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MORPHOMETRIC EVALUATION OF FRONTAL AIR SINUS - A CT STUDY

Anatomy

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ABSTRACT

Background: The revolutionary changes in the surgical treatment of sinusitis in recent years, particularly in endonasal endoscopic surgery require the clinician to have precise knowledge of nasal sinus anatomy.

Materials and methods: This study was undertaken on 100 normal paranasal sinus CT images (50 male & 50 female) in the age group of 20 to 70 years. The different dimensions like Antero-posterior diameter, Height and Width were measured.

Results: In our present study, there was a significant increase in width of frontal sinus in males on right side and height of frontal sinus in males on left side.

Conclusion: The sound knowledge of frontal sinus morphometry and variability is very useful to plan surgical approach to frontal sinus and also in medico-legal issues.

KEYWORDS

Frontal sinus, Morphometry, CT

INTRODUCTION:

The frontal sinus is a funnel-shaped cavity, unique to individual and separated by septum. It is lobulated, irregular shaped, air-containing chambers, lined by mucoperiosteum. It is situated bilaterally in between the external and internal cortical surface of the frontal bone, posterior to the superciliary arches and at the root of the nose [1]. In general, central septum separates the left and right sides, however often there may be several septations. It is as unique to each individual as fingerprint [2], even monozygotic twins differ in sinus characteristics [3]. The paranasal sinus begins development early in fetal life. By the sixth year, they can be demonstrated radiographically and grow larger in size by late adolescence [2].

The frontal sinus is often thought as a more "symptomatic sinus" because of the difficulties encountered in frontal sinusitis and maintaining a patent frontal sinus ostium in patients with frontal rhinosinusitis [4]. It is a sturdy part of the skull that is likely to be retrieved for forensic investigations [5, 6]. It has been suggested that frontal sinus patterns have a potential to be used as aids for personal identification, age estimation, and sexual dimorphism. The right and left frontal sinuses develop independently, and are often asymmetrical.Various studies on the frontal sinuses have been reported.

Schuller found that X-ray of the frontal sinuses is a very good tool for identification [7].Variations in the appearance of frontal sinuses during lifetime are primarily due to thinning of the bone with old age and trauma, and in rare occurrences from tumors or severe infections. Among the paranasal sinuses, frontal sinus shows the maximum variations. Some factors can modify the normal anatomy of the frontal sinus, such as fractures, neoplasia, severe infections and mucoceles. CT is an excellent cross-sectional imaging technique that is used to map sinus anatomy prior to surgical intervention to limit morbidity.

It is important for surgeons to be aware of variations that may predispose patients to increased risk of intraoperative complications and help avoid possible complications, thereby improve success of management. Therefore, this work aimed to study the size of frontal sinus to assess the variability of the frontal sinus pattern in an Indian population and to evaluate the reliability of frontal sinus in gender determination using computerized tomography.

MATERIALS AND METHODS:

With prior approval of the ethical committee, this observational study was carried out over 100 normal paranasal sinus CT images of 50 male and 50 female. CT images were collected from the Department of Radiology, linked with this institute. We categorized the study population into three age groups of 20-34, 35-49 and >50 years. CT images of healthy adult male and female were included. CT images of Individuals with apparent maxillofacial deformities or asymmetry, with any ailment of paranasal sinuses, history or clinical features of any other systemic or congenital disorder were excluded.

Different Coronal and Axial slices with 0.6 mm, 1.25 mm and 4 mm thickness were collected and further analysis was done with help of computer analogue attached with 64 SLICE CT scan machine (General Electronics, OPTIMA). Antero-posterior diameter, Width and Height were taken at their maximum measurements as shown in **Figure No. 1&2.** Antero-posterior diameter (AP) and Width was measured in axial section. Height and Width was measured in coronal section.The data was analyzed for significant differences between measurements made at the selected points in the frontal sinus, for left to right variations, and for gender variations.

Statistical Analysis:

The data obtained were subjected to analysis using statistical software SPSS 20. Comparison of frontal sinus dimensions between males and females were done using unpaired t- test and $p<0.05$ was considered statistically significant.

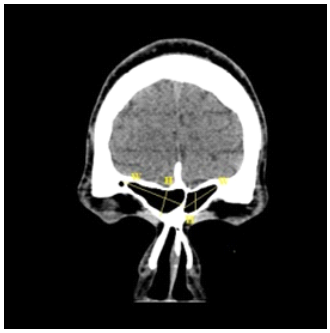

Figure No.1. Coronal section (W- Width, H- Height)

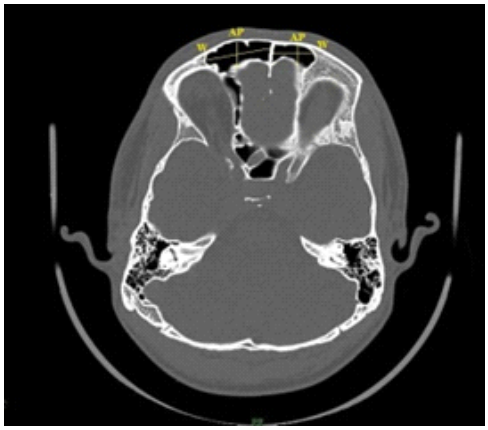

Figure No.2: Axial section (AP- Antero-posterior diameter, W-Width)

RESULTS:

The mean corrected Antero-posterior diameter of frontal sinus with Standard Deviation in males and females taken on both sides showed the differences among them are not statistically significant (Table 1).

