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Assessment Of Adult Maxillary Sinus Dimension in Panoramic Radiographs for Sex Determination

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ABSTRACT

Aim: The purpose of this study was to analyze right and left maxillary sinus dimensions of adult subjects on panoramic radiographs and their possible application in sex determination.

Background: The human identification process is based on the statistical parameters associated with qualitative and quantitative features such as species, sex, age, height and racial group. The forensic dentistry is closely related to human identification in situations where other means are not indicated or are not applicable. Maxillary sinuses are cavities contained within the maxillary bone, delimited by the orbital floor, nasal wall and alveolar ridge with close proximity to the maxillary posterior teeth roots. Panoramic radiography is one of the most commonly used imaging techniques in forensic dentistry.

Materials And Methods: 100 male and 100 females, aged 18 years or older, were selected. Their panoramic radiographs were evaluated. OPGs with completely formed right & left maxillary sinus and acceptable definition with adequate contrast, density and clarity were included in this study. Radiographs bearing pathologies or malformation and images with positioning errors were excluded.

Results: For female subjects, the mean height and width of the left maxillary sinus were 25.32±3.39 mm and 42.4±4.26 mm, respectively. And the right maxillary sinus was 24.67±4.26mm for height and 43.25±2.83 mm for width. Male subjects were found to have the mean height and width of the left maxillary sinus 29.32±3.43 mm and 47.54±3.42 mm, respectively. And the right maxillary sinus was 28.68±4.38 mm for height and 45.37±4.24 mm for width. There was a statistically significant difference in the height and width of maxillary sinuses between males and females.

Conclusion: Maxillary sinuses dimensions in panoramic radiographic images, such as height and width, can be used for gender determination. Males have greater mean values of height and width, for both sinuses than females. There were no significant differences between right and left maxillary sinuses across genders.

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Keywords: *Adult, Dimension, Maxillary sinus, Panoramic radiographs, Sex determination*

INTRODUCTION

Forensic dentistry, or forensic odontology, is the application of dental and paradental knowledge to the solution of legal issues in civil and in criminal matters.1 It includes human identification and bite marks. By this way, dentists contribute to the identification of human remains after disasters or crimes, assisting other medical specialties. Matching specific features discovered on the dead bodies with data recorded during the life of an individual is an important aspect in forensics. It can be carried out by fingerprint analysis, DNA matching, anthropological methods, radiological methods and other techniques which can help in age and sex identification.2 Species, sex, age, height and racial group parameters are used in the human identification process. The forensic dentistry can be used for human identification in instances where other means are not applicable.3

Important parameter in forensic identification is gender determination. Gender determination in skeletal remains or dead mutilated bodies is the first step for identification in medico-legal examination. Different methods constitute for gender determination 4 and the reliability of the gender determination depends on the skeletal remains and the degree of inherent sexual dimorphism in the population.5

The skull, as well as the pelvis, is the anatomical portion that presents more sexual dimorphism providing an accuracy of above 92%.6 Autopsy complemented with imaging tests of anatomical structures will be helpful in gender determination. Maxillary sinuses are anatomical structures in the skull. These are cavities contained within the maxillary bone, bounded by the floor of the orbit, nasal wall and alveolar ridge, with close proximity to the posterior teeth roots and the maxillary tuberosity associated with the infratemporal and pterygomaxillary fossa.7

Happonen RP et al recommended use of orthopantomogram in identification which enables visualization of the structures of the jaws and related areas as a single radiograph. In forensic odontology, panoramic radiography is commonly employed for imaging the maxillofacial complex.8 Many studies have used CBCT However, there is lack of research with maxillary sinus dimensions measurements being used in order to determine gender in the course of individual human identification.9,10

The purpose of this study was to estimate right and left maxillary sinuses dimensions on panoramic radiographs to determine gender of an individual.

MATERIALS AND METHODS

The research project was approved by the Saveetha Dental College - Institutional Human Ethics Committee.

