10.5005/jp-journals-10015-1503

ORIGINAL RESEARCH

Frontal Sinus as an aid in Gender Identification in Forensic Dentistry: A Retrospective Study using Cone Beam Computed Tomography

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ABSTRACT

Aim: The aim of our study was to measure the frontal sinus morphology that could aid us in gender determination and also to assess the difference in measurements between the right and left frontal sinus.

Materials and methods: A retrospective study was done using 100 cone beam computed tomography (CBCT) images (50 males and 50 females) matched with age and gender with full field of view (FOV). The examinations were carried out using Promax 3DMid (Planmeca Oy., Helsinki, Finland) CBCT unit. The frontal sinus was assessed in coronal, sagittal, and axial planes, and the maximum measurements in each section were recorded. The results to compare the right and left frontal sinus were analyzed using paired t-tests, and independent Student's t-test was used to compare the difference in measurements of frontal sinus between males and females.

Results: We found that the left side of the frontal sinus was bigger than the right side, and while comparing between the genders, it was found that the measurements were greater in males. Statistically significant results were obtained on comparing between the sides and gender.

Conclusion: As mentioned in previous studies, frontal sinus measurements are significantly higher in males compared with females which can, therefore, be used in gender identification in cases of mass disasters.

Clinical significance: Frontal sinus measurements can be used as an adjunct in gender identification in mass disasters and with advances in technology. Cone beam computed tomography, in addition to providing accurate measurements, has overcome all the disadvantages with two-dimensional imaging.

Keywords: Cone beam computed tomography, Forensic investigations, Frontal sinus, Gender determination.

How to cite this article: Denny C, Jacob AS, Ahmed J, Natarajan S, Binnal A, Sujir N. Frontal Sinus as an aid in Gender Identification in Forensic Dentistry: A Retrospective Study using Cone Beam Computed Tomography. World J Dent 2018;9(1):34-37.

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Source of support: Nil

Conflict of interest: None

INTRODUCTION

Cone beam computed tomography as an imaging tool in dentistry has varied clinical applications, one of which is viewing sinuses. The accuracy of measurements using CBCT is also commendable. The basic two-dimensional imaging though vastly used has disadvantages like superimpositions and changes in the quality of image secondary to positioning errors and processing the films.

The frontal sinus shows no change after the age of 20 and remains stable throughout the individual's life until old age, when gradual pneumatization can occur from atrophic changes.[1] Similar to fingerprints, the frontal sinus is very unique in every individual, even monozygotic twins. Therefore, frontal sinus radiographs can be compared to make the identification a simple, swift, and an unambiguous procedure.[2] Camargo et al[3] in their article stated that correlation of the morphology of the frontal sinus with gender shows that the frontal sinus is smaller in women, an aspect that points out its unique characteristic and importance in human identification. Imaging of the human body, especially the head and neck region, has been useful in forensic dentistry for proving medicolegal cases and inhuman identifications during mass disasters. Hence, this study was done to measure the frontal sinus morphology, which in turn helps us in gender determination.

MATERIALS AND METHODS

A retrospective study was conducted after obtaining clearance from the Institutional Ethics Committee. One hundred CBCT images (50 males and 50 females) matched with age and gender with full FOV were retrieved. Information regarding age, sex, and systemic conditions, etc., of the study subjects was collected from their dental records. The subjects included in the study were healthy individuals without any pathology in the sinus and patients in the age range of 20 to 30 years. The reason for age criteria was due to the fact that the growth of frontal sinus completes or attains its development by 20 years and as age progresses the walls become thinner and hence, appears larger. The patients excluded from the study were those

who reported with history of trauma or pathology to the sinus, absence of sinus unilaterally or bilaterally, syndrome patients, patients with congenital disorders and patients with history of surgical intervention, such as orthognathic surgery, sinus lift, or any surgery. The examinations were carried out using the Promax 3DMid (Planmeca Oy., Helsinki, Finland) CBCT unit. The radiographs were taken at 90 kVp, 8 mA, and an exposure time of 27 seconds. A slice thickness of 0.400 mm was used to assess the sections. The exposure parameters according to the standard default values were based on the FOV.

The frontal sinus was assessed in coronal, sagittal, and axial planes, and the maximum measurements in each section were recorded. The height and width of the frontal sinus were measured. The coronal sections were assessed for maximum superoinferior and mesiodistal measurements for both right and left frontal sinus (Fig. 1). The measurements for right and left frontal sinus in the sagittal section, i.e., maximum superoinferior measurement, were established from the patient's medial line and the measurements taken were correlated with the coronal sections. The maximum anteroposterior (AP) measurements were recorded for right and left frontal sinus after correlation with the axial section. In the axial section, the AP measurement was recorded after correlating it with the sagittal section, and mesiodistal measurements were taken at a section where maximum mesiodistal measurements were available.

