Role of Maxillary sinus in Gender Determination: A morphometric analysis using lateral Cephalogram

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ABSTRACT

Background: Radiography plays a key role in forensics for the identification of humans especially in cases where the body is decomposed, fragmented, or burned. Radiography can help in giving accurate dimensions with the help of using certain formulae which can be applied for gender determination. It is reported in literature that maxillary sinuses remain intact, although the skull and other bones may be badly disfigured in victims who are incinerated and therefore, that maxillary sinuses can be used for identification of gender and age.

Aim: This study has been carried out to check the accuracy and reliability of maxillary sinus in gender determination using morphometric parameters.

Materials and Methods: Lateral cephalogram of 50 subjects (25 males and 25 females) were taken and morphometric parameters of maxillary sinus were analyzed using CS Imaging Version (8.0.20) software.

Results: The mean area and perimeter of maxillary sinus in males was 1.7261 cm^2 and 5.2885 cm whereas, the mean area and perimeter in females was 1.3424 cm^2 and 4.3901 cm.

Conclusion: It can be concluded that morphometric analysis (area and perimeter) of maxillary sinus using CS Imaging Version (8.0.20) software which can assist in gender determination.

Key words: Maxillary sinus Forensic odontology, Morphometric analysis, Sex determination.
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Introduction

Identification of decomposed bodies and corpses is a difficult forensic procedure and it is dictated laws and social rules.[1] The study of anthropometric characteristics is of fundamental importance to solve problems related to identification. Skeletal remains have been used for sexing the individual as bones of the body are last to perish after death, next to enamel of teeth.[2] Since an era radiology has been limited applications in identification, in the field of forensic medicine. The most helpful area of the body for comparison radiography is the cranium.[3] Radiography is used in forensic pathology for the identification of humans especially in cases where the body is decomposed, fragmented or burned. The skull, pelvis and femoral are the most useful for the radiological determination of gender.[2] the Maxillary sinuses remain intact although the skull and other bones may be badly disfigured in victims who are incinerated and therefore, that maxillary sinuses can be used for identification.[1] During fatal development, the paranasal sinuses originate as invagination of the nasal mucosa into the lateral nasal wall, frontal, ethmoid, maxilla and the sphenoid bones. This unique development explains the enormous amount of anatomical variation.[4]

Maxillary sinuses can be defined as two spaces, which are filled with air, located in the

maxillary bone and can be in various sizes and shapes. They have thin walls and their apex can extend into the zygomatic process and can occupy the zygomatic bone. The floor formed by the alveolar process, the first, second and third molars and the roots of the canines which may elevate the sinuses or may perforate their floor.[1]

The maxillary sinus is the largest of the paranasal sinuses and at 10 weeks in utero, is the first to develop. After birth, the sinus continues to pneumatise into the developing alveolar ridge as the permanent teeth erupt. At 12-13 years of age, the sinus floor is at level with the nasal floor and at the age 20, with the completion of the eruption of the third molars, the pneumatization of the sinus ends and the sinus reaches 5 mm inferior to the nasal floor.[5]

The genetic diseases, post infections and environmental factors can affect the sizes of maxillary sinuses. Szilvassy has divided the maxillary sinuses into four bases according to their shapes: i.e., triangular, leaf, scapular and renal shaped. It has been reported that triangular sinuses were the most common in both females and males. Maxillary sinuses have also been classified into triangular, oval, curved, rectangular and square shapes.[1]

The present study was designed to determine the reliability and accuracy of maxillary sinus (area and perimeter measurement) as a technique for gender identification using morphometric analysis in Kanpur City.

Material and Methods

The present study was carried out in the Department of Oral Medicine and Radiology Rama Dental College Hospital & Research Centre after required approval from the institutional ethical committee. The study group comprises of 50 subjects (25 males and 25 females) above the age group of 18 years. Healthy subjects were enrolled randomly attending out-patient department and informed consent was obtained. A patient-specific data was recorded in a questionnaire form for social history, general history; dental history and oral hygiene.

Those subjects with the history of facial trauma, fracture of maxillary sinus, congenital developmental abnormalities, sinusitis and cleft palate were excluded from the study.

Digital Lateral cephalogram radiographs were obtained using standard techniques with cephalometric device for extra-oral radiography set at 85 kvp and 10 mA. Area and perimeter of maxillary sinus was measured by marking the outer borders of maxillary sinus with CS Imaging Version (8.0.20) software on the lateral cephalogram [Figure 1].

Data collected was entered in excel sheet using Windows 7 version and was compiled and prepared to be compatible for the statistical SPSS software. Data analysis was explained under descriptive statistics and inferential statistics. For descriptive statistics frequencies were obtained for all the categorical variables. Although mean, standard deviation, variance and standard error values were calculated for all the numerical variables wherever needed.

