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Radio morphometric comparison of frontal and maxillary sinus in south eastern Punjab population by conventional methods.

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Abstract:

Aims and objectives: A comparative study was conducted in the field of forensic odontology for sex determination in south eastern Punjab population to evaluate the reliability and accuracy of frontal and maxillary sinus in gender determination using conventional radiography.

Methodology: The study was conducted in the department of oral medicine and radiology on 200 participants (100 males and 100 females) with an age range of 20– 35 years. Caldwell's radiographic technique was applied to view frontal sinus and lateral cephalogram for maxillary sinus. Both methods were applied on each participant, and the data were collected. After obtaining the data, it was coded, analysed, decoded, interpreted, and statistically analysed. The data were entered into MS Excel and then analysed with IBM SPSS Statistics 20.0 Data Editor software using chi square, independent sample test.

Results: In the present study, on comparing, it was found that in case of frontal sinus there was no significant difference between the means of frontal sinus area and the gender of the subjects and the corresponding p value was found to be 0.679 which is non-significant. On the other

hand, classification results of area of maxillary sinus (82%) of original grouped cases were correctly classified with a significant P value (P < 0.001), with males having larger area as compared to females.

Conclusions: Maxillary sinus area parameter is an accurate and reliable method as compared to forensic sinus for sex determination

Key words: Forensic odontology, maxillary sinus, frontal sinus, sex determination

Introduction

Human body has 4 pairs of Para-nasal sinuses which are connected to the nasal cavity by a small canal. They are air-filled spaces that is, they are hollow and are found within the bones of the face and base of the skull surrounding the nasal cavity namely; frontal, ethmoidal, maxillary and sphenoid sinuses. The paranasal sinuses perform varied functions, which include:(1) to lighten the weight of the head, (2) to improve nasal function, (3) to humidify and heat inhaled air, (4) to increase the resonance of speech, (5) to aid the immune defences of the nasal cavity and (6) to serve as “shock absorbers” to protect vital structures in the event of facial trauma. The sinuses have shown to be affected by environmental stress, for example, people living in warmer climates have larger volume of the sinuses.[1,2,3,4]

Plain film radiography for the sinuses includes: (i) Water’s (occipitomental view), (ii) lateral (cephalometric), (iii) Caldwell (occipitofrontal view), (iv) basal and oblique view and (v) submentovertex view. These conventional techniques are still frequently used for the evaluation of paranasal sinuses. This form of radiography comes with its own set of advantages: decreased radiation dose, easy availability and examination, simple, rapid and safe tests, non-invasive and economical.[5, 6]

Sex determination of an unidentified person is of paramount importance to disclose his/her identity. When it comes to forensics, sinuses especially, maxillary and frontal sinus plays a vital role as many times only a fragment of the skull is found. Anthropologic, medical and dental forensic studies have shown that no two people have same sinus especially frontal sinus and secondly, maxillary sinus remains intact in fragmented specimen of the skull.[7,9,8,10]

This study was intended to access the diagnostic value of conventional radiography for gender determination using frontal and maxillary sinus. This can serve as an aid in future forensic odontology studies.

Subjects and Methods

The present study was conducted on the population of south eastern Punjab, north western India, after the required approval from the ethical committee. The study included 200 participants, including 100 males and 100 females, with age ranging from 20 to 35 years. After explaining the entire procedure to the patients, a written consent was obtained. A thorough detailed oral examination was conducted, and the data were collected as per the pro forma. The individuals were selected on the basis of the inclusion and exclusion criteria.

Inclusion criteria: Both sexes were considered randomly, subjects above 20 years of age.

Exclusion criteria: Chronic sinusitis (maxillary and frontal) and other maxillary sinus pathologies, facial bone fracture and aplasia of frontal sinus.

Caldwell’s projections were taken using Kodak intensifying screen (Eastman Kodak Company, Rochester, New York, United States) image receptor (8x10’ digital cassette) on stationary bucky. Radiographs were taken using Adonis 500 mA machine (Adonis Medical Systems Private Limited, Mohali, India, 1998) with mA300, KvP 70 and mAs 60. The lateral

cephalograms were obtained using 8 × 10' digital cassette image receptor which was a Kodak intensifying screen (Eastman Kodak Company, Rochester, New York, United States). Standard radiographic technique was applied for this form of extra-oral radiography using Allengers-Alldent HF machine (Allengers, passion for excellence, Derabassi, Punjab, India 2011) for extra-oral radiography set at 850W, 76 kVp, 10 mA, and 2 s. Both the X-ray films were developed with FCR PRIMA Console Software V1.1 automatic processing unit. After taking radiograph, it was digitally processed. Each X-ray was assessed for maxillary and frontal sinus area respectively with AutoCAD 2010 software (AUTODESK, California, United States) (Figure 1, 2). Both right and left and total area of frontal sinus was evaluated along with maxillary sinus. Each picture was saved in JPEG format and data was coded. All the collected data was analysed using the IBM SPSS Statistics 20.0 Data Editor software (Microsoft Corporation Inc., Chicago, IL, USA) using chi square, independent sample test.

