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CLINICAL ARTICLE

A RETROSPECTIVE LATERAL CEPHALOMETRIC STUDY ON FRONTAL SINUS HEIGHT AND WIDTH MEASUREMENT PROTOCOL FOR GENDER DETERMINATION

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ABSTRACT

Aim: To develop and assess a protocol proposed for sex determination using frontal sinus height and width measured from two dimensional lateral cephalometric radiographs.

Material and Methods: The frontal sinus index was measured on sixty-four cephalometric scans (32 males & 32 females). The maximum height and width of the sinus were measured. The data was tabulated and independent t test was done to determine the correlation to gender.

Results: There was a high statistically significant difference between the frontal sinus width measured between male and female groups. The p value for width was found to be 0.02 which is significant.

Conclusion: Measuring the frontal sinus height and width by the proposed protocol is promising. Multicentric study is recommended to reach a solid evidence-based result. Also testing the reliability of the standardization protocol is recommended by applying it on multiple drawn sinus borders by multiple experienced radiologists.

Keywords: Keywords: Frontal Sinus Index, 2D Radiographs, Gender, Forensic Medicine

Introduction

Determining the sex of human skeletal remains is an essential requirement for their identification. For this purpose, several metric and morphological methods have been explicitly devised.[1] According to the literature, some researchers have proposed ways for determining gender utilizing Mesiodistal and Buccolingual, Cervical dimensions of teeth[2], as well as quantitative study of the sexual dimorphism of the occlusal surface of the first deciduous molar[3], first and second permanent molars, canine teeth using

geometric morphometric approaches.[5]
There has been comprehensive inclusion of the Two Dimensional[4] and Three-dimensional geometric measures, including volumes and surface areas have also been observed to be utilized in the gender determination.[5]
However, utilizing the Dental tissue is subjected to multiple challenges. For proper estimation of the gender, it is important the teeth must/dental tissue be intact. The teeth must not have undergone any wear which might substantially affect the detection of the gender.[6]
The frontal sinuses are two paired, lobulated chambers in the frontal bone that enter into the respective middle meatus through the infundibulum. They are situated posterior to the superciliary arches (Moore, 1992; Standring, 2005). Development starts around the second year of life, although they are not detectable radiographically until the age of five. They are not noticeable at birth. It is generally agreed that the frontal sinus develops fully by the age of around 20 and remains stable until additional growth of the chambers can result from bone resorption in older ages.[7] The frontal sinus chamber structure begins to mature and the frontal sinus partly appears between the ages of 2-3 years. At around age 8, increasing gasification causes the sinus chamber to enlarge to the supraorbital edge. During this moment, X-ray imaging makes the frontal sinus visible. At puberty, the frontal sinus grows at its fastest pace. At the age of 20, the frontal sinus cavity and frontal sinus' volume and form stabilize. [8-10]

Frontal sinus is a distinctively shaped anatomical landmark that may be compared to a fingerprint in personality, therefore frontal sinus index (FSI) could be employed in forensic personal identification.[11] Past research that assessed FSI and connected it to gender lacked a valid, uniform method of application in addition to being constrained and contradictory. [12-14]The foundation of forensic and anthropological study is a collection of physical traits which are particular to each person.[15] Recognizing sex is a crucial part of identifying oneself as a person.[16] Furthermore, until puberty, the accuracy of the skull in identifying sex is debatable.[17-19] It has been said that no one characteristic may be specifically deterministic of sex; accurate identification depends on a collection of diagnostic features.[17,18] Professor Roentgen took the first radiograph in 1895, beginning the field of diagnostic radiography, and it took another three years for the first radiographic autopsy study to be published.[20] The use of lateral cephalograms in skull and facial studies has progressively grown since Broadbent first introduced them in the orthodontic industry in 1931.[21] The lateral cephalogram is a tool used in orthodontics to help with diagnostic and treatment planning. Additionally, this technology may be utilised to infer a person's development and progress. Because of its distinct hollow structure, the frontal sinus may be seen clearly in the lateral cephalogram. Thus, it was shown that the frontal sinus served as a measuring reference scale and considerably increased the accuracy of sex discrimination. Several studies have already looked into the frontal sinuses' potential for sex identification. [22–27] The findings of those studies suggested that the frontal sinus index approach has limited promise since accurate classification rates were consistently low and only marginally better than random chance. [24–27]

The goal of this study, which took into account the aforementioned history, was to design and evaluate novel procedures for accurate sex determination utilizing the frontal sinus index calculated from two-dimensional lateral cephalometric radiographs.

