ORIGINAL RESEARCH PAPER
Volume-9 | Issue-1 | January-2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

GENDER DETERMINATION USING MAXILLARY SINUS INDEX ON LATERAL CEPHALOGRAMS – A RETROSPECTIVE STUDY

Radiology

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ABSTRACT

Gender determination from unidentified human remains is an important procedure in forensic medico-legal investigations. Sinus radiographs can be used for the identification of gender. The aim of the present study was to determine gender using maxillary sinus index from lateral cephalograms and also to evaluate the reliability of this technique. Methodology: 100 digital lateral cephalograms (50 males and 50 females) were obtained from previous data of patients with age ranging between 20-50 years. The width, height and maxillary sinus index were calculated and gender was determined using discriminant function analysis. Results: The mean maxillary sinus height, width and index were greater among males than females and the accuracy of maxillary sinus measurements to identify males was 84.0% and females was 74.0%.
CONCLUSION: The morphometric analysis of maxillary sinus can be used as a reliable tool in gender determination.

KEYWORDS

Gender Detemination, Maxillary Sinus Index, Discriminant Function Analysis

INTRODUCTION:

Identification of a person is an important part of mass disasters, road accidents and investigations of criminal cases (1). It is a difficult procedure mandated by the laws and social rules (2).In order to conduct personal identification appropriately, study of anthropometric characteristics of skull is of fundamental importance (2, 3).Among human bones, skull is the most easily sexed portion of skeleton (1). The first and foremost step in identification of individual from dead or mutilated bodies or skeletal remains is gender determination (4).

Radiography of paranasal sinuses has been previously extensively studied and proven to be an extremely helpful aid in gender determination (1). It has been of immense assistance in the identification of human bodies that are easily decomposed or disfigured (5). Paranasal sinuses are complex anatomical structures with significant inter-individual variation. During fetal development, maxillary sinus originates as an invagination of the nasal mucosa into the lateral nasal wall, frontal, ethmoid and sphenoid bones, and is the largest of the paranasal sinuses formed by two air filled spaces, located in the maxillary bone(2). Maxillary sinus is considered to be a potent marker in the personal identification due to its uniqueness and highly individualistic nature (6).

Among various imaging modalities, lateral cephalograms plays a predominant role in providing architectural and morphological details of skull, thereby revealing supplementary characters and multiple points for comparison (1).Considering the easy availability, cost effectiveness and reliability in providing accuracy of 80 -100% of lateral cephalograms (1,7). The following study was designed for gender determination using maxillary sinus index on lateral cephalograms and to evaluate the reliability of this technique and its discriminant function analysis.

MATERIALS AND METHODS:

The present retrospective cross-sectional study was conducted at Sri Sai College of Dental Surgery, Vikarabad, Telangana in the Department of oral medicine and radiology. 100 lateral cephalograms were obtained from the previous data of patients with age group ranging between 20 - 50 years, and consisting of 50 females and 50 males, and maxillary sinus index was calculated for each one of the radiograph.

INCLUSION CRITERIA:

Good quality digital lateral cephalograms of 50 female patients and 50 male patients ranging between ages of 20 – 50 years.

EXCLUSION CRITERIA:

Lateral cephalograms with maxillary sinus abnormalities like congenital developmental abnormalities, agenesis, sinusitis, mucocele, abnormally enlarged sinus, fracture of sinus, history of surgery in anatomical areas of interest, excessive artifacts, cleft palate, facial trauma, maxillary sinus pathology. Lateral cephalograms of patients less than 20 years and greater than 70 years were excluded.

METHODOLOGY:

All the radiographs were interpreted and sinus analyses were done by using Care Stream Dental Imaging software. The maxillary sinus height, width were evaluated by a radiologist on all lateral cephalograms. The maxillary sinus width was measured from most anterior to most posterior point. The maxillary sinus height was measured from most Superior to the most Inferior point. The ratio of maxillary sinus width to height is taken as Maxillary sinus index (MSI). All measured values of maxillary sinus height, width and MSI were analyzed with IBM.SPSS Statistics Software 23.0 Version.