100 male and 100 female, aged 18 years or older, were selected. The inclusion criteria were the presence of all teeth. However, the subjects who were missing the third molar were also included. Their panoramic radiographs were subsequently evaluated. The included radiographs should present images of completely formed right and left maxillary sinuses, acceptable definition with adequate density, contrast and clarity. On the other hand, the radiographic images of maxillary sinuses bearing pathologies or malformation, or the images with errors in the radiograph processing were excluded.

Firstly, the removal of identification and the randomization of all samples were performed, in order to ensure the study to be blind. Also, the same observer carried out two analyses of all samples.

During the course of this study, the “straight line” of the Triana program was used to measure the maxillary sinus height and width. Two vertical lines were drawn parallel to the left lateral extremity of the limiting rectangle of the panoramic radiograph image, and were created to be “dragged” to the distal limits of each maxillary sinus. After that, horizontal lines, perpendicular to the horizontal ones, were drawn, passing over the floors of the orbits of the distal limit until the mesial limit of each sinus to obtain its width. For the height, the center of each horizontal line, until the floor of each maxillary sinus, was used

(Figure 1). Then the same procedure was repeated for the maxillary sinuses of all samples.

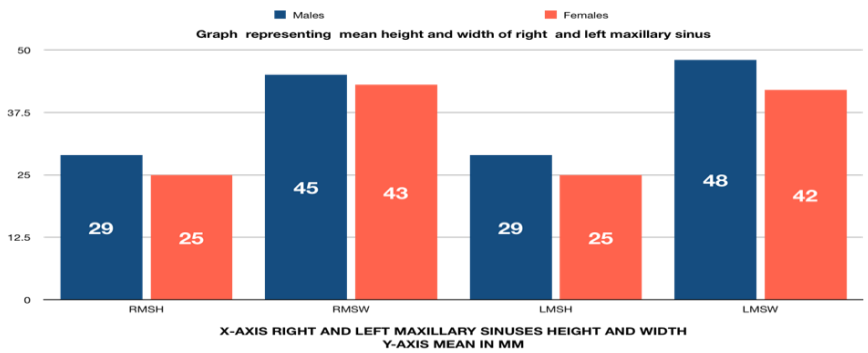
FIGURE 1: Image of one of the panoramic radiographs used, showing how the width and the height of maxillary sinuses were measured

RESULTS

The assessment of female maxillary sinus dimensions revealed, the mean height and width of the left maxillary sinus were 25.32±3.39 mm and 42.4±4.26 mm, respectively. And the right maxillary sinus was 24.67±4.26mm for height and 43.25±2.83 mm for width. Male subjects were found to have the mean height and width of the left maxillary sinus 29.32±3.43 mm and 47.54±3.42 mm, respectively. And the right maxillary sinus was 28.68±4.38 mm for height and 45.37±4.24 mm for width (Table 1). Regarding the differences between right and left dimensions, no statistical difference was found in height or in width, for both sexes. On the other hand, there were differences between the mean values of the maxillary sinuses dimensions evaluated for both sexes.

TABLE 1: Mean and standard deviation measurements (height and width) of both maxillary sinuses for male and female subjects

Maxillary Sinuses	MALE MEAN±SD (mm)	FEMALE MEAN±SD (mm)
Left Sinus Height	29.32 ± 3.43	25.32 ± 3.39
Left Sinus Width	47.54 ± 3.42	42.41 ± 4.26
Right Sinus Height	28.68 ± 4.38	24.67 ± 4.26
Right Sinus Width	45.37 ± 4.24	43.25 ±2.83



GRAPH 1: Mean and standard deviation measurements (height and width) of both maxillary sinuses for male and female subjects

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DISCUSSION

The maxillary sinuses were chosen for this study due to the fact that they present features suggesting that they can be used to identify human remains11, helping to determine sex.