Results

The average area of Frontal sinus in males and females was recorded according to the particular side. In males, total average area of frontal sinus was 1.016396mm. In females, the total average area of frontal sinus was 0.976170mm (Table I). This table shows that there was no significant difference between the means of frontal sinus area and the gender of the subjects as the F statistic was 0.824 and the corresponding p value was found to be 0.679 which is non-significant.

A significant sex difference was found in relation to maxillary sinus area. The mean area for males (1.65260) was larger than females (1.36674) (Table II). In group centroids, if someone's DF score is above −0.052, then the person belongs to female category, whereas if DF score is <−0.052, the person belongs to male category. The classification results of area of maxillary sinus (82%) of original grouped cases were correctly classified with a significant P value ($P < 0.001$) (Table III). Hence, males showed larger area of maxillary sinus as compared to females.

On statistically comparing frontal and maxillary sinus, it was found that frontal sinus area did not show any significant difference between males and females whereas maxillary sinus area showed a significant P value and hence, is useful in sex determination and can be used in future studies.

Discussion

Sex determination is one of the main aspects of human identification. It has been reported that if the entire skeleton is available, then sex of the unidentified subject can be assessed with 100% accuracy. But when skeletal remains are found, after pelvis, skull is the second most important part which aids in gender determination. It should be noted, that studies have also found that if both skull and pelvis are retrieved from a site, gender can be determined with an accuracy of 98%. Besides well documented parts of the skull used for sex estimation, sinuses play a very important role. Out of the 4 paranasal sinuses, frontal and maxillary sinus are being studied extensively in the present scenario to assess their role in forensics.[11-14]

Growth and development of the frontal sinus is regulated by genetic and environmental factors and hence it is unique for each individual. Because of this it plays an important role in identification.[15] With the advent of technology, the use of radiography to confirm the identity of individual has really aided in the field of forensics. Frontal sinus radiography has been used since long and till date various radiographic techniques along with different methods is being used in forensics. [16]

Kawarai et al.[17] in 1999 conducted a study on 20 Japanese subjects to volumetrically assess healthy paranasal sinuses using 3-dimensional CT imaging modality and found that individually and as a whole, paranasal sinuses are larger in case of males than females.

For the present study, 100 males and 100 females with the age group above 20 years was taken into consideration because frontal sinus attains its full maturity after the age of 20 years. Skeletal changes are expected with aging so age above 35 years was not considered. Similar studies were conducted by Verma S et al[18], Belaldavar C et al[19], Camargo et.al.[20], Maria Priscilla David and Runjhun Sexena[21]. Caldwell's radiographic view was the choice of radiograph for this study because of the following reasons:

(a) Less magnification- forehead (frontal sinus area) is kept in close approximation with the film receptor.

(b) This view gives a clear image of the frontal & ethmoidal sinuses without loss of definition by super imposition with the petrous ridge of temporal bone.[22]

AutoCAD 2010 software was used to calculate an area of frontal sinus because it is the most accurate in calculating area of irregular shapes, easy, less time consuming and its functions are well adapted to any form of shapes and structures. The mathematical formula which can be used to calculate the area of an irregular shape (Frontal Sinus) is the one in which the figure is divided into squares, triangles and rectangles and then area of these specific shapes is determined to get the final result.[23]

Eboh DE et al[24] conducted a radiographic anthropometric study on 216 X-ray films in Benin city, South-South Nigeria. In this study, frontal sinus of subjects aged 20–91 years was assessed for sex determination. It was found that all dimensions were higher in males than in females. It was also found that the left side height and width were statistically significant ($P < 0.05$). Verma S et al[18] conducted a radio-morphometric analytical study of frontal sinus for gender determination on 50 women and 50 men aged 20 years and above using 100 Caldwell views. Vernier callipers were used for measurements. The mean values of variables were greater in men, with total area, gender prediction of females as 55.2%, of right area and of left area as 55.2%.

