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Research Article

VOLUMETRIC COMPARISON OF MAXILLARY SINUS BETWEEN GEOMETRIC MEASUREMENTS AND SOFTWARE CALCULATIONS- A PILOT STUDY

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ABSTRACT

Head and neck has complex anatomy and one of these complex anatomical structures are air sinuses that embryo logically develops from air cells. These sinuses are present in bone as bone cavities. Some of them surround the nasal cavity known as paranasal sinus. The paranasal sinuses are four paired air-filled cavities at the entrance of the upper airway. The maxillary sinus is one of paranasal sinuses situated within maxillary bone which enlarges with increasing age and fully developed after the eruption of permanent dentition. The aim of this study is to evaluate the difference in volume of maxillary sinuses measured by morphometric method and software method on Cone Beam Computed Tomography.

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INTRODUCTION

The development of the air cells is preceded by a formation of bone cavities and a physiological process related to periosteal activity that promotes the increase of the air cells. The skull has several cavities filled with air, which is called pneumatization. These pneumatic areas can arise at different locations and varies according to gender, age and sides in terms of size and shape.¹ It has been reported that the paranasal sinuses stay intact though the skull and other bones may be severely disfigured in victims who are incinerated and can be used for forensic identification.²

The volume determination of paranasal sinuses is important for forensic purpose, like determining the age of victims, as the sizes of paranasal sinuses are different in different age groups and also important for the gender determination as the volume of sinuses varies between males and females.³ The knowledge of volume variation of normal paranasal sinuses is also important to diagnose the presence or absence of pathology and also for pre-surgical evaluation in surgeries like maxillary sinus floor lifting. The maxillary sinus is one of paranasal sinuses present within maxillary bone. It has a quadrangular pyramid shape with base towards nasal wall and apex towards zygomatic complex.² The sinus is small at birth, but it is

radiographically identifiable. The maxillary sinus enlarges with the growing maxilla and fully developed after the eruption of permanent dentition.³ The use of imaging examination in legal matters has been described in forensic literature both in cases of lawsuits against health care professionals and in case of human identifications. Cone-beam computed tomography (CBCT) is an advanced radiographic imaging modality which has high clinical applications in dentistry that provides three dimensional representation of the maxillofacial structures with minimal distortion and least radiation exposure.

The aim of this pilot study is to evaluate the difference in volume of maxillary sinuses measured by morphometric method and volume measured by software using Cone Beam Computed Tomography.

MATERIALS AND METHOD

The CBCT examinations were made using a Kodak CS 9300 digital imaging system. For comparing the volume measured by morphometric and volumetric method 10 patients (5 males and 5 females) were included which were subjected to ONDEMAND3D App1.0.9.4138 software for calculations. The mid sagittal plane aligned perpendicular to the horizontal plane using vertical and horizontal alignment beams. The obtained

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DICOM (Digital Imaging and Communication in Medicine) images were converted into ONDEMAND3D App1.0.9.4138. Each volumetric record was stored properly with patients name, age and gender. Right and left volumetric measurements were taken for the ten patients.

1. Volume determination via segmentation technique using ONDEMAND3D software.(FIG-1)
2. Volume determination via geometric calculation method according to the geometrical equation: Volume of Pyramid= Base Surface Area × 1/3 Height.(FIG-2)

