CBCT Evaluation of Maxillary Sinus in Forensic Gender Determination

Tahreem Fathima, Devika S Pillai

Department of Oral medicine & Radiology, Saveetha Dental College, Saveetha Institute of Medical and Technical sciences, Chennai-600077, Tamil Nadu, India

ABSTRACT:

Introduction

Gender determination is a vital step towards identifying deceased individuals especially when the remains of said individuals are not detailed. Skeletal bones, especially the skull are more preferred for identification as they can be recovered rather undamaged. One of the key areas used for identification is maxillary sinuses as they are unique to every individual in terms of their anatomy and dimensions. Modalities like MRI, CT and CBCT are used to plot out the accurate dimensions of these structures.

The aim of this study is to evaluate the dimensional variation of the maxillary sinuses for gender determination by CBCT and to provide additional information to the existing literature.

Materials and methods

This retrospective analysis was done in the Department of Oral Medicine and Radiology in Saveetha Dental College and Hospital in India where CBCT data of 100 patients were collected from Carestream CS 3D 9600 software (50 males and 50 females). The CBCT scans were analysed for its volume in axial and sagittal sections. The data was tabulated in Microsoft Excel 2016 and later exported to SPSS and subjected to statistical analysis. The Chi-square test was employed with a level of significance set at $p<0.05$.

Results: The mean sinus width in males varied from 27.5 ± 1.56 whereas in females was 19.7 ± 4.95, the mean sinus height ranged from 35.12 ± 2.56 in males and 31.45 ± 3.17 in females

Conclusion: The study proposes the reliability, usability and accuracy of CBCT for evaluating maxillary sinus dimensions in the field of forensic science.

Introduction

Gender determination is a vital step towards exhibiting individuality of deceased individuals[1]. Skeletal remains help in identifying gender as the bones are last to perish after death[2,3]. The skull, pelvis, paranasal sinus, foramen magnum and mandibular ramus usually are 100% accurate[4,5]. The issue is that most of the time, these bones are recovered either in a fragmented state or the morphology is so altered due to external factors that using them as a basis of gender determination will lead to false results[6]. Maxillary sinuses[MS] are the only denser bones which are usually recovered intact [7].

The anatomy of MS is different for every individual in terms of dimensions and that change is subjective to age. This variation is vital in gender determination as the results are more reliable[8]. Modalities like Magnetic Resonance Imaging(MRI) and Computed Tomography(CT) are the gold standard to evaluate the anatomy of MS, given the complexity of the sinuses. But the cons of these modalities, namely high cost, restricted accessibility and dosage limits their usage. One other modality is Cone Beam Computed Tomography (CBCT) which is the preferred imaging modality which allows precise information of MS anatomy making it an ideal tool in forensic science[9].The introduction of CBCT has helped overcome these drawbacks. Not only can CBCT map out the entire anatomy of the MS, it can also help

visualize and provide precise information about teeth and surrounding complex anatomical structures, as it is characterized by rapid volumetric image acquisition with high resolution and low dose radiation level. These advantages of CBCT make it a reliable tool for sex determination in forensic medicine.

Most of the literature done on this topic involved the analysis of MS using CT scans. Very few studies focus on the use of CBCT on the analysis of MS on the South Indian population. On the basis of this background, this study was done to evaluate the dimensional variation of the maxillary sinuses for gender determination by CBCT and to provide additional information to the existing literature.

MATERIALS AND METHODS

A retrospective study was carried out in the Department of Oral Medicine and Radiology in Saveetha dental college and hospital in India. The present study is an institution based study carried out within a time frame of (July-December 2019). The sample size estimation was done by using Raosoft software and the sample consisted of 100 patients (50 males and 50 females). All the selected patients were informed about the study and voluntary informed written consent was obtained from them. The patients were divided into two groups, group A consisted, CBCT of males and group B consisted, CBCT of females. Data was collected through clinical reports and the data collected was analyzed using SPSS software version 23.0. Independent Student's t-test, ANOVA, and chi square test were performed. p<0.05 was considered statistically significant.

ETHICAL APPROVAL:

The ethical approval was obtained from the institutional ethics committee.

STUDY POPULATION

The study population included patients who reported to Saveetha Dental College

- Inclusion criteria- Subjects that fall within the age group of 20 – 60 years with full permanent dentition, high quality reconstructed images were considered under the inclusion criteria
- Exclusion criteria- Maxillary sinus pathology like cyst or tumors, any previous history of surgery, orthognathic surgery/fractures

involving maxillary bone and documented craniofacial anomaly were excluded from the study.

DATA COLLECTION

The data for this study was taken by analyzing the patient records from Saveetha Dental College in Chennai. A total sample of 300 patients was taken out of which only 250 patients met the inclusion criteria. These patients belonged to group A being males and the other females. Repeated patient records and incomplete data were excluded. Data was reviewed by an external reviewer.