Belaldavar C et al[19] in 2014 studied Indian adult population for sex determination using frontal sinus dimensions. 150 males and 150 females aged between 18-30 years were considered using 300 digital postero-anterior view radiographs. The measurements were carried out Adobe® Photoshop® CS3 extended. The results depicted that the mean values of the frontal sinus height, width and area are greater in males as compared to females with right frontal sinus area larger than the left sinus area.

In this study mean frontal sinus area was found to be 1.01 in males and 0.976 in females which was found to be statistically insignificant with p value of 0.679. Studies by Eboh DE et al[24], Belaldavar C et al[19], Camargo et.al.[20] Rubira-Bullen et.al.[22] Cristiane Regina Ruiz and Nader Wafae[25] measured area of frontal sinus using Caldwell's radiograph. All these studies showed males had larger frontal sinus area as compared to females, which was not in accordance with the present study. This variation in results could be because of geographic variations, standardization of Caldwell's radiograph and also nonspecific mathematical formula which has been used in other studies.

Maxillary sinus, although a hollow space found in our skull, is extensively being studied in field of forensics. It has been concluded that in fragmented remains, if maxillofacial area is found, this sinus remains intact and is helpful in determining sex of the unknown entity. Nowadays, various radiographic techniques are being

used to study and assess volumetric measurements (height, length, breadth) of the sinus, namely, conventional techniques, Computerized tomography, Cone beam CT etc. For measurements, vernier callipers, ADOBE, photoshop, AutoCAD software etc are being used. In the present study a routine extra-oral radiograph, lateral cephalogram, was used. All the lateral cephalometric radiographs were taken using a standardized technique. This technique included patient's sagittal plane parallel to the film with the teeth in centric occlusion and lips relaxed. The head position was stabilized by gently inserting bilateral ear rods into the external auditory meatus. The Frankfort horizontal plane of the patient was adjusted parallel to the floor.

Vidya et al.[26] in 2013 conducted a gender determination study on 30 dry skulls of south Indian origin using 3D computerized tomography. The study depicted height, length, width and volume of maxillary sinus of males were slightly more compared to females.

Kanthem RK et al[27] in 2015 studied 17 male and 13 female patients who visited outpatient department by making patients undergo plain CT and using SYNGO software for measurements of maxillary sinus. It was concluded that maxillary sinus volume showed statistically significant results with a higher percentage of sexual dimorphism,

Cristhiane Leão de Queiroz et al[28] in 2016 conducted a study on the panoramic radiographs of 32 male and 32 female subjects for sex determination and to evaluate dimensions of adult human maxillary sinuses on these radiographs. Subjects included in the study were 20 years or older in age. A statistically significant difference in the height and width of maxillary sinuses between males and females concluded that panoramic radiographs can be used to determine the gender.

Dangore-Khasbage S, and Bhowate R[29], in 2018 analyzed CT scans of 200 patients (100 males, 100 females). The mean of the mediolateral, supero-inferior and anteroposterior dimensions, volume and antero-lateral angle of the right and left maxillary sinuses had statistically significant difference between males and females with an overall accuracy of 86%.

Hence, the results of the present study are in accordance with those of Vidya et al.[26], Kanthem RK et al[27], Cristhiane Leão de Queiroz et al[28] and Dangore-Khasbage S, and Bhowate R[29]. On the other hand, Praveen et al[30] and Urooge and Patil[31] conducted studies and found that maxillary sinus did not show any statistically significant difference in measurements and therefore cannot be used for gender determination. Various studies show that different growth rates result in increased cranial measurements in males as compared to females.[10]

Conclusion

Varied studies have been caried out in the field of forensic odontology keeping in consideration the sinuses. In the present study maxillary and frontal sinus were compared and studied to check their accuracy for determination of sex. It should be noted that this type of comparative analysis has not been done previously. But when the present study was compared with other individual studies, it was observed that their results showed variation because of geographic and sample quantitative differences. Maxillary sinus area, was found to be statistically significant while frontal sinus area did not show any sexual dimorphism. However. further studies should be carried out on larger sample to quote more definitive values and for a strong base for future research. Our study is added to set a definitive trial to compare sinuses for sex determination and to justify the role of each in forensic odontology.