Materials and methods

This retrospective study was conducted on 64 lateral cephalometric scans for patients who had been in the OPD of Karnavati School of Dentistry. The selected patients were 32 males and 32 females.

Inclusion criteria

Scans of patients above 20 years old were selected.

Exclusion criteria

Agenesis of frontal sinus, disease affecting the frontal sinus, scans with artifacts, congenital deformities, and scans with a history of surgery in the anatomical area of interest were all eliminate

Procedure

The height and width of the frontal sinus were assessed after analysis of the images. A horizontal line was drawn from the most anterior point crossing perpendicular to the vertical line and reaching the appropriate posterior boundary of the frontal sinus. A

vertical line was drawn from the most anterior point crossing perpendicular to the vertical line. The results were collated together with each patient's gender-specific score and statistical analysis was performed. On the cephalogram, a sella-nasion line was drawn horizontally. The maximum height and width of the sinus were measured as shown in (Figure 1).

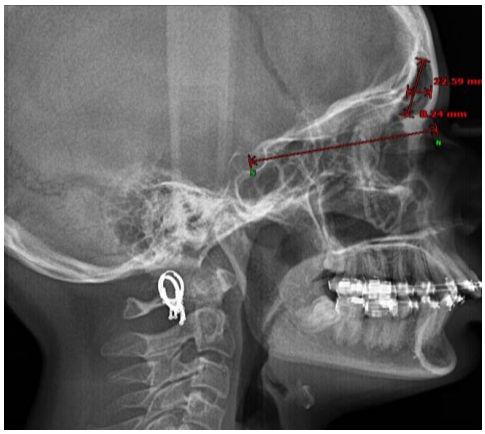

Figure 1: Assessment of the Frontal sinus Height and Width in Lateral Cephalogram with reference to S-N line.

Sample Size Estimation

The sample size was estimated using Open Epi Software keeping confidence interval at 95% and power of the study at 80%. The Proportion based sampling technique was utilized. The formula for estimation of the sample size was $n=p*q(Za/2/E)^2$ The final sample size was estimated to be 60. 32 male and 32 female participants cephalograms were utilized for the study.

Statistical Analysis

Total of 64 lateral cephalometric scans were analyzed for measuring height and width of frontal sinus as gender identification tool in 32 males & 32 females. The data was observed to be continuous in nature. Descriptive Statistics (Mean and Standard Deviation) was obtained for the Height and Width of Frontal Sinus To compare the difference of the Height and Width of the Frontal Sinus between the Gender independent t test was applied. The statistical analysis was performed using the statistical software package SPSS Statistical Package for Social Science (Chicago, IL, USA) version 21.0 and P < 0.05 was considered statistically significant.

Table 1 Comparison of the frontal sinus height and width between the gender.

Mean of Height and Width								
	GENDER	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	t	p Value
Height	Male	32	27.2128	5.71834	1.01087	.61438	.383	.703 (NS)
	Female	32	26.5984	7.04601	1.24557			
Width	Male	32	10.8163	2.92229	.51659	1.58875	2.342	.022 * (S)
	Female	32	9.2275	2.48801	.43982			

*Std.Deviation- Standard Deviation t – Independent t-test t Value, * - (p<0.05) evaluated using Independent t test.*

In male group, the mean height and width was found to be 27.2 and 10.8 respectively, with standard deviation 5.7 and 2.9 respectively and standard error mean 1.01 and 0.5 respectively. In female group, the mean height and width was found to be 26.5 and 9.2 respectively, with standard deviation 7.04 and 2.4 respectively and standard error mean 1.2 and 0.4 respectively as shown in Table (1). Independent sample t test was performed and p vale was found to be 0.7 for height which is non-significant and p value for width was found to be 0.02 which is significant as shown in Table (1). The statistical test of data showed a statistically significant difference of frontal sinus width between male and female group. There was significant difference for Width but not Height.

