DOI: https://doi.org/10.53350/pjmhs22169435

ORIGINAL ARTICLE

Value of Maxillary Sinus Morphology in Identification of Gender by Using Digital Radiography

YOUNAS KHAN[1], SADIA SYED[2], RIFFAT SHAMIM[3], SYEDA BANO[4], SHABIR AHMED ORAKAZAI[5], ZAFAR IQBAL[6]
[1]*Mbbs Mphil forensic medicine and toxicology, Swat Medical college Swat*
[2]*Assistant Professor forensic medicine, Shifa college of Medicine, Islamabad*
[3]*Assistant Professor, Forensic Medicine, Rai Medical college Sargoda*
[4]*Assistant Proffesor, Anatomy Shifa college of Medicine, Islamabad*
[5]*Associate Professor,Pathology, Swat Medical college Swat*
[6]*Assistant Professor Anatomy, Rai Medical college Sargoda*
Corresponding author: Younas Khan

ABSTRACT

Background: Human being recognition is significant for a variety of purposes, including for the humanitarian and sentimental needs for others, for relatives as well as for the court before rendering a decision. In forensic radiology, the radiographic tests and procedures that are relevant to the law or the courts are performed, interpreted, and then reported. Comparing radiography to three-dimensional (3D) cone beam computed tomography, radiography has the benefits of being more widely available, having a lower radiation dose, and having a lower cast. The systemic change in size or shape between individuals of varying sexes belonging to the same species is known as sexual dimorphism. Sexual dimorphism is reflected by different species' maxillary sinuses. The first paranasal sinus to develop in utero at the age of 10 weeks are the maxillary sinuses, which are two air-filled cavities found in the maxillary bone. They are the largest of the paranasal sinuses. Bones like the pelvis, skull, and femur are used in radiology to identify gender. Maxillary sinuses can be utilized for identification in mass tragedies like aero plane accidents, war, explosions, burnt, decomposing remains, and other calamities. In these situations, all the bones suffer severe damage, but the sinuses are left undamaged.

Aim and objective: This research used digital radiography to identify gender based on the morphology of the maxillary sinus.

Materials and Methods: From the radiographs (A.P view) of 128 subjects (64 males and 64 females), the morphometric characteristics of the maxillary sinus were assessed using microdicom software.

Results: The right maxillary sinus average height and width in males was 28.15mm and 25.04mm whereas, in females it 22.39mm and 22.54mm respectively and was found statistically highly significant. Likewise, the left maxillary sinus average height and width in males was 28.91mm and 25.33mm and in females it was 22.39mm and 20.81mm respectively and was statistically highly significant.

Conclusion: It was concluded from my study that the anteroposterior (AP) view of digital radiographs can be used to detect the gender based on the height and width of the maxillary sinuses.

Keywords: Forensic radiography, maxillary sinus, sexual dimorphism, gender determination mass disaster.

