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Original Research

Lateral cepahalogram- A tool for gender determination using maxillary sinus

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ABSTRACT:
Introduction: The study of anthropometric characteristics is of fundamental importance to solve problems related to criminal cases, mass disasters, and in other forensic concerns. Maxillary sinuses are two air filled spaces located in the maxillary bone.Sinus radiography has been used for identification of skeletal remains and determination of gender. **Aim and objective**: The aim and objective of the present study is to establish the reliability of maxillary sinus dimensions for gender determination using lateral cephalogram. **Material And Methods:** A total of 40 lateral cephalograms of healthy subjects belonging to both genders (20 males and 20 females) were involved in this retrospective study by simple random sampling.All radiographs were interpreted and the maxillary sinus height and width were measured using Newtom software. The maxillary sinus index (MSI) was calculated as follows: MSI = maxillary sinus width/height,discriminant function analysis performed, and discriminant equation derived for determination of gender. **Results**:The mean maxillary sinus height was found to be significantly higher in males, whereas the maxillary sinus index was significantly higher in females. The discriminant function analysis derived in the study was able to differentiate the sex groups with sensitivity of 90% and specificity of 75%. **Conclusion**: The morphometric analysis of maxillary sinus can be used as a reliable tool in gender determination.

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INTRODUCTION

Individual identification is a subtle concept and often one of the most important priorities in mass disasters, road accidents, air crashes, fires, and even in the investigation of criminal cases. Matching specific features detected on the cadaver with data recorded during the life of an individual is an important aspect in forensics, and can be performed by fingerprint analysis, deoxyribonucleic acid matching, anthropological methods, radiological methods and other techniques which can facilitate age and sex identification. Sinus radiography is one such method that has been used for determination of the sex of an individual by using different dimensions of the maxillary sinus.[1]

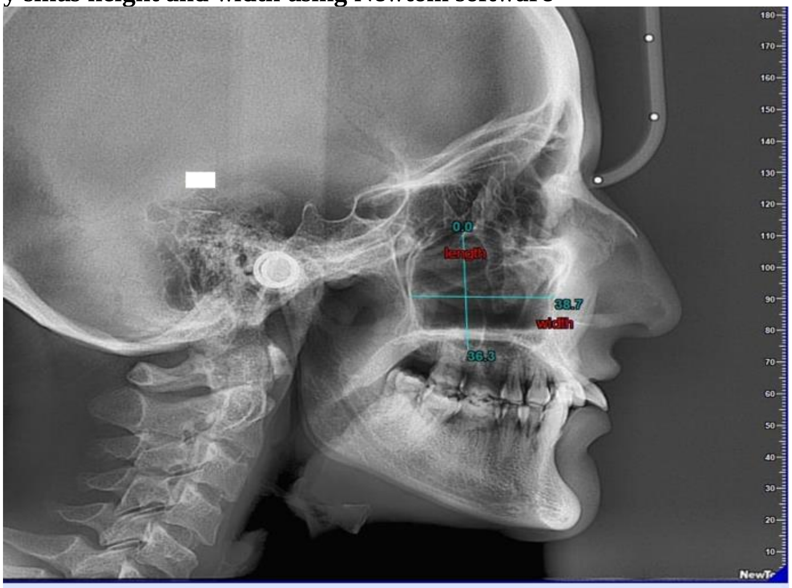
The maxillary sinus is a bilateral pyramidal-shaped pneumatic chamber that has the largest volume compared to other sinuses. Located in the upper jaw and opens in the lateral wall of the nose.[2] The maxillary sinus anatomy is important in forensic odontology examination procedures. Sinus growth begins about three months in foetal development as epithelial migration from the lateral wall of the nasal fossa. Postnatal maxillary sinus growth, according to the current literature, occurs mainly during the first three years of life and between 7-12 years. Adult growth occurs between 12-15 years.[3]Sinus radiography has been used for identification of skeletal remains and determination of gender. There are various imaging modalities varying from conventional techniques such as water’s view and lateral cephalogram to advanced technologies including computed tomography and cone beam computed tomography. Lateral cephalogram plays a predominant role providing architectural and morphological details of the skull, thereby revealing supplementary characteristics and multiple points for comparison. Various researchers have alleged this conventional radiograph as cost effective, easily available, and reliable in providing accuracy of 80–100%.[4]

On the basis of this background, this study was done to evaluate the dimensional variation of the maxillary sinuses for gender determination by lateral cephalogram.

MATERIAL AND METHODS

This retrospective study was done on 40 subjects belonging to both genders (20 males and 20 females) of age group 25–55 years using Lateral Cephalogram which were taken using New- Tom Vgi Scanner (QrSrl; Verona, Italy) in Standard Resolution Mode(Tube Potential :50- 85kvp), Tube Current :12mA, And Time :14 Sec. Subjects with history of facial trauma, fracture of maxillary sinus, congenital developmental abnormalities, and any maxillary sinus pathology were excluded from the study.Radiographs were taken from the department records, were interpreted and the maxillary sinus height and width was measured. The following variables were measured using Newtom digital software as shown in (figure 1). The maxillary sinus index (MSI) was calculated as follows: MSI = maxillary sinus width/height. The measurements obtained were recorded and entered in the proforma specially designed for the study.

Figure 1: Maxillary sinus height and width using Newtom software



STATISTICAL METHODS

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as Mean±SD and categorical variables were summarized as frequencies and percentages. Student's independent t-test was employed for comparing height, weight and Maxillary sinus index (MSI) between males and females. Discriminant analysis was done using gender as a grouping variable and MSI as an independent variable. A P-value of less than 0.05 was considered statistically significant.