Panoramic radiographs are two-dimensional images and, even though anatomic structures overlap12, they allow the visualization of all teeth, the maxilla, jaws and some facial bones in a single exposure.13 Therefore, they are often used in several dental specialties14, which motivated us to use them in our study.

Recent literature highlights excellent diagnostic accuracy of Computed Tomography due to its broad availability and high special resolution. The analysis of facial sinuses by means of Computed Tomography (CT scan) is often present in the literature. Computed Tomography is a highly effective technique because it eliminates the overlapping of structures by creating sectional images, providing tridimensional information, which allows a satisfactory assessment of the anatomy of the sinuses and their frequent variations.15 However, in spite of the high-definition of this kind of image, the high cost to acquire such equipment may be considered a limitation for this technique to be used in the forensic field, particularly in India where most Medical Examiner Offices lack resources.

The width and height of maxillary sinuses can be used with other bones to determine sex when the skeleton is not complete. It is known that maxillary sinuses present anatomic variables between sexes, and this could be seen in the present study, in which the mean width and height values for both male maxillary sinuses were greater than the values for both female maxillary sinuses.

Unlike the facts pointed out by Uthman et al., who observed that the height of the left sinus was the best variable to discriminate between sexes, the present study showed that both the height and the width of both sinuses were relevant for the differentiation between sexes.,16,17 Teke et al., also found that the mean height of male maxillary sinuses is bigger than the female ones, which is in agreement with the present study.18

In agreement with the data of the present study, Jasim & Al-Taei, who also used a dentulous group as sample, obtained the following mean values for the width and height of the right and left maxillary sinuses: for male subjects, 24.07±0.62mm; 24.67±0.63mm and 39.68±0.61mm; 39.50±0.63 mm respectively, and for the female ones they were 22.38±0.95mm; 22.26±0.94mm and 36.55±1.26mm e 36.67±1.06mm. The authors did not find any significant differences between right and left sinuses, but they could see that male maxillary sinuses are wider, deeper, and higher and have more volume than the female ones.19

In a study with panoramic radiographs, that used manual technique to obtain the measurements, the mean height of male right and left maxillary sinuses was 43.59±6.46mm; 44.34±9.54mm respectively, and for women, 38.95±7.18mm; 40.61±7.47mm respectively. The width of the sinuses for men was 38.95±718mm; 4061±7.47mm respectively, and for women, 46.02±6.49mm; 48.73±6.85mm respectively. The data obtained by those authors showed values that are similar to data in the present study regarding the width of the sinuses for both sexes. However, regarding the height, the values were rather different. Both studies showed that the width was larger than the height for both sexes, stressing a strong correlation between studies that used the same radiographic examinations.

To avoid biases such as alterations due to tooth loss, fully dentate individuals with the third molar and those who were missing it, were included in this study.

Thus, it is possible to infer that subjects with maxillary sinuses higher than 31mm and wider than 48mm are male, whereas when they are less than 27mm high and less than 44mm wide, it is likely that the subject is female. However, when the values are between 27mm and 31mm for height, and 44mm and 48mm for width, it is impossible to determine the sex.

Another relevant finding of this study is that it is possible to determine sex even if the skull is fragmented as long as there is one maxillary sinus, since there is no statistical difference between left and right sinuses of the same individual.

According to our findings, panoramic radiographs can be very useful. However, there are some limitations to use them in the forensic area, such as lack of equipment in most forensic laboratories, and the difficulty to put the remains in a static or sitting position, due to rigor mortis. It is also noteworthy, as is often the case, that radiographs are not filed, processed or fixed, which limits their application.

CONCLUSION

Maxillary sinuses dimensions in panoramic radiographic images, such as height and width, can be used to determine sex in adults, since men have greater mean values of height and width, for both sinuses than women. There were no significant differences between right and left maxillary sinuses for both sexes.

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CONFLICT OF INTEREST

There are no conflicts of interest.

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