INTRODUCTION

Recognition of a human being is essential for many reasons such as for relatives, humanitarian, sentimental reasons and for the judicature before passing verdict (Kunigal, 2017; Prabhat, 2016 Identification is necessary for both living and dead bodies. For legal and moral reasons, one of the most crucial aspects of any medicolegal investigation is the successful identification of unidentified human remains. (Ciaffi et al. 2011). Forensic radiology entails carrying out, interpreting, and subsequently reporting radiological exams and processes that are relevant to the law or courts. (B.G. Brogdon, 1998). Bones like the skull, pelvis and femur are used in radiology to identify gender. However, combustion severely deforms these bones, hence in these circumstances, the maxillary sinuses are utilized for identification. (Asma, Natheer, Ahmed and Jalal, 2011). Comparing radiography to three-dimensional (3D) cone beam computed tomography, radiography has the benefits of being more widely available, having a lower radiation dose, and having a lower cast. (Malina-Altzinger, Damerau, Gratz and Stadlinger, 2015). Radiographs have been used for identifying unidentified human remains since the early 1900s. (J.L. Besana, T.L. Rogers, 2010). Since radiological examination is usually performed for this purpose, the radiologist becomes a crucial component of the identification process. (T.D Ruder et al, 2012). The application of radiography for identification in common and widespread disasters has been long-standing, efficient, and simple. (T. Kahana, J. Hiss., 1997). Additionally, by closely collaborating with radiologists, forensic pathologists today receive training in gathering and interpreting radiological evidence. (S.Grabherr., T. Uldin., F. Dedouit, 2017). Age, fingerprints,sex and footprints general characteristics including stature, complexion, religion, teeth, superimposition, DNA fingerprinting, anthropometric measures, and personal items are all factors used in the identification of deceased people. (P.C Dikshit, 2013). Two of the most reliable identification methods are fingerprinting, which occasionally becomes impossible due to human remains that have been burned, dismembered, or decomposed, and DNA fingerprinting, that sometimes becomes impossible due to the need for advanced laboratory resources and time and is particularly difficult if the body remains have been decayed. (Thais, Andrea & Ricardo, 2015). Anthropometric traits are crucial in forensic medicine for resolving identification issues. (Rainio, Lalu, Ranta & Pentilla, 2001). One of the key aspects of a person's identity is their sexual orientation. (Tanya, Arpita, Uday & Ritika, 2017). Various physical elements are used to determine gender, primarily the pelvis, long bones and skull (Ruhi et al, 2014). To recognize the deceased, it is required to check the antemortem and postmortem records. However, identity is difficult to establish using commonly employed forensic techniques until distinct postmortem changes have developed. (Teke, Semra, Nergis and Canturk, 2006). The maxillary sinuses are able to be utilized for identification since they are unharmed in mass disasters like aero plane accidents, war, explosions, and burnt, decomposed remains. as reported by (Kanthem, 2015) and cited by Tanya et al, 2017. The first paranasal sinus to form in utero at the age of 10 weeks are the maxillary sinuses, which are two air-filled chambers located in the maxillary bone. (Ruhi et al,2014). The formation of the paranasal sinuses occurs in two stages. Prenatal phase, often referred to as primary pneumatization, is the first stage. Secondary pneumatization, which starts at the prenatal period and lasts till adulthood, is the second stage. (M. Pifferi et al, 2011). It continues to develop until the third decade in males and the second decade in females. (A. Akkurt, M. Dogru, S. Hekimoglu and I. Kaeadede, 2013). According to reports, the diameters of the maxillary sinuses can be impacted by environmental variables, post infections, and genetic illnesses. (Teke, Semra, Nergis and Canturk, 2006). The systemic variation in size or shape between people of differing sexes belonging to the same species is known as sexual dimorphism. Sexual dimorphism is reflected by different species'

maxillary sinuses (Kanthem et al, 2015). The features of the maxillary sinus make it useful as a forensic identifying sinus. (Musse OJ., Marques JAM., Oleibera RM, 2009). In the field of forensic medicine, an examination of the maxillary sinus may be beneficial. (C.L. fernandes, 2004). Thus, gender identity can be easily and affordably determined by morphology of the maxillary sinus with the aid of digital radiography as reported by Kanthem et al,2015 as cited in Tanya et al, 2017 In contrast to the costly, unaffordable, and more sophisticated computed tomography (CT) scan, X-ray facilities are frequently available in developing nations like Pakistan. Therefore, more research is required to determine the efficacy of digital radiography for gender and identity estimate through the maxillary sinus. (Mousse OJ., JAM Marques and RND Olibeira, 2009 The purpose of this research was to identify gender from morphology of maxillary sinus with digital radiography.