RESULTS

A retrospective study was conducted to determine the gender of individuals using maxillary sinus parameters on 40 lateral cephalogram radiographs In the present study, out of 40 lateral cephalogram radiographs 20 were of males and 20 belong to females.

Table 1: Comparison of maxillary sinus height, width, and MSI in males and females

Parameter	Males		Females		P-value
	Mean	SD	Mean	SD	
Height	32.6	3.41	30.8	2.29	0.021*
Width	36.7	3.14	35.1	3.01	0.116
Maxillary sinus index (MSI)	1.12	0.082	1.24	0.054	<0.001*

***Statistically Significant Difference (P-value<0.05)**

Table 1 depicts the mean maxillary sinus height which was found to be 32.6 mm in males and 30.8 mm in females and it was statistically significant with *p* value of 0.021. The mean maxillary sinus width was 36.7 mm in males and 35.1 mm in females which was statistically non-significant with *p* value of 0.116. The mean MSI was higher in females (1.24) when compared with males (1.12) with statistically significant p value of <0.001

Table 2: Calculation of the discriminant equation and discriminant score (D)			
	Males	Females	
Function at group centroids	-0.815	0.815	Classified as male if D < 0
			Classified as female if D > 0
Discriminant equation: ($D = 14.301 * MSI - 16.851$)			

Table 2 shows that obtaining of discriminant equation as follows: ($D = 14.301 * MSI - 16.851$) using gender as a grouping variable and MSI as an independent variable. This equation calculated "D" which aided in prediction of gender by substituting the values of specific measurements (MSI) in the equation. A greater calculated D ($D > 0$) indicated female gender, while D value less than the reference value ($D < 0$) indicated male gender. The more extreme the calculated D value from the cut-off value, the higher the probability that the predicted gender is correct.

Table 3: Discriminant analysis showing sensitivity of 90% and specificity of 75%				
	Gender	Predicted group		Total
		Male	Female	
Original count	Male	15	5	20
	Female	2	18	20
%age	Male	75	25	100
	Female	10	90	100

In table 3 the obtained determinant equation was applied to the study sample, Discriminant analysis was done and revealed that 15 out of 20 were correctly identified as males and 18 out of 20 as females with sensitivity of 90% and specificity of 75%.

DISCUSSION

Identification from remnants of human skeletons is a significant forensic procedure. Determination of age and gender is an essential part of identification. Gender determination is certainly significant for identification. It has been stated that the precision rate of gender determination is 100% from a skeleton, 98% from both the pelvis and the skull, 95% from the pelvis only or the pelvis and the long bones, 90-95% from both the skull and the long bones, and 80-90% from the long bones only.[5]It is said that the skeleton, next to the enamel of the teeth, provides important information in the identification of gender, as it is last to decompose after death.[6] Though certain skeletal components, like the pelvis and sternum, are widely used in gender determination, these are some- times recovered in a fragmented or incomplete state.[7]In such cases, it is imperative to use for forensic purposes alternate areas of the skeleton, like the maxilla, since they are reported to remain intact, irrespective of the severe destruction of the skull and other bones, and can be used for identification of victims.[8,9]

Gender can be determined by various methodologies such as sexual dimorphism with tooth morphology, pulpal DNA analysis, study of lip prints, palatal rugae, and finger prints and even with radiological techniques by morphometric analysis of paranasal sinuses.[1]During adulthood, the shape and size of the maxillary sinus change especially due to loss of teeth**.** After the maximum growth period, the volume of the maxillary sinus decreases in both genders. This is attributed to the fact that the loss of minerals in the bone matrix of the entire body structure surrounding the maxillary sinus in all directions contracts the maxillary sinus and results in decrease in the maxillary sinus volume.[10]Radiographic images provide adequate measurements for maxillary sinuses that cannot be approached by other means.[4]

Similar studies conducted by Tanya Khaitan in (2017) about gender determination using maxillary sinus dimensions showed the mean maxillary sinus height and width were found to be higher in males, whereas the maxillary sinus index was greater in females.[4]Teke et al. (2007) established the accuracy of gender determination of 69.4% in females and 69.2% in males.[8] Uthman et al. (2011) concluded that 74.4% of male sinuses and 73.3% of female sinuses were sexed correctly and the overall percentage for sexing maxillary sinuses correctly was 73.9%.[11] Fernandes in (2004) about gender determination from measurement of the maxillary sinuses showed that the maxillary sinus was larger in males than in females with an accuracy rate of 79.0%.[12]Chandra et al. (2014) established the accuracy and reliability of maxillary sinus in gender determination using morphometric parameters (area and perimeter), using lateral cephalogram. The correct predictive accuracy was found to be 70.8% in males and 62.5% in females.[13]Vidya et al. (2013) studied the height, length, width, and volume of maxillary sinuses of 30 dry skulls of south Indian origin and stated that the measurements and volume of maxillary sinus of males were slightly more.[14] Kanthem et al. (2015) found that the dimensions and volume of maxillary sinuses of right and left side using computed tomography were markedly larger in males compared with females.[1] All the results of the aforementioned studies were nearly analogous to the present study.

CONCLUSION

Lateral cephalometry, a two-dimensional conventional radiographic technique, readily available, inexpensive, permits a good assessment of the soft tissue elements that defines the paranasal sinuses and their surrounding structures. Therefore, assessment of sexual dimorphism by the morphometric analysis of maxillary sinus has been proved to be a valuable tool. By using maxillary sinus index, it can add to the accuracy of assessment of sex of an individual. However, in our study the sample size was very less, so further studies are desirable on large sample size in the future.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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