The results to compare the right and left frontal sinus were analyzed using paired t-tests, and independent Student's t-test was used to compare the difference in measurements of frontal sinus between males and females.

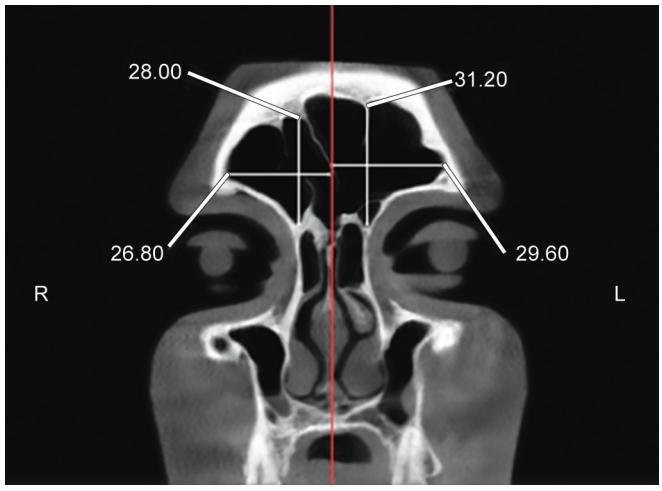

Fig. 1: Frontal sinus measurement superoinferiorly and mesiodistally in coronal section

RESULTS

Paired t-test

The paired t-test was applied to compare the difference in measurements of right and left frontal sinus in axial, coronal, and sagittal sections irrespective of gender. One hundred patients were included in the study, which was divided into 50 males and 50 females (Table 1).

Axial Section

On comparison of the mean values in the axial section anteroposteriorly on both right and left side, it was seen that the mean values in the axial section of left side were higher with a mean difference of 0.9698, which was

Table 1: Total group irrespective of gender comparison of the right and left frontal sinus: paired t-test

				Paired differences			
	Mean	*n*	*Standard deviation*	*Mean difference ± SD*	*t-value*	*df*	*p-value*
Pair 1							
Axial section right AP	9.8822	100	4.823391	–0.9698 ± 3.352842	–2.892	99	0.005
Axial section left AP	10.852	100	5.120162				
Pair 2							
Axial section right MD	22.2003	100	8.410006	–0.286 ± 18.737443	–0.327	99	0.744
Axial section left MD	22.4864	100	7.542099				
Pair 3							
Sagittal section right AP	11.4504	100	5.703515	–0.824 ± 3.512907	–2.346	99	0.021
Sagittal section left AP	12.2744	100	5.279986				
Pair 4							
Sagittal section right SI	24.3642	100	9.612597	–1.6842 ± 5.668888	–2.971	99	0.004
Sagittal section left SI	26.0484	100	9.336425				
Pair 5							
Coronal section right SI	23.8624	100	8.419029	–2.0716 ± 10.3888	–1.994	99	0.049
Coronal section left SI	25.934	100	11.02097				
Pair 6							
Coronal section right MD	21.944	100	7.627122	–0.454 ± 7.990745	–0.568	99	0.571
Coronal section left MD	22.398	100	7.545016				

SD: Standard deviation; SI: Superoinferiorly, MD; Mesiodistally; df: Degree of freedom

statistically significant (p = 0.005). While comparing the mean values of right and left side mesiodistally, the mean value on the left side mesiodistally was higher with a mean difference of 0.2861, which was statistically insignificant.

Sagittal Section

In this section on comparing both sides anteroposteriorly and superoinferiorly, it was found that the mean value on the left side was higher with a mean difference of 0.824 anteroposteriorly, which was statistically significant with a p-values = 0.021 and 1.6824 superoinferiorly with significant p = 0.004.

Coronal Section

On comparison of the mean values of right and left side superoinferiorly, it was found that the mean value on the left side was higher with a mean difference of 2.0716, which was statistically significant (p = 0.049). It was found that the mean value on the left side was higher mesiodistally, with a mean difference of 0.454, which showed statistically significant p = 0.571.

Independent Student's t-test

This test was done to compare the difference in measurements of frontal sinus between males and females (Table 2).