MATERIALS AND METHODS

This study included 128 individuals (64 men and 64 women) who were instructed to get an x-ray (A.P view showing maxillary sinuses) after visiting Kuwait Teaching Hospital and Khyber Teaching Hospital Peshawar for ENT-related issues. Age between 25 and 40 years, eruption of all permanent teeth, and radiographs showing fully developed left and right maxillary sinuses with clarity, appropriate density, and contrast were the inclusion criteria. Radiographs having processing errors, artefacts, as well as images with diseases or abnormalities of the maxillary sinuses were excluded. After official permission from the administration of Kuwait teaching hospital & Khyber teaching hospital Peshawar, the patients who are visiting the said hospitals for their treatment, and who have done their digital radiography (A.P view showing maxillary sinus) for their E.N.T related problems, verbal informed consent from such patients were taken. All radiographic samples have their height and width measured using an image processing software called microdicom. This developer was given a reference radiograph of the left and right maxillary sinuses, and under the direction of a radiologist, height and width were measured in the half along the coordinate axes of radiographs.

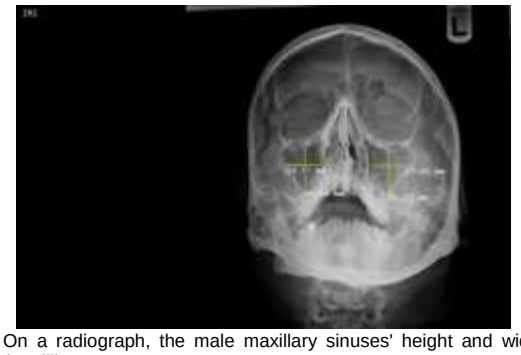

Fig.1: On a radiograph, the male maxillary sinuses' height and width are shown in millimetres.

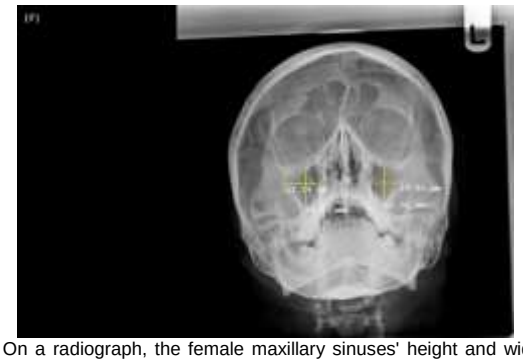

Fig.2: On a radiograph, the female maxillary sinuses' height and width are shown in millimetres.

Dimensional measurements obtained from radiographs are fed in excel spreadsheet (Windows7) and spss version 20 software is used. To analyze differences between males and females gender, T student test is used.

Table 1: Male cases = 64. With maxillary sinus height & width in mm

Variable	N	Mean	Std Dev
Age	64	29.81	5.97
Height Right Maxillary Sinus (mm)	64	28.15	5.14
Width Right Maxillary sinus (mm)	64	25.04	4.53
Height Left Maxillary Sinus (mm)	64	28.91	4.00
Width left Maxillary sinus (mm)	64	25.33	5.59

Table 2: Female cases = 64. With maxillary sinus height and width in mm

Variable	N	Mean	Std Dev
Age	64	31.91	4.68
Height Right Maxillary Sinus (mm)	64	22.39	2.58
Width Right Maxillary sinus (mm)	64	22.54	4.18
Height Left Maxillary Sinus (mm)	64	22.78	4.32
Width left Maxillary sinus (mm)	64	20.81	3.47

Table-3: Comparison between males and female's maxillary sinus height and width

		males		females		
variables	N	Mean	Std dev.	Mean	Std Dev	P value
Age in years	64	29.81	5.97	31.91	4.68	
Height right maxillary sinus in mm	64	28.15	5.14	22.39	2.58	0.001
Width Right Maxillary sinus (mm)	64	25.04	4.53	22.54	4.18	0.002
Height Left Maxillary Sinus (mm)	64	28.91	4.00	22.78	4.32	0.001
Width left Maxillary sinus (mm)	64	25.33	5.59	20.81	3.47	0.001