References

1. Juhl J, Crummy A B, Kuhlman J. Paul and Juhl's.Essentials of radiologic imaging. 1998 7th ed. Philadelphia: Lippincott-Raven.
2. Keir J. Why do we have paranasal sinuses?. The Journal of Laryngology & Otology. 2009;123(1):4–8
3. Gallup AC, Hack GD. Human paranasal sinuses and selective brain cooling: A ventilation system activated by yawning? Medical Hypotheses. 2011;77(6):970–973
4. Koertvelyessy T. Relationships between the frontal sinus and climatic conditions: A skeletal approach to cold adaptation. American Journal of Physical Anthropology. 1972;37(2):161–172
5. Dr. Darshan Shah, Dr. Tushar Vaishnav. Conventional Radiography and CT Scan Correlation for Evaluation of Paranasal Sinus Pathologies. International Journal of Science and Research (IJSR), Volume 8 Issue 12, December 2019, 181-183.
6. Ebrahimnejad H, Zarch SH, Langaroodi AJ. Diagnostic efficacy of digital waters and Caldwell's radiographic views for evaluation of sinonasal area. Journal of Dentistry (Tehran). 2016;13(5):357–364.
7. Kolo ES. The role of plain radiographs in the diagnosis of chronic maxillary rhinosinusitis in adults. African Health Sciences 2012; (4): 459 - 463
8. Navdeep Kaur, Sunira Chandra, Parvathi Devi, M Srinivasa Raju, Neeraj Taneja, Ruhi Sidhu. The Forensic Importance of Frontal Sinus in Gender Discrimination. J Oral Sign 2013; 5 (1): 2-5
9. Fernandes CL. Forensic ethnic identification of crania: The role of the maxillary sinus – A new approach. Am J Forensic Med Pathol 2004; 25:302-13.
10. Ruhi Sidhu, Ravindra Setru Veerabhadrappa, Navdeep Kooner Shergill, Parvathi Devi. A Comparative Study on the Accuracy of an Odontometric and Radiographic Method for Determination of Sex in Western Uttar Pradesh Population. Int J Forensic Odontol 2019; 4:59-64.
11. Eboh A dimorphic study of maxillary first molar crown dimensions of Urhobos in Abraka, South-Southern Nigeria. J Morphol Sci 2012;29:96-100.
12. Fowler HW, Coulson J, Onions CT. Shorter Oxford English Dictionary. 6th ed. United Kingdom: Oxford University Press; 2007.
13. Pinheiro J. Introduction to Forensic Medicine and Pathology. In: Schmitt A, Cunha E, Pinheiro J, (eds). Forensic Anthropology and Medicine. Humana Press, New Jersey, United States. 1st edition; 2006, p. 5-18.
14. Tanushri Naeem A, Nadia K, Saluja SA, Taseer B, Akhtar H. Evaluation of gender by measuring the size of maxillary sinus using computed tomographic: Scan in Indian Population. JIOH. 2015; 7(10):88-92.
15. Juan Rogelio Falguera, Fernanda Pereira Sartori Falguera and Aparecido Nilceu Marana. Frontal Sinus Recognition for Human Identification. Proc. of SPIE 2008; 6944:1-7.
16. Angi M. Christensen. Testing the Reliability of Frontal Sinuses in Positive Identification. J Forensic Sci. 2005; 50(1):1-5.
17. Kawarai Y, Fukushima K, Ogawa T, Nishizaki K, Gunduz M, Fujimoto M, et al. Volume quantification of healthy paranasal cavity by three-dimensional CT imaging. Acta Otolaryngol Suppl. 1999;540:45–9. [PubMed] [Google Scholar]
18. Verma S, Mahima VG, Patil K. Radiomorphometric analysis of frontal sinus for sex determination. J Forensic Dent Sci 2014; 6: 182-7.
19. Belaldavar C, Kotrashetti VS, Hallikerimath SR, Kale AD. Assessment of frontal sinus dimensions to determine sexual dimorphism among Indian adults. J Forensic Dent Sci 2014; 6:25-30.

20. Camargo, Daruge, E. Prodo. F B, Caria P H E, Alves, M C, Silva, R F & Daruge Jr.E. The frontal sinus morphology in radiography of Brazilian subjects. Braz.j.Morphol. Sci.2007; l24 (4):239 -243

21. Maria Priscilla David and Runjhun Saxena. Use of frontal sinus and nasal septum patterns as an aid in personal identification: digital radiographic pilot study. J of Forensic Dent Sci 2010; 2(2):77-80.

22. Rubira-Bullen, Rubira, Sarmento, and Azevedo. Frontal sinus size on facial plain radiographs. J. Morphol. Sci. 2010; 27(2):77-81.