Table: 1 Comparison of frontal sinus AP diameter between males and females in the study population

Frontal sinus dimension		Male (n=50)	Female (n=50)	t value	p value
		Mean ± SD	Mean ± SD		
AP diameter (mm)	Right	8.41 ± 2.77	8.56 ± 2.08	0.219	0.828 (NS)
	Left	8.62 ± 2.34	8.38 ± 1.64	0.419	0.677 (NS)

p<0.05 is considered statistical significant
NS: Not significant

The mean corrected width of frontal sinus with Standard Deviation in males and females on both sides were compared. After intercomparison, on right side the p-value was found to be 0.027(p<0.005) which was statistically significant **[Table 2].**So there was a significant increase in width of frontal sinus in males on right side.

Table: 2 Comparison of frontal sinus width between males and females in the study population

Frontal sinus dimension		Male (n=50)	Female (n=50)	t value	p value
		Mean ± SD	Mean ± SD		
Width (mm)	Right	24.45 ± 9.08	19.88 ± 4.15	2.288	0.027*
	Left	22.56 ± 10.04	21.70 ± 4.46	0.389	0.699 (NS)

*p<0.05 is considered statistical significant
NS: Not significant

The mean corrected height of frontal sinus with Standard Deviation in males and females on both sides were compared. After intercomparison, on left side the p-value was found to be 0.028(p<0.005) which was statistically significant **[Table 3].** So there was a significant increase in height of frontal sinus in males on left side.

Table: 3 Comparison of frontal sinus height between males and females in the study population

Frontal sinus dimension		Male (n=50)	Female (n=50)	t value	p value
		Mean ± SD	Mean ± SD		
Height (mm)	Right	11.92 ± 4.77	10.75± 4.44	0.892	0.377 (NS)
	Left	12.86 ± 5.36	10.11 ± 2.86	2.262	0.028*

*p<0.05 is considered statistical significant
NS: Not significant

Comparison of frontal sinus dimensions between different age groups in the study population were analyzed using ANOVA and p<0.05 was considered statistically significant. The anteroposterior diameter, width and height of frontal sinus in different age groups were compared in all 100 images. After intercomparison, the p- value of height on right side was found to be 0.000(p<0.005) which was statistically significant. There was no statistical significant difference found among the different age groups on other various dimensions in the study population.

DISCUSSION:

There are considerable variations in the shape, capacity and symmetry of the frontal sinuses. The environmental & genetic factors, ethnicity, craniofacial configuration and the thickness of frontal bone etc. can play a major role in these differences. Our study, correlates with the study of Pradnyesh et al[8] (2017) & Mathew KL et al[9] (2010), they observed that, different parameters in male and female taken on right and left side, the differences among them are not significant. But, values of different parameters in male are towards higher side compared to females. AP diameter, Height & Volume are towards higher side on right side compared to left; while width showing opposite i.e. higher values on left side. In our present study, there was a significant increase in width of frontal sinus in males on right side and height of frontal sinus in males on left side.

Rubira Bullen [4] (2010) showed there was a significant correlation between the width and height by the Spearman Test. However, there was no significant difference among the age groups regarding the height and width of the frontal sinuses. In the present study, there was significant correlation between the width on right side and height on left side. Similarly there was no significant correlation among the age groups.

Camargo JR et al [10] (2007) through their study on the forensic importance of radiographic morphology of frontal sinus employing Caldwell technique, stated that the mean dimensions of the frontal sinus in the men were consistently greater than in the women. Tatlisumak et al [11](2007) and Tang et al[12](2009) assessed the patterns of frontal sinus for personal identification through similar variables as in our study using CT images. Tang et al[12](2009) found statistical sex differences for three out of eight variables (P < 0.05). Both the studies do not comment on the differences in the variables among males and females.

The present study has certain limitations such as this technique needs standardized parameters for measurement of the dimension of frontal sinus with minimal chances of error. The frontal sinus patterns can be affected by genetic factors as well as growth hormone.

CONCLUSION:

The sound knowledge of frontal sinus morphometry and variability helps surgeon in carrying out various surgical procedures viz. FESS, cranioplasty and sinus surgery. The morphometric ante-mortem data of particular patient can also be stored for post-mortem identification of the same individual just like record of fingerprint.The presence of anatomic variations in the paranasal sinuses has necessitated that the surgeon be more familiar with this in addition to a careful surgical technique so as to increase patient safety.

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