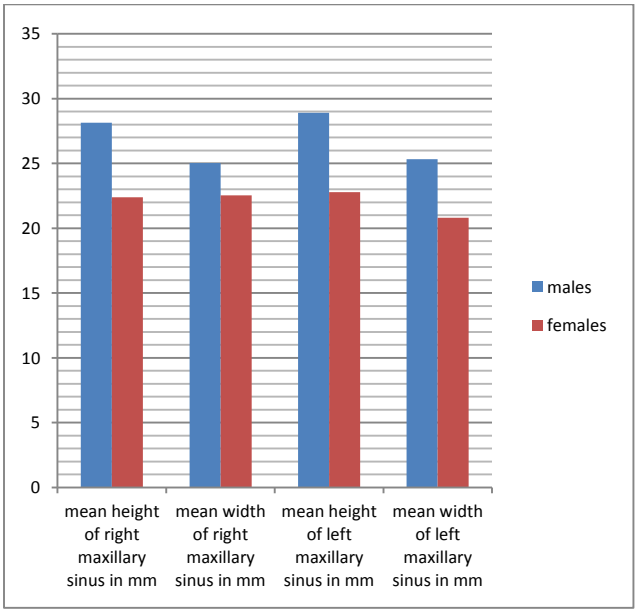

Chart-1: compares the dimensions of the male and female maxillary sinuses

RESULTS

Males seemed to have a right maxillary sinus with an average height of 28.15mm, whereas females had a right maxillary sinus with an average height of 22.39mm and a p value of 0.001. With a p value of 0.002, the right maxillary sinus in men was on average 25.04mm wide, while it was 22.54mm wide in women.

Males had an average left maxillary sinus height of 28.91mm, whereas females had an average left maxillary sinus height of 22.78mm, with a p value of 0.001. Males had a mean left maxillary sinus width of 25.33mm, whereas females had a mean left maxillary sinus width of 20.81mm, with a p value of 0.001.

DISCUSSION

Identification is the process of determining the distinctive identity of a person. It may be complete or partial identification. When a name of a person is known along with his name, it is complete identification. But when only certain characteristics such as sex, age etc. are known, then it is partial identification. The points to be taken for consideration for identification of a dead body includes sex, age, religion, complexion, general development such as stature, fingerprints, footprints, anthropometric measurements, teeth, superimposition, personal belongings and DNA fingerprinting. In cases of living persons ,the following criteria are taken into consideration ,in addition to above mentioned features, voice and speech, handwriting, gait, habits, memory and education. In situations involving divorce, matrimony, infertility, authenticity, heirship, and rape, sex determination becomes medicolegally significant.(P.C Dikshit, 2013). Recognition of identity using human skeletal remains is a crucial forensic technique. Identification involves specifying a person's age and gender. According to reports, the accuracy rate for predicting gender is 100% using the entire skeleton, 98% using the skull and pelvis together, 95% using the pelvic instead of the pelvis and long bones, 90–95% through using skull and long bones, and 80–90% using the long bones alone. (Teke HY, Duran S, Canturk N, Canturk G 2007). Recent research demonstrates that CT scans, which are widely available and have a high particular resolution, provide outstanding diagnostic accuracy.There is additional information in the literature about using Computed Tomography(CT scan) to analyse the face sinuses. It is a very useful technique since it offers 3-dimensional information, reduces structural overlaying through sectional images, and allows for a satisfactory evaluation of sinus architecture and its variants. The expensive expense of purchasing and maintaining such technology, particularly in developing nations, may be viewed as a hindrance to its employment in the forensic profession. The width and height of the maxillary sinuses, together with other bones, can be utilized to determine sex in the absence of a full human skeleton. (Cristhiane et al, 2016).