STATISTICAL ANALYSIS:

The mean values of maxillary sinus height, maxillary sinus width and maxillary sinus index (MSI) among females and males, were done using unpaired t test. Discriminant function analysis was performed for determination of gender and discriminant equation was also derived with gender as classifying variable and MSI as an independent variable. The discriminant scores (D) thus obtained were recorded and gender differentiation was done accordingly. The probability value 0.05 considered as significant level in above both statistical tools.

RESULTS:

In the present retrospective study consisting of lateral cephalograms of 50 males and 50 females, the mean age of males was 30.40 and females was 25.68.

MAXILLARY SINUS HEIGHT (M-H):

The maximum M-H for males was 32.46 and for females was 30.60 and the minimum M-H for males was 25.56 and for females was 25.18. The mean value for the M-H recorded for males was 29.01 and for

females was 27.89 as shown in (Fig 1). On statistical analysis, the maxillary sinus height was greater among males than females and was statistically non-significant with p values 0.73 (Table1).

MAXILLARY SINUS WIDTH (M-W):

The maximum M-W for males was 40.03 and for females was 37.78 and the minimum M-W for males was 33.59 and for females was 30.24. The mean value for the M-W recorded for males was 36.81 and for females was 34.01 (Fig 2). On statistical analysis, the maxillary sinus width was greater among males than females with statistically highly significant p value of 0.0005 (Table 1).

MAXILLARY SINUS INDEX (MSI):

The ratio of maxillary sinus width to height is taken as Maxillary sinus index (MSI). The maximum MSI for males was 1.39 and for females was 1.32 and the minimum MSI for males was 1.17 and for females was 1.12. The mean value for the MSI recorded for males was 1.28 and for females was 1.22(Fig 3). On statistical analysis, the MSI was greater among males than females with statistically highly significant p value of 0.0005 (Table 1).

In the present study, the lowest value was presented by maxillary sinus width (MW) which is comparatively the better indicator for sex determination among all the variables. The Discriminant Equation for maxillary sinus index (MSI) is as follows: D = 11.509 - 8.871 X MSI. By substituting the specific values, these equations are helpful to calculate the D values for gender determination. If the calculated D value is closer to -0.802 indicate males, whereas if D value is closer to + 0.802 indicates females. The determinant equations were applied to the present study sample and revealed 74.0 % females and 84.0 % males were correctly evaluated with a total accuracy of 79.0 % in gender determination.

DISCUSSION:

One of the most significant procedures in forensic medicine is to identify an individual using skeletal remains and the first and foremost step in identification is gender determination. The accuracy of sexual dimorphism reported for skeleton is 100% followed by 95% for pelvis (7, 8). Lateral cephalograms play an important role in the assessment of craniofacial measurements as it is easily reproducible, cost effective, readily available, and provides accuracy of 80 - 100% in depicting the morphological and architectural details of the skull (1,7). The ratios were considered to overcome the shortcomings of lateral cephalograms like maxillary sinus index which is the ratio of maxillary sinus width to height (9).

Paranasal sinuses play a major role in the identification of a person. Of all the paranasal sinuses, the largest is the maxillary sinus and is the first to develop. It continues to pneumatize till the third molars erupt and approaches 5 mm inferior to the nasal floor. After the maximum growth period of maxillary sinus it decreases in volume due to loss of minerals in the bone matrix (1).

In the present study, the mean values of height and width of maxillary sinus were significantly greater in males than in females. The mean value of maxillary sinus index (MSI) was also observed to be greater in males than females. The present study is statistically analysed with IBM.SPSS Statistics Software 23.0 Version. For gender determination Discriminant function analysis (D) was done and discriminant equation was also derived with gender as classifying variable and MSI as an independent variable. The calculated D value when closer to -0.802 indicates males, whereas if D value is closer to +0.802 indicates females. The determinant equations were applied to the present study sample and revealed that 74.0 % females and 84.0 % of males were correctly evaluated with a total accuracy of 79.0 % in gender determination.

