and volumetric measures of the maxillary sinus in a specific population is therapeutically important [6, 7]. The purpose of this study was to calculate the volumetric measurement of the maxillary sinus using cone beam computed tomography (CBCT), which has gained popularity in both clinical and research settings in dentistry since its introduction in 1998 [8]. CBCT represented a true revolution because it could provide accurate and distortion-free images of the craniofacial bones while consuming less radiation than multi slice computed tomography (MSCT) [9-11].

Material and Methods: The present study was descriptive observational study conducted among the 140 adult individuals selected from the OPD of Janaki Medical College Teaching Hospital, Tribhuvan University, Ramdaiya, Bhawadi, Dhanusha, Nepal. The time frame of the research was for one year, retrospectively from January 2021 to September 2021 & prospectively from October 2021 to December 2021. Institutional review board approval was obtained prior to research implementation.

Inclusion Criteria

Patients who present with headache or sinusitis symptoms, but who have a negative CT scan and no history of trauma.

Exclusion criteria

A patient with a history of maxillofacial surgery, a cleft palate, ectopic and supernumerary teeth, or a radiographic examination of the maxillary sinus revealing illness, trauma, facial asymmetry, or septal deviation.

Methodology

This research employed CT scans of 140 adults (aged 20-60) of both sexes. All of the people were scanned using a Toshiba (64 slice) Multi Detector Spiral Computed Tomography Scanner. Maxillary air sinus AP, breadth, and height measurements were all collected on the computer using the Electronic Caliper included in the DICOM viewer programme. With the use of a mathematical method, we were able to manually calculate the sizes of the maxillary sinuses. After obtaining many coronal and sagittal slices, the greatest value was determined. When comparing the right and left maxillary air sinuses, the following characteristics were recorded:

1. On a reconstructed Sagittal image, the antero-posterior dimension was calculated as the largest distance between the picture's front and back.
2. By measuring the vertical distance between the sinus ceiling and floor, the sinus height was calculated from a reconstructed coronal picture.
3. On a coronal reconstructed image, the transverse distance/width was calculated as the greatest perpendicular distance between the medial wall of the maxillary sinus and the tip of its lateral process.
4. By hand, we determined the volume of each maxillary air sinus by applying the following tried-and-true mathematical formula: (height breadth AP diameter 0.52) by taking the maximum measurements of each sinus and dividing by 0.52.

The statistics were run. Means, standard deviations, and t-values were calculated using the Independent sample t-test, and differences in parameter levels between males and females were compared using the F-test for equality of variances. The significance level used was 0.05.

Results

Over the course of this study, 140 adults took part. Right maxillary sinus mean estimated volumes ranged from 13.89 cm^3 in patients aged 18-30 years, 15.87 cm^3 in patients aged 31-40 years, 16.56 cm^3 in patients aged 41-50 years, 15.88 cm^3 in patients aged 51-60 years, and 16.45 cm^3 in patients aged 60 and over. The mean value of estimated volumes of the right maxillary sinus was greatest in the age group 41–50, and lowest in the age group 18–30. Patients between the ages of 18 and 30 had left maxillary sinus volumes of 13.70 cm^3, those between 31 and 40 had 15.82 cm^3, those between 41 and 50 had 16.50 cm^3, those between 51 and 60 had 15.52 cm^3, and those above 60 had 15.90 cm^3 (Table 1). There was a significant difference between the estimated right maxillary sinus volumes for those aged 18-30 and those aged 41-50.

Table 1: Right & left maxillary sinus of different age groups.

Age (yrs)	N	Mean of right maxillary sinus	Mean of left maxillary sinus
18-30	52	13.89	13.70
31-40	24	15.87	15.82
41-50	28	16.56	16.50
51-60	9	15.88	15.52
>60	27	16.45	15.90

Discussion

The maxillary sinus is a tricky anatomical feature that has significant clinical and linguistic ramifications. Thanks to recent developments in technology, we now have ways of seeing and describing this structure in three dimensions [12]. The initial CT investigations employed formulas and algorithms to analyse linear data and determine the equivalent volume; however, certain software used for their interpretation may be difficult or prohibitively costly depending on the degrees of accuracy needed [13].

Our values of 24.3 mm (SD = 3.8) and 35.5 mm (SD = 3.9) for transverse and anteroposterior widths, respectively, are comparable to those reported by Ariji *et al*. 1996 for their patient series, where they reported average transverse and anteroposterior widths of 27 mm (SD = 0.60) and 35.6 mm (SD = 0.47), respectively.

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Ariji *et al*. [14] reported a range of maxillary sinus volume from 4.56 cm3 to 35.21 cm^3, which is similar to the range we found in our research. Head CT images were utilised by Sahlstrand-Johnson *et al*. to determine the sizes of 120 maxillary and frontal sinuses. Maxillary sinus capacity was significantly higher (15.7 5.3 cm3) in men compared to females. Maxillary sinus volume was not correlated with either age or side, according to a statistical analysis [15].

For their study, Emirzeoglu *et al*. [16] analysed 77 coronal CT scan images from Turkish patients (38 females and 39 men) aged 18 to 72 years. They found that the maxillary sinus volumes of men and women differed significantly (Males: 19.86.3 cm^3; Females: 165.5 cm^3). Variances between male and female faces, particularly in the midface, may be attributable to differences in maxillary sinus volume [16].

Conclusion
As this study shown, MDCT volumetric examination of the maxillary sinus may be useful in detecting paranasal sinuses and adjacent tissues.

Conflict of Interest
Not available

Financial Support
Not available

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