In the latest research, 128 radiographs—64 of men and 64 of females—were taken to measure the height and width of the maxillary sinuses.. The p values for right maxillary height and width are 0.001 and 0.002 respectively and are highly significant statistically. The p values for left maxillary sinuses height and width are 0.001 and 0.001 respectively and again both are highly significant statistically. Similar results of higher values of maxillary sinuses dimensions in males as compared to females are also found in other studies as well. According to Cristhiane et al. (2016), who studied panoramic view radiographs of the maxillary sinuses from Brazil, the average height of the right maxillary sinuses in men was 30.743.59mm, in comparison to 27.713.92mm for females. Males had right maxillary sinuses that were on average 48.574.49mm wide, whilst females had sinuses that were on average 45.182.83mm wide. The average width and height of the left maxillary sinuses in men and women, respectively, were 30.993.38mm and 48.774.24mm and 28.783.39mm and 44.614.62mm, respectively. Additionally, this study demonstrates that males have broader and higher maxillary sinuses than females. The sample size of their study was smaller (64 total cases) as compared to our study (128 total cases).

Thais et al. (2015) done research on papers about sex recognition and determination using computed tomography and radiography of the maxillary and frontal sinuses that were published in Brazil between 2003 and 2014. Out of these 47 publications, 30 publications were about determination of sex and identification. The study outlined in the article revealed that the dimensions of the maxillary sinuses in men and women differed noticeably on computed tomography and radiography. As a result, maxillary sinuses can be more accurately utilized to determine gender than frontal sinuses.

Similar findings were made by Teke et al. in 2007, who performed computed tomography to distinguish between genders based on the size of the maxillary sinuses. They discovered that females had smaller maxillary sinuses than males. The p values for right maxillary sinuses height, width and length were 0.034, 0.006 and 0.001 respectively while p values for left maxillary sinuses height, width and length were 0.002, 0.002 and 0.000 respectively. They recorded lower accuracy percentages for the exact measurements, with 69.3% for males and 69.4% for women, for a total accuracy of 69.3%. Kunigal et al also discovered that the length and height of male maxillary sinuses are greater than those of females, by using lateral cephalograms. However, there was no statistical significance probably because of small sample size of 40 patients (20males and 20females).

Using reconstructed helical CT images, Uthman et al. conducted research on the validity and consistency of the maxillary sinus dimensions measurement in the gender classification and discovered that 74.4% of male sinuses and 73.3% of female sinuses could be successfully identified as either male or female. By obtaining lateral radiographs of 50 patients (25 males and 25 females) who were free of illnesses of the maxillary sinuses, Ruhi et al. carried out a study for gender identification from the maxillary sinuses by lateral radiography. According to research methodology, the maxillary sinus's mean area and perimeter were 4.3901 cm and 1.3424 cm2 for females and 5.2885 cm and 1.7261 cm2 for males. They came to the conclusion that gender can be determined by radiographic measurements of the size of the maxillary sinuses.

CONCLUSION

According to the results of my research, using the anteroposterior (AP) view of digital radiographs, it is possible to identify a person's gender based on the size and width of their maxillary sinuses.

Recommendations: It is advised that additional research be done to identify gender using maxillary sinus radiography. These studies should be multi-ethnic and have a big sample size.

REFERENCES

1. Kunigal, S.P., Charan, G., Ganganna K., Jayadev, S., Shubha, K., Suchetha, D. N., (2017). Gender differentiation using maxillary sinus. International Journal of oral care & research, 2017; 5(1):19-22.
2. Prabhat, M., Shalu,R., Mandeep K., Kanika, P., Puneet, B., Sapna, P. (2016). Computed tomography based forensic gender determination by measuring the size and volume of the maxillary sinuses. Journal of forensic dental sciences 2016; 8(1), 40-46.
3. Ciaffi R, Gibelli D, Cattaneo C. (2011). Forensic radiology and personal identification of unidentified bodies: a review. Radiological Medicine, 2011; 116:960-968.
4. B.G. Brogdon, (1998). The scope of Forensic Radiology. Clinics in laboratory Medicine, 1998; 18(2):203-240.
5. Asmaa, T. U., Natheer, H. A., Ahmed, S. A., Jalal, F. A. (2011). Evaluation of Maxillary Sinus Dimensions in Gender Determination Using Helical CT Scanning. Journal of Forensic sciences, 2011; 56(2):403-408.
6. Malina-altzinger, George D., Klause W.G., Bernd S., (2015). Evaluation of maxillary sinus in panoramic radiography-a comparative study. International Journal of Implant Dentistry, 2015; 1:17.
7. J.L., Besana, T.L., Rogers, (2010). Personal identification using frontal sinus. Journal of Forensic Sciences, 2010; 55(3):584-589.
8. T.D. Ruder, Markus K., Walther F.G., Sandra Mathier., Lars C.E., Michail J.T., Gary M.H., (2012). Radiologic identification of disaster victims: a simple and reliable method using CT of the paranasal sinuses. European Journal of Radiology, 2012; 81:e132-e138.
9. T. Kahana, J. Hiss. (1997). Identification of human remains: Forensic radiology. Journal of clinical Forensic Medicine, 1997; 4:7-15.
10. S.Grabherr., T. Uldin., F.Dedouit., (2017). Radiodiagnostic and molecular innovation in personal identification. P5 Medicine and Justice, 2017; 427-436.