STATISTICAL ANALYSIS

Data were recorded in Microsoft Excel 2016 (Microsoft office 10) and later exported to SPSS (Statistical Package for Social Science for Windows Versions, 20.0, SPSS Inc, (Chicago IU, USA)) and subjected to statistical analysis. The Chi-square test was employed with a level of significance set at p<0.05.
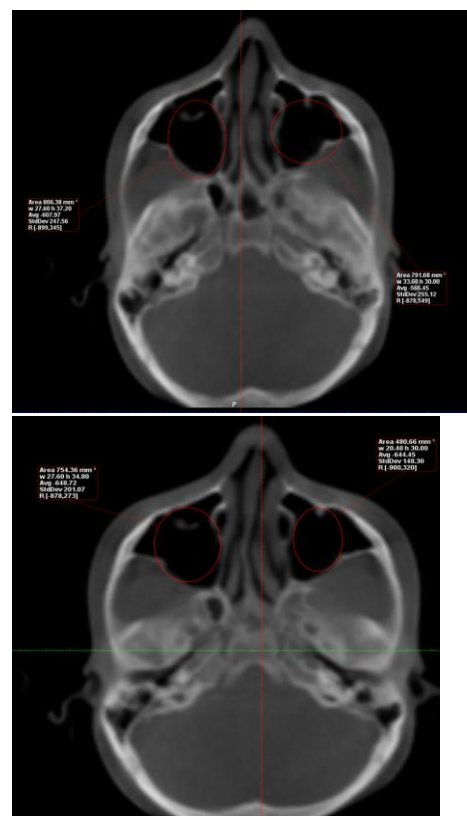
RESULTS & DISCUSSION
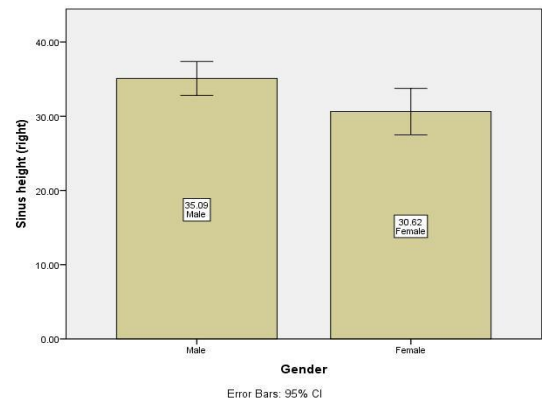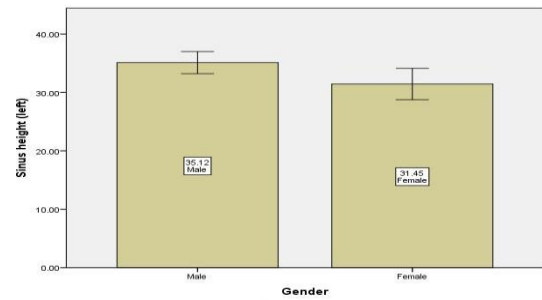

**Figure 1: shows the Width and height of a male cbct**
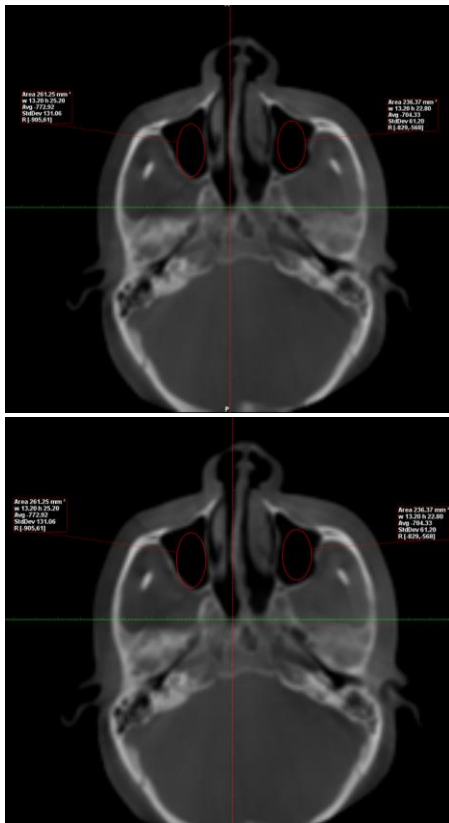
Figure 2: depicts width and height of a female cbct