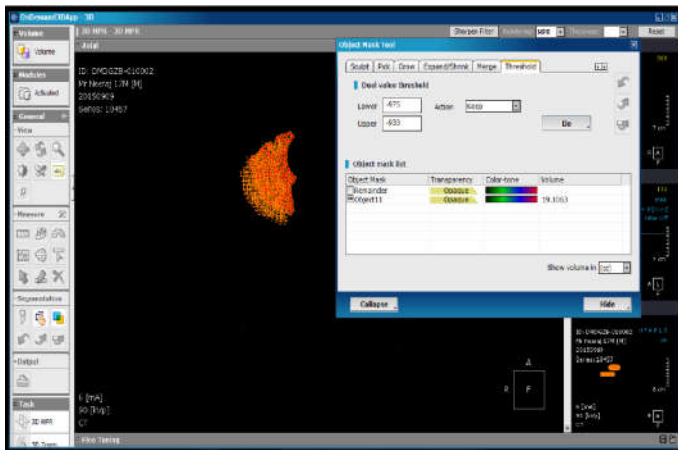


Fig 1 Volume determination via segmentation technique

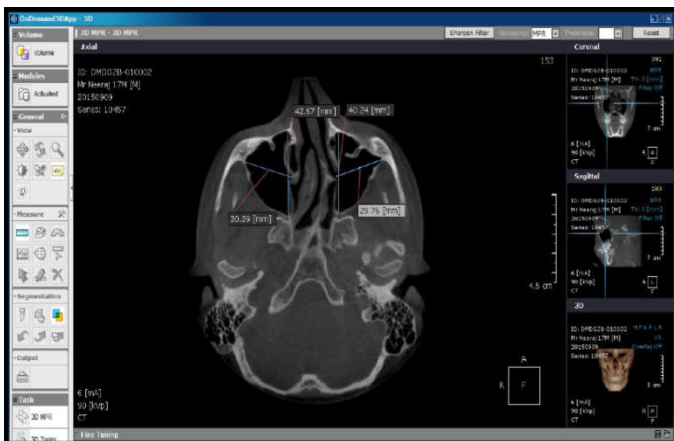


Fig 2 Volume determination via geometric calculation method

RESULTS

The mean total volume of maxillary sinus calculated by morphometric method and software method was 23359.29 mm³ (SD±10538.74mm³) and 23696.4 mm³ (SD±10430.56 mm³) respectively with significant correlation was found (p<0.001), but no statistical significant difference was detected (p= 0.412). The mean volume of left and right maxillary sinus calculated by morphometric method was 11664.75 mm³ (SD±5353.57 mm³) and 12156.55 mm³ (SD±5181.93 mm³) and software method was 11694.53 mm³ (SD±5283.47 mm³) and 11539.84 mm³(SD±5387.27 mm³) respectively, which was found to be highly significantly correlated (p<0.001). But the mean difference between morphometric method and software method was significant (p= 0.044) only at left side (table 1).

Table 1

Volume	No.	Mean	Std. Deviation	Correlation Value	p value	t value	p value
Left							
Morphometric max. sinus Volume	10	11664.7570	5353.57607	0.993	0.000	2.346	0.044
Left software calculated max. sinus volume	10	12156.5580	5181.93200				
Right							
Morphometric max. sinus Volume	10	11694.5360	5283.47928	0.989	0.000	0.626	0.547
Right software calculated max. sinus volume	10	11539.8490	5387.27858				
Total							
Morphometric max. sinus Volume	10	23359.2930	10538.74653	0.993	0.000	0.860	0.412
Total software calculated max. sinus volume	10	23696.4070	10430.56161				

DISCUSSION

The normal dimension and volume of the maxillary sinus is useful in treatment planning of sinuses diseases, evaluation of outcome and establishment of base line data for forensic purpose. Genetic diseases, environmental conditions and past infections may affect the developmental process and the resultant volume of the maxillary sinus.⁵

In our study the total volume measured by morphometric method was found to be positively significantly (P<0.001) correlated with total volume calculated by software method (correlation value ranges 0.98 to 0.99). But the mean difference was not statistical significant for total volume & right side except the volume difference at left side, which was found to be statistically significant (p=0.44). Johnson P *et al* (2011)⁶ also showed a good concordance between the manual and automatically calculated volume of the maxillary sinus with correlation coefficient ranging between 0.90 and 0.93.Hamdy RM *et al* (2014)⁷ showed 3D volumetric measurements of the maxillary sinus obtained for only five patients using the Simplant software which highly correlated (P<0.001) with the mathematically obtained volumes by the geometric calculation (correlation coefficient: 0.98 for the right and 0.96 for left side). These above studies were in accordance to our study.

CONCLUSION

The present study concluded that the there is good concordance between the manual and automatically calculated volume of the maxillary sinus. Hence CBCT provides an excellent method for examining maxillary sinus. CBCT measurements of maxillary sinus may be useful to support gender and age determination in forensic medicine.

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