11. P.C Dixit (2013). Textbook of Forensic Medicine and Toxicology. (2nd ed.). New Delhi, India: Peepee Publishers.
12. Thais, A.X., Andrea, S.S.D.t., Ricardo, H.A.D.S. (2015). Forensic application of the frontal and maxillary sinuses: A literature review. Journal of Forensic Radiology and Imaging, 2015; (3):105-110.
13. Rainio J, Lalu K, Ranta H, Pentilla A. Radiology in forensic operations. Leg Med, 2001; 3(1):34-43.
14. Tanya, K., Arpita, K., Uday, G., Ritika, J. (2017). Cephalometric analysis for gender determination using maxillary sinus index: A novel dimension in personal identification. International Journal of Dentistry, 2017. Volume 2017 article ID 7026796.
15. Ruhi, S., Sunira, C., Parvathi, D., Neeraj, T., Kunal, S., Navdeep, K. (2014). Forensic importance of maxillary sinus in gender determination: A morphometric analysis from Western Uttar Pradesh, India. Europian Journal of General Dentistry, 2014; 3(1):53-56.
16. Teke, Semra,D., Nergis C., Gurol, C. (2006). Determinationof gender by measuring the size of the maxillary sinuses in computerized tomography scans. Surg Radiol Anat, 2006; 29:9-13.
17. Kanthem, Venkateswara,R.,G., Sivaranjani,Y., Geeta,K. (2015). Sex determination using maxillary sinus. Journal of Forensic Dental Sciences, 2015; 7(2):163-167.
18. M. Pifferi, Andrew B., D. Caramella, M.D. Cicco, M. Zangani, I. Chinellato, P. Macchia, A. L. Boner (2011). Agenesis of paranasal sinuses and nasal nitric oxide in primary ciliary dyskinesia. European Respiratory Journal, 2011; 37(3):566-571.
19. A., Akkurt, M., Dogru, S. Hekimoglu, I. Karadede, (2013). Three dimensional comparison of maxillary sinus volume in patients with and without posterior crossbite maxillary sinus volume. International Archives of Medical Research, 2013; 5(1):1-8.
20. Mousse JO, Marques JAM, Olibeira RN (2009). Contribution of the maxillary sinus analysis for human identification. Health, Ethics & Justice, 2009; 14(2): 65-76.
21. C.L. Fernandes (2004). Forensic Ethnic Identification of Crania: the role of the maxillary sinus. Am J Forensic Med Pathol, 2004; 25:302-313.
22. Christiane, L. D. Q., Andrea, S. S. D. T., Thais, U. D., Lais, G. D. A., Rodigro, G., Christiano, O., (2016). Sex determination of adult human maxillary sinuses on panoramic radiographs. Acta Stomatol Croatia, 2016; 50(3):215-221.
23. Asmaa, T. U., Natheer, H. A., Ahmed, S. A., Jalal, F. A. (2011). Evaluation of Maxillary Sinus Dimensions in Gender Determination Using Helical CT Scanning. Journal of Forensic sciences, 2011; 56(2):403-408.