Axial Section

Comparison of the right and left frontal sinus measurements anteroposteriorly and mesiodistally between the two groups showed that both the measurements were greater in the males. The p values for right AP, mesiodistal and left AP measurements are <0.001 and the left mesiodistal measurement had p = 0.007, all of which were statistically significant.

Sagittal Section

Comparison of the right and left frontal sinus measurements anteroposteriorly and superoinferiorly between the two groups showed that both the measurements were greater in the males. The p values for right and left AP measurements were <0.001 and the right and left superoinferior measurements had a p = 0.141 and 0.082 respectively, which was statistically nonsignificant.

Coronal Section

Comparison of the right and left frontal sinus measurements superoinferiorly and mesiodistally between the two groups showed that both the measurements were greater in the males. The p values for right and left mesiodistal measurements were <0.001, and the right and left superoinferior measurements had a p = 0.243 and 0.805 respectively, which was statistically nonsignificant.

Table 2: Independent t-test for comparison of frontal sinus among both the genders

	Sex	*n*	*Mean ± SD*	*t-value*	*df*	*p-value*
Axial section right AP	M	50	12.252 ± 4.826764	5.621	98	<0.001
	F	50	7.5124 ± 3.49946			
Axial section right MD	M	50	25.12 ± 6.749513	3.686	98	<0.001
	F	50	19.2806 ± 8.941291			
Axial section left AP	M	50	13.156 ± 5.828717	5.02	71.253	<0.001
	F	50	8.548 ± 2.856517			
Axial section left MD	M	50	24.4924 ± 7.491728	2.746	98	0.007
	F	50	20.4804 ± 7.1126			
Sagittal section right AP	M	50	13.7916 ± 5.974485	4.483	98	<0.001
	F	50	9.1092 ± 4.3409			
Sagittal section right SI	M	50	25.7844 ± 7.681863	1.486	87.111	0.141
	F	50	22.944 ± 11.11587			
Sagittal section left AP	M	50	14.5044 ± 6.210793	4.641	67.593	<0.001
	F	50	10.0444 ± 2.757305			
Sagittal section left SI	M	50	27.6724 ± 8.743145	1.758	98	0.082
	F	50	24.4244 ± 9.710389			
Coronal section right SI	M	50	24.852 ± 5.580843	1.178	74.676	0.243
	F	50	22.8728 ± 10.49105			
Coronal section right MD	M	50	25.172 ± 5.816095	4.653	98	<0.001
	F	50	18.716 ± 7.90196			
Coronal section left SI	M	50	26.208 ± 8.524247	0.247	98	0.805
	F	50	25.66 ± 13.13722			
Coronal section left MD	M	50	24.824 ± 7.348318	3.38	98	0.001
	F	50	19.972 ± 7.000526			

SD: Standard deviation, SI: Superoinferiorly, MD: Mesiodistally; df: Degree of freedom

DISCUSSION

Frontal sinus is a hollow cavity in the frontal bone, and it is unique to each person. Like fingerprints, frontal sinus is unique in each person, even in monozygotic/dizygotic twins. Compared with fingerprints, frontal sinus assessment is preferred as soft tissues can get destroyed or mutilated when it gets burnt,[4] and its arch-shaped nature with internal bony structure protects it from getting decomposed or damaged even in high impact accidents. Frontal sinuses also remain stable throughout human life. Hence, it is preferred in forensic investigations.[5]

In this study, on comparing the left and right frontal sinuses irrespective of gender, we found that left side was larger when compared with the right side, which is in accordance to the study conducted by other studies by Rubira-Bullen et al[6] and Soman et al.[7] The reason for the asymmetry in individuals of the same age could be due to the fact that both the sinuses develop independently and have different rates of osseous resorption,[3,8-10] and our result was not in accordance to the study conducted by Belaldavar et al[4] where they found it vice versa.

The difference in the frontal sinuses among sexes could be due to factors, such as genetic followed by muscular, nutritional, and hormonal.[11,12] Our study showed that frontal sinuses in males were larger than in females, which was similar to studies conducted by Camargo et al,[3] Belaldavar et al,[4] and Rubira-Bullen et al.[6]

According to our study, we found that males had a larger frontal sinus and the left side of the frontal sinus was larger than the right. These findings help us in sex determination in mass disasters, crime scene, or if the body is severely decomposed. Although the radiation exposure to the patient using three dimensions is much more compared with two dimensions, the benefits outweigh the disadvantage, which makes CBCT a valuable tool in assessing the anatomy of oral and maxillofacial structures.

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