23. S.L. Gupta. Mathematics for mechanical Engineers. 3rd ed, Elsevier; 1997:28-48.

24. Eboh DE, Ogbeide OU, Ivwighren T. Radiographic anthropometric study of frontal sinus for sex determination in Benin city, South-South Nigeria. J Forensic Dent Sci 2017;9:31-5

25. Cristiane Regina Ruiz and Nader Wafae. Anatomo-Radiological and Morphometrical Study of the Frontal Sinus in Humans. Braz. J. morphol. Sci. 2004; 21(1): 53-56.

26. Vidya CS, Shamasundar NM, Manjunatha B, Raichurkar K. Evaluation of size and volume of maxillary sinus to determine gender by 3D computerized tomography scan method using dry skulls of South Indian origin. Int J Curr Res Rev. 2013;5:97–100.

27. Ranjith Kumar Kanthem, Venkateswara Rao Guttikonda, Sivaranjani Yeluri, and Geetha Kumari Sex determination using maxillary sinus. J Forensic Dent Sci. 2015 May-Aug; 7(2): 163–167.doi: 10.4103/0975-1475.154595

28. Cristhiane Leão de Queiroz, Andrea Sayuri Silveira Dias Terada, Thais Uenoyama Dezem, Lais Gomes de Araújo, Rodrigo Galo, Christiano Oliveira-Santos, Ricardo Henrique Alves da Silva. Sex Determination of Adult Human Maxillary Sinuses on Panoramic Radiographs. Acta stomatol Croat. 2016;50(3):215-221.

29. Dangore-Khasbage S, Bhowate R. Utility of morphometry of maxillary sinuses for gender determination by using computed tomography. Dent Med Probl. 2018;55(4):411–417. doi:10.17219/dmp/99622

30. Praveen KS, Gowda C, Kokila G, Jayadev S, Shubha K, Suchetha DN. Gender differentiation using maxillary sinus. Int J Oral Care Res 2017;5:1-4.

31. Urooge A, Patil BA. Sexual dimorphism of maxillary sinus: A morphometric analysis using cone beam computed tomography. J Clin Diagn Res 2017;11:ZC67-70.

Legend Figures and Tables

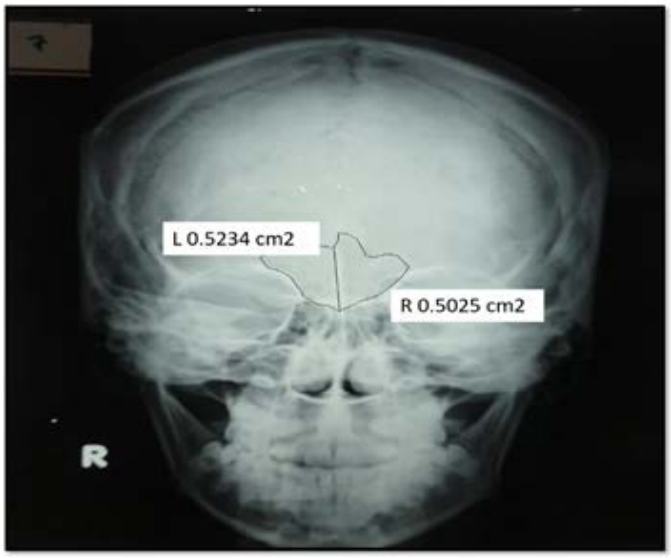

Fig 1: Frontal sinus morphometric analysis.

Fig 2: Maxillary sinus morphometric analysis.

Table 1: Showing descriptive statistics of Right, Left and Total area of frontal sinus

Group statistics				
	Sex	N	Mean	Std. Deviation
Frontal Sinus-Right side Area	Male	100	.506271	.3423067
	Female	100	.500989	.2826165
Frontal Sinus-Left side Area	Male	100	.510125	.2436356
	Female	100	.475181	.2698732
Frontal Sinus-Total Area Sqcm	Male	100	1.016396	.5859423
	Female	100	.976170	.5524897
p value -0.679; Non-Significant				

Table 2: Showing Discriminant functional analysis: Area Of Maxillary Sinus.

Group statistics			
Sex code		Mean	S D
Female	100	1.36674	.220101
Male	100	1.65260	.224418
Total	200	1.50967	.263332
p value-0.0001; Significant			

This table shows the gender wise descriptive statistics of parameter Area (cm2), Where SD = Standard Deviation

Table 3: Showing Classification Results of Area of Maxillary Sinus

Classification Results					
		Sex code	Predicted Group Membership		Total
			Female	Male	
Original	Count	Female	88	12	100
		Male	24	76	100
	%	Female	88	12	100.0
		Male	24	76	100.0
a. 82.0% of original grouped cases correctly classified.					

Where % = Percentage