A study was conducted in the population of South Africa by Fernandes et al. in the year 2004, the results of which showed that male sinuses were significantly larger than female sinuses but there was no significant difference in volume of sinuses in both the genders. The accuracy of gender determination in this study was 79.0% (10). Another study that was conducted among Turkey population by Hacer Yasar T et al. in 2007, showed that the male sinuses were significantly wider than those of females with an accuracy rate in estimation of gender was 69.3% (11). A similar study was conducted by Uthman et al. in 2011, which showed that maxillary sinus height can be considered as the best parameter in gender estimation with an overall accuracy of 73.9%. In this study the male and female sinuses were with an accuracy of 74.4% and 73.3% accuracy (5).

Another study that was conducted on dry skulls among south Indian population by Vidya et al. in 2013, demonstrated that the height, width and volume of maxillary sinuses were measured using 3D CT scan, the volume and measurements of maxillary sinuses are statistically significantly greater among males compared to that of females (12). Another study was conducted among Karnataka population by Kiruba et al. in 2014 using CT in which the width, height and depth were measured. This study showed that the size of maxillary sinus of females is smaller than those of males with a mean accuracy rate in gender identification of 63.6% (8). A similar study was conducted by Chandra et al. in 2014 where the area and perimeter of maxillary sinus were measured by using lateral cephalograms. The accuracy and reliability was found to be 70.8% in males and 62.5% in females (2). Another study conducted by Kanthem et al. in the year 2015 in which the volume and dimensions of maxillary sinus of right and left side using Computed Tomography scan, showed that the dimension and volume of maxillary sinus were larger among males than among females with statistically significant values 85.46% for the right side and 78.38% for the left side (13). A study conducted by Taniya K et. al in 2017 reported that mean maxillary sinus height and width was higher among males when compared to that of females (1).

All the studies that were conducted in population of different areas showed similar results to the present study that is the maxillary height (MH), maxillary width (MW) and maxillary sinus index (MSI) was noticed to be greater in males than females and identified the males and females correctly with an accuracy of 84% and 79% respectively.

CONCLUSION:

Gender determination is an important aspect in forensic science and criminal investigations. The morphometric measurements of maxillary sinus can be used for the gender determination. The results in present study showed that the maxillary sinus height, width and maxillary sinus index can be used to identify the gender. Hence, further studies on larger sample size are desirable.

TABLE

Table 1: Comparison between Maxillary sinus height, width & MSI in males and females [p value ≤ 0.01 is considered significant]

Parameters	Gender	N	Mean	P Value
Height (M-H)	Male	50	29.01 ± 3.45	0.73
	Female	50	27.89 ± 2.71	0.73
Width (M-W)	Male	50	36.81 ± 3.22	0.73
	Female	50	34.01 ± 3.77	0.73
Maxillary Sinus Index (MSI)	Male	50	1.28 ± 0.11	0.0005
	Female	50	1.22 ± 0.10	0.0005

GRAPHS

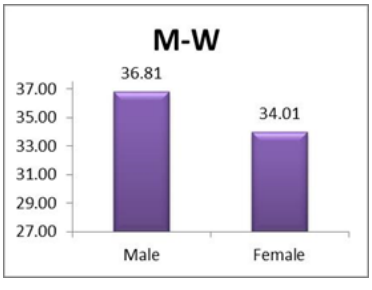

Fig 1: Comparison of maxillary width among males and females

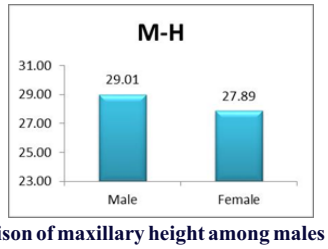

Fig 2: Comparison of maxillary height among males and females

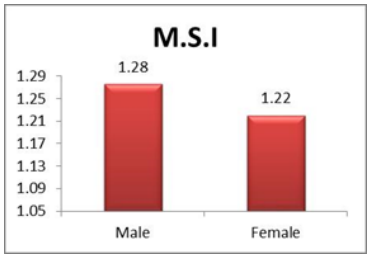

Fig 3: Comparison of maxillary sinus index among males and females

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