Figure 1: Measuring area and perimeter of maxillary sinus by CS Imaging Version (8.0.20) software on the lateral cephalogram.

Results

The area and the perimeter were calculated from the CS Imaging Version (8.0.20) software. The mean area in males was 1.7261 cm^2 with a standard deviation of 0.2364 and in females was 1.3424 cm^2 with a standard deviation of 0.2369. The mean perimeter in males was 5.2885 cm, whereas the mean perimeter in females was 4.3901 cm [Table 1]. Hence, showing males have a larger area and perimeter when compared with females.

Sex	Mean	Range	Standard Deviation	Standard Error of Mean	Variance
Male Area (cm^2) Perimeter (cm)	 1.7263 5.2887	 0.9760 2.7517	 0.2365 0.5702	 0.0475 0.1142	 0.0557 0.3253
Female Area (cm^2) Perimeter (cm)	 1.3425 4.3901	 1.1675 2.5923	 0.2368 0.7523	 0.0473 0.1506	 0.0561 0.5757

Table 1: Descriptive statistics of maxillary sinus in males and females.

Discussion

Identification on skeletal and decomposing human remains is one of the most challenging skills in forensic medicine. Gender determination is also an important problem which faced during identification from skeletal remains. When the skeleton exists completely, sex can be determined with 100% accuracy. This estimation rate is 98% in existence of pelvis and cranium, 95% with only pelvis and long bones and 80-90% with only long bones. Next to the pelvis, the skull is the most easily sexed portion of the skeleton, but the determination of sex from the skull is not reliable well until after puberty. Sex estimation can be accomplished using either morphological or metric methodologies.[1]

The result of the present study showed that the maxillary sinus exhibits anatomic variability between genders. A significant sex difference was found in relation to maxillary sinus area and perimeter with the mean area in males as 1.7261 cm^2 and mean perimeter as 5.2885 cm whereas, the mean area in females as 1.3424 cm^2 and mean perimeter as 4.3901 cm. Hence, showing males have a larger area and perimeter as compared to females.

Kim, conducted a study on 561 subjects (363 males and 198 females) using PA view and lateral cephalogram. Manual linear measurements were done using a mathematical formula and the area was calculated. Their results showed right and left sinus size was almost equal with males having larger size when compared to females.[6]

Fernandes et al. conducted a study on dried skulls on 53 subjects (13 males; 13 females, European); (13 males; 14 females, Zulu) using neural network and linear measurements and estimated volume. Ethnic and gender variations were found in the different groups and the predictive role of the maxillary sinus in ethnic classification was established. They found that European crania had significantly larger antral volumes than Zulu crania and males had larger volumes than females. Dimensions of European sinuses were larger than those of Zulu sinuses. The medial antral wall of the sinus allowed for ethnic classification. The discriminant analysis allowed for a very successful 90% ethnic prediction, while gender prediction was ultimately 79%.[3]

Uthman et al. also conducted a study to check the accuracy and reliability of maxillary sinus

dimensions measurement in gender classification through the use of reconstructed helical computed tomography (CT) images. A total of 88 patients, of these 43 were men and 45 were women with age range from 20 to 49 years were selected in this study. The width, length and height of the maxillary sinuses in addition to the total distance across both sinuses were measured and found that maxillary sinus height was the best discriminants parameter that could be used to study sexual dimorphism with an overall accuracy of 71.6%, 74.4% of male sinuses and 73.3% of female sinuses were sexed correctly. The overall percentage for sexing maxillary sinuses correctly was 3.9%. It was concluded that reconstructed CT image could provide valuable measurements for maxillary sinuses and could be used for sexing when other methods of sexing are not conclusive.[2]

Amusa et al. conducted a study on 24 dried skulls of Nigerians from which the temporal bones had earlier been dissected were studied. A 0° sinus endoscopy (Telescope) was utilized to visualize the paranasal sinuses and their degree of pneumatization was noted. Vernier caliper was employed to measure the distance between the anterior and posterior nasal spine. The height, width, depth and volume of each of the sinuses were determined. The anatomical variants were noted. In all the paranasal sinuses, the right side was found to be larger than the left except for the maxillary sinus where the left side was found to be larger.[4]

The present study was in consistent with the other studies; males have larger maxillary sinus when compared with females.

Conclusion

Gender determination is an important step in identification in forensic medicine. Maxillary sinus dimensions measurements are valuable in studying sexual dimorphism. As the maxillary sinus tends to stabilize after second decade of life and the radiographic images could provide adequate measurements for maxillary sinuses that cannot be approached by other means. Hence, morphometric analysis of maxillary sinuses can assist in gender determination. However, this is a preliminary study further studies on large sample size is desirable.

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