Gender		Sinus_width_left	Sinus_width_right	Sinus_height_left	Sinus_height_right
Male	Mean	27.5100	29.3600	35.1200	35.0900
	N	10	10	10	10
	Std. Deviation	1.56024	4.40762	2.65447	3.19633
Female	Mean	19.7900	21.2800	31.4500	30.6200
	N	10	10	10	10
	Std. Deviation	4.95927	5.25543	3.76039	4.38553
Total	Mean	23.6500	25.3200	33.2850	32.8550
	N	20	20	20	20
	Std. Deviation	5.33731	6.28219	3.68514	4.38268
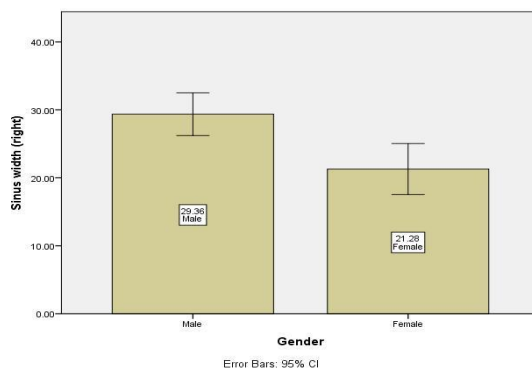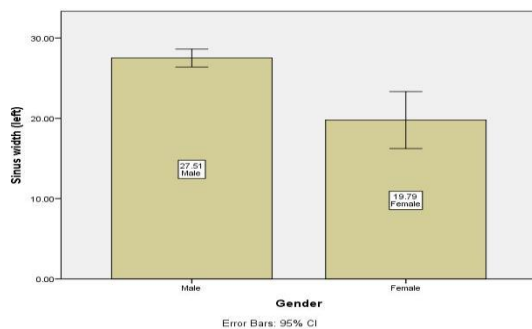
DISCUSSION

Gender determination using human skeletal remains is an important step in forensic profile considering that the evidence relating to the deceased individual is not extensive. The emphasis of using skeletal bones for gender identification is solely focused on maxillary sinuses as they can be recovered rather unharmed [10]. After birth, the maxillary sinus continues to pneumatice into the developing alveolar ridge as the permanent teeth erupt which ends at the age of 20 when the eruption of the third molars is completed. It has been stated that genetic diseases, post infections and environmental factors can disturb the sizes of maxillary sinus [10–12]. Considering this factor the patients with disease conditions were excluded from the study.

The present study was designed to determine the reliability and accuracy of measuring Maxillary Sinus dimensions as a method for gender identification using CBCT on 100 patients. The results showed that the maxillary sinus exhibits anatomic variability between genders. A significant sex difference was found in relation to maxillary sinus dimensions with respect to following parameters such as width, length, height, and bizygomatic distance. The values of males were relatively greater than values of females. Within the males, left side width and depth were greater compared to the right side while in females, left side width, depth, height were greater compared to the right side. For these two explanations can be given. First, males need to have correspondingly bigger lungs to support relatively massive body muscles and organs [13]. Second, males need larger nasal cavity complex as a direct result of respiration related needs such as warming and humidifying air [14]. The maxillary sinus height depicted 70% of original grouped cases could be correctly classified as females and 80% of original grouped cases could be correctly classified as males. The mean bizygomatic distance was significantly higher in males (94.88 mm) than females (89.23 mm). In our study, the maxillary sinus height and bizygomatic distance showed relatively better discrimination to study sexual dimorphism.

Our study was in accordance with a study carried out by Doaa A El Baz et al. in 2019, where, in assessing maxillary sinus dimensions in a sample population of Egypt by CBCT, they found that all maxillary sinus parameters showed higher mean value in males when compared to females. Our study was comparable with study carried out by Dr. Cristalle Soman in 2019 in Saudi population by the use of Cone Beam Computed Tomography (CBCT) for evaluating gender through maxillary sinus.

According to study conducted by Uthman et al. in 2011 and Tambawala SS et al., maxillary sinus height was the best discriminate parameter that could be used to study sexual dimorphism with overall accuracy of 71.6%. Attia et al. in 2012, evaluated maxillary sinus dimensions, and concluded that the right height was a valuable tool in studying the sexual dimorphism with overall accuracy 69.9%.

CONCLUSION

Gender determination plays a key role in forensic medicine and to conclude, this study shows that the maxillary sinus height are the most reliable discriminant parameter that could be used for the purpose of gender discrimination. The study also proposes the reliability, usability and accuracy of CBCT for evaluating maxillary sinus dimensions in the field of forensic science. This research work could thus prove vital in recognizing the gender of a person in forensic anthropology. The results of the present work showed all the parameters of maxillary sinus had highly significant difference between males and females. Males had higher value when compared to females. Maxillary sinus height were better discriminant parameters for sexual dimorphism. The results of the present work showed that the MS exhibits anatomic variability between genders, as female group showed statistically significant higher values for left side MS width. CBCT provides an excellent and reliable tool for analyzing maxillary sinus dimensions.

CONFLICTS OF INTEREST:

The authors declare no potential conflict of interest

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