

Frontal sinus imaging: Tool for gender determination

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Abstract

Background: Gender determination of unknown or deceased individual is an important task of forensic sciences. Sometimes, only skull remains are available for identification, in such situations frontal sinus radiographs can be used for gender determination.

Objective: The present study was aimed to determine gender among Bihar population using PNS view cephalograph.

Materials and Methods: A total of 100 individuals (50-male, 50-female) aged between 20-30 years were included in the study for which height and width of frontal sinus was determined using PNS view radiographs.

Results: Significant differences were observed for frontal sinus height and width between males and females.

Conclusion: Frontal sinus measurements can be used as a tool for gender determination.

Keywords: Forensic, Frontal sinus, Gender, Imaging.

Introduction

Identify the unknown or deceased individual is the main objective of forensic sciences, which further acts as an adjunct to the law of enforcement agencies. Routine techniques have few limitations, particularly in situations where bodies are severely mutilated.¹ Gender determination in these instances helps in establishing a biological profile of human remains. Considering body skeleton, apart from pelvis, skull being the most reliable for gender determination but after puberty as changes takes place in skull till puberty.² During forensic or archeological excavations, all bones are usually not retrieved and it is very common to have head amputated from the trunk. Cranium being relatively resistant to decay and their anatomical landmarks are standard, well defined and easy to locate which further aids as a substantial tool for gender determination.³

Human cranium consisting of four major sinuses namely, the maxillary sinus, frontal, sphenoidal and ethmoidal; among which frontal sinus evolved as forensic interest in identification of unknown remains. The reason being its unique characteristics described by anatomists, radiologists and anthropologists as even monozygotic twins have different frontal sinus parameters and it's alike for every individual.⁴ Frontal sinuses are paired lobulated cavities located deep to the superciliary arches in the frontal bone. It starts developing embryonically from an ethmoidal cell during the second year of life; the overall development

is usually completed by the 20 year of age and remains stable throughout the life.^{5,6}

Literature provides several studies regarding the uniqueness of frontal sinus for identification purposes. Morphometric measurements of frontal sinus were extensively used for gender determination in various parts of India.⁷⁻¹⁰ The present study was taken to determine the gender of individuals among Bihar population through measurements calculated using frontal sinus imaging.

Materials and Methods

After obtaining institutional ethical clearance, the present study was conducted on 100 individuals of Bihar origin (50 males and 50 females) age ranged between 20-30 years. The intention of limiting the sample to young adults was that frontal sinus become stable by the age of 20 years with complete development. In older age the walls become thin and size of frontal sinuses appear to be larger.⁷ However, individuals with history of any sinus pathologies, orthodontic treatment or orthognathic surgery, trauma, or any surgery of the skull, history or clinical characteristics of endocrine disturbances, nutritional diseases or hereditary facial asymmetries, were excluded from the study. Written consents were taken from the individuals taking part in the study which explained study nature in their own language. Digital Paranasal Sinus (PNS) view radiographs were taken by Caldwell technique using the Kodak 8000C Digital Panoramic and Cephalometric system at standard exposure parameters (10 mA, 84 kvp, 0.63 seconds). All radiographs

were taken by the same radiologist to avoid technical error. The radiographic images were saved as high resolution JPEG file and imported to Adobe Photoshop CS3 extended to measure the dimensions of the frontal sinuses. The lower border of both the frontal sinuses was standardized first. The greatest height of frontal sinus was determined from the maximum distance between the base and upper lines of the frontal sinus, and the largest width of the frontal sinus was determined from the maximum distance between the lateral most lines of the right and left side of the frontal sinus. The obtained data for both genders was analyzed using Student's t-test for means of height and width of frontal sinus.

Results

Table 1 depicts the mean difference for height and width of both the frontal sinuses among males and females of Bihar population. Student's t-test showed statistically significant difference ($p < 0.00$) between the heights of frontal sinus of both genders. Similarly both right and left side widths of frontal sinuses also showed significant difference ($p < 0.00$) between males and females of Bihar population. Present study indicates that height and width of frontal sinus is greater in males as compared to females.

Table 1: Mean difference for height and width of frontal sinus among males and females of Bihar population

Variable	Mean	p- value
Right side height	Male- 1.53 cm Female- 1.16 cm	0.00
Left side height	Male- 1.43 cm Female- 1.11 cm	0.00
Right side width	Male- 2.67 cm Female- 2.19 cm	0.00
Left side width	Male- 2.43 cm Female- 2.03 cm	0.00

Discussion

Schuller was first to study frontal sinus in 1921 and provided the details regarding its distinctive shape, size and uniqueness which can be used further for forensic purposes in disabling the identity. Radiographic comparison of bony structures has been extensively used for the identification of an individual, where either the body is highly mutilated or burnt.⁷ Gender determination plays a central role in establishing the identity of an individual for forensic or medico- legal cases.⁸

The present study conducted on 100 individuals of Bihar population in the age range of 20-30 years revealed significant differences in height and widths of frontal sinuses between both the genders. Mean dimensions of

height and width for both sides were larger in males as compared to females. Along with genetic factors, few environmental factors like nutrition or hormonal parameters may also play a role in differences of morphometric measurements among both genders. These could attribute in the fact that males have larger frontal sinus. Similarly, Verma et al reported greater measurements in males for South Indian population.² The mean right, left and total frontal sinus area of males was comparatively higher than females in a study done by Hussain et al in Indian population.⁴ Even the results of studies done by Mathur et al, Pandeshwar et al, Belaldevar et al were in accordance with the present study.⁵⁻⁷ In a study done by Eboh et al in Nigerian population left side height and width were statistically significant.⁸ Shireen et al revealed in Saudi population that mean values of height, width and area to be consistently larger in males compared to that in females.¹⁰ In the study done by Nethan et al, no significant difference was seen in the frontal sinus dimensions between males and females.⁹

Our study revealed that right side dimensions of frontal sinuses were larger than the left; but the differences were not statistically significant ($P > 0.05$). The reason for this difference could be due to their independent development. Hussain et al also showed slightly higher values of right side measurements but differences were not significant.⁴ In the study by Belaldevar et al mean measurement of right side frontal sinus was greater than the left side in both males and females.⁷ In contrast to these studies Verma et al, Eboh et al and Nethan et al presented with greater left side dimensions but the differences were not statistically significant.^{2,8,9}

Our research proposed that it is possible to detect gender on the basis of morphometric measurements of frontal sinuses for personal identification purposes in forensic science. Further studies should be conducted with wider age range and specific ethnic background.

Conclusion

Morphometric measurements of frontal sinuses obtained after suitable imaging technique can definitely provide an adjunctive tool to forensic sciences in gender determination. Particular study was limited to Bihar origin, therefore author intend to carry further study with larger population size including individuals of different ethnic origin.

Source of Funding

None.

Conflict of Interest

None.

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