Discussion

Identifying one's gender is crucial for forensic dental examinations that might be used to a variety of dental techniques, including teeth palatal rugae or lip morphological prints, and sinus measurements in the paranasal region [28]. There is plethora of literature findings which have jotted the importance of usage of Dental Structures in identification of the Gender. Dentition of individual has significantly offered to be of great assistance to the forensic society.[1-6] The usage of Human Dentition often presents with multiple of challenges which include overlapping

traits like crown size, dimensions[5] which may not significantly aid in the determination of the gender. Even after using the 3D Technology for identification of the Teeth the investigation is often limited if any wear of has occurred in the tooth structure[6] Another limitation of using the dentition is the performance or alteration in any tooth structure resulting in restoration or prosthesis cementation. From the literature it is also observed that there are a definitive cultural and regional differences observed [2-6] which can definitely alter the gender determination of individual. While these studies have been conducted in various regions of the globe complete generalizability of these studies is questionable due to cultural and regional differences. Using Frontal Sinus offers exquisite advantages like it being a unique anatomical landmark which will not be altered unless otherwise injured. These sinuses have been persistent after death and are less susceptible to environmental degradation.[27,29,30] Our study has investigated and put forth a crucial method to analyze and determine the sexual dimorphism. While there are multiple methods in determining sex our method can enhance forensic odontologist in determining the sex using a unique and fixed anatomical landmark which undergoes less alteration/changes over the time period. The inspiration for this research came from the distinct form of frontal sinus. Researchers early on verified this. similar to Asherson, who, in 1965, despite performing the frontal sinus was consistently present in twin studies distinct[29]. Quatrehomme et al successfully recognized frontal sinus was used in two forensic cases, and in one of them contributed to the murderer's arrest. [30]

Cephalometry is still the most popular method for skull analysis because of its low dose, affordability, accessibility, and constant accuracy, irrespective of the fact that maxillofacial imaging has advanced from conventional two-dimensional techniques to cutting-edge three-dimensional technologies. The issue with 2D imaging was that even little adjustments to the angulation and location of the object in reference to the receptor and the machine might affect the anatomical characteristics. As they were believed to be more dependable in terms of elements like geometric distortion, ratios were utilized to remedy this issue. Due to its fixed morphological form following an individual's development, the frontal sinus has emerged as a key component of forensic study. The frontal sinus is frequently used by researchers to determine sex. In 2014, Belaldavar et al.[27] reported a 64.6% correct sex discrimination rate using 300 digital poster-anterior radiographs taken of 150 males and females of age between 18 to 30 years. It was done by measuring right and left areas, maximum height and width of the frontal sinus, as well as employing the logistic regression analysis to determine sex. They promoted the use of the frontal sinus for sex differentiation as a consequence.[31] The discriminant function equation for the correlation between sex and frontal sinus index was developed by SaiKiran et al. using the frontal sinus index in the same year. The accurate sex discrimination percentage in this study was found to be 67.6%. [32]

Zhang et al. discovered that although there were no appreciable differences between sexes, the morphometric measures of the frontal sinus varied greatly from person to person. Therefore, he suggested that frontal sinus would be a superior method for identifying a certain person than sex [33]. Only 60% of the 100 radiographs from the Para nasal sinus view in research by Goyal et al. (50 men and 50 females) were correctly classified as to gender.[34]For the study of sexual dimorphism, the frontal sinus index is an invaluable instrument. The frontal sinus measurements tend to settle with age, making it ineffective for determining sex in growing skulls. Due to the standardization of the measuring process and the use of cephalograms, the results of the current study are more trustworthy and reproducible. These findings establish the frontal sinus index as a trustworthy auxiliary tool for sex identification. However, other studies produced findings that were different from our own, such as Elbeshlawy & Helaly's[14] conclusion that the FS index was merely a poor sex predictor. This might be because their methodology is different.

Conclusion

The suggested procedure for measuring the frontal sinus height and width shows promising result. To arrive at a conclusive, empirically supported conclusion, multicentric investigation is advised. It is advised to apply the standardisation process to several drawn sinus boundaries made by various qualified radiologists in order to assess the methodology's dependability.

Declarations

Conflicts of interest and financial disclosures:

The authors declare that they have no conflict percent and there was no external source of funding for the research in question.

Ethical approval

The study was approved by the Institutional Ethics Committee

Informed consent

Informed consent was obtained from all individual participants included in the study.

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