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Anthropometric study of the frontal sinus on plain radiographs in Delta State University Teaching Hospital

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Abstract:

INTRODUCTION: The paranasal sinuses are air-filled spaces located within the bones of the skull and face. The different anatomical dimensions of paranasal sinuses can be obtained from plain radiograph and computed tomography images. Determining the possible significant variation of the right and frontal sinuses of males and females is essential for clinical purpose.

PURPOSE OF THE STUDY: The purpose of this study, therefore, was to measure the anthropometric length and width of the frontal sinus on plain radiograph in different age groups and to determine the possible variations in males and females.

MATERIALS AND METHODS: This descriptive cross-sectional study adopted the simple random sampling technique. The study population comprised 200 individuals (100 males and 100 females).

RESULTS: Frontal sinus length and width were measured using the inelastic plastic ruler (in centimeter) and recorded on a data sheet pro forma. The mean total frontal sinus length and frontal sinus width across the entire population for both the right and left sides as regards males and females were given as (4.42 ± 4.79 cm, 3.85 ± 4.24 cm, 4.05 ± 4.44 cm, 3.57 ± 3.93 cm) and (3.64 ± 4.01 cm, 3.29 ± 3.46 cm, 3.23 ± 3.57 cm, 2.83 ± 3.13 cm), respectively. The Student's *t*-test statistics between the right and left sides in each of the studied parameters were highly statistically significant ($P = 0.000$).

CONCLUSION: The frontal sinus is a constant structure in human beings, but shape and dimensions may vary among individuals; thus, the dimorphic nature of the left frontal sinus dimensions has implications for human identification.

Keywords:

Anthropology, frontal sinus, radiographs, variation

Introduction

Sinuses are mucosa-lined air spaces in the bone of the face and skull. The frontal sinuses are paired lobulated cavities situated posterior to the supercilliary arches in the frontal bone and each frontal sinus opens into the subsequent middle meatus through the infundibulum. The frontal bone is membranous at birth and there is rarely more than a recess until the bone tissue starts its ossification at the age of 2. The frontal sinuses are not evident at birth and its development begins during the 2nd year of life but is not always visible radiographically. The development of the frontal sinus is complete at about age 20 and remains stable from bone resorption during the advanced ages. As a result of the discovery of X-ray in 1895, studies on the paranasal sinuses were frequently carried out on plain film radiography.

The posterior-anterior (PA) injection described by Caldwell (1907) was designed to provide a clear print of the frontal and the ethmoid sinuses with the exception of the loss of definition by superimposition of portions of the sphenoid bone. The

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function of the paranasal sinuses are, however, not well understood, but anatomical literatures have suggested that the paranasal sinuses lighten the skull and also add more resonance to the voice. Several factors are responsible for the modification of the normal anatomy of the frontal sinuses among which are fractures, neoplasis, severe infections, and mucoceles. It has also been reported that no two individuals have similar frontal sinuses, as well as identical twins: Barghout *et al*. (2002) reported differences between the right and left frontal sinuses of the Brazilian population. Ponde (2003) conducted similar studies among Australian subjects with the exception of the transverse diameter. Carmargo *et al.* (2007) carried out a study on the frontal sinus morphology in radiographs of Brazilian patients and reported the males to have higher values compared to the female counterpart.

Tattisumak and Angi (2011) carried out a study on computerized tomography study on the morphometry of the frontal sinus in Turkey and reported that all measurements gotten proved to be larger on the left side than on the right side and were significantly larger in males compared to the female counterpart. Rubira-Bullen *et al.* (2010) conducted a similar study on the frontal sinus size on facial plain radiographs in Brazil. A thorough search of the literatures has shown that similar studies to obtain data from the Delta State University Teaching Hospital, in Nigeria are not available. The data obtained from the study will serve as a baseline data for surgeons to be aware of these variations that may predispose patients to increased risk of intra-operative complications and also help to prevent possible complications that will help to enhance the successfulness of good management. However, a good understanding of the normal pneumatization and development of the frontal sinuses (also known as paranasal sinuses) is thus important for the evaluation of sinus disease and to propose adequate treatments (Danai, 1997). This study was undertaken to measure the morphological length and width of the frontal sinus on plain radiographs in Delta State University Teaching Hospital.

Materials and Methods

This was a retrospective study that involved all patients that attended the radiological services of the Delta State University Teaching Hospital for plain X-ray of the frontal sinus formed the study population. Two hundred radiographs of individuals aged 18–49 years were taken and investigated by Caldwell method (PA view) and selected through the simple random sampling technique. The study population for this study was comprised 100 adult Nigerian females and 100 Nigerian males. The bio-data of each individual was obtained from the records in the hospital. X-ray films of the frontal sinus that showed normal anatomical landmarks were included and those with a trace of pathology as a result of prior surgery of the skull were excluded from the study. The research Ethics Committee of the Institution approved the research method. Anthropometry involved the measurement of the frontal length (right and left) and frontal sinus width (right and left) based on international standard (Verma *et al*. 2014). The data obtained were subjected to statistical analysis using descriptive statistics; Student's *t*-test with the aid of Statistical Package for Social Sciences (SPSS, Version 20.0, Chicago). $P < 0.05$ was considered as statistically significant.

Results

Table 1 shows age and gender distribution. The participants were divided into five age groups with equal intervals.

Table 2 depicts combine data from both sides in both genders (200). The mean values were recorded, respectively, as the right frontal sinus length, right frontal sinus width, left frontal sinus length and left frontal sinus width for males and females: (4.42 and 4.79; 4.05 and 4.44; 3.85 and 4.24; 3.57 and 3.93) and (3.64 and 4.01; 3.23 and 3.57; 3.13 and 3.46; 2.83 and 3.13). The mean values for the right frontal sinus length and right frontal width were greater in males than that of females.

Table 3 depicts the statistical *t*-test between the right and left frontal sinuses of males. It was observed that all males studied variables were highly statistically significant ($P = 0.000$). Table 3 also depicts that the male right frontal sinus length and width values was greater than the left frontal sinus length and width. This implies that there is significant variation in the right and left frontal sinuses of males.

Table 4 depicts the statistical *t*-test between the right and left frontal sinuses of females. It was observed that all females studied variables were also highly statistically significant ($P = 0.000$). Table 4 also depicts that the female right frontal sinus length and width values was greater than the left frontal sinus length and width. This implies that there is significant variation in the right and left frontal sinuses of females.

Table 1: Age and gender distribution in the current study

Gender	Age (years)				Total
	18-25	26-33	34-41	42-49	
Males	21	15	35	29	100
Females	19	17	35	29	100
Total	40	32	70	58	200

Source: Statistical package for social sciences output

Table 2: Descriptive Statistics of parameters measured on both sides with respect to gender

Variables	Gender	*n*	Minimum (cm)	Maximum (cm)	Mean (cm)	SD (cm)
$RFSL_m$	Male	100	2.90	6.90	4.42	4.79
$RFSW_m$	Male	100	3.10	7.20	4.05	4.44
$LFSL_m$	Male	100	2.40	7.70	3.85	4.24
$LFSW_m$	Male	100	2.90	6.30	3.57	3.93
$RFSL_f$	Female	100	2.70	5.30	3.64	4.01
$RFSW_f$	Female	100	2.60	5.10	3.23	3.57
$LFSL_f$	Female	100	2.40	4.90	3.13	3.46
$LFSW_f$	Female	100	2.50	5.00	2.83	3.13

Source: Statistical package for social sciences output. RFSL - Right frontal sinus length, RFSW - Right frontal sinus width, LFSL - Left frontal sinus length, LFSW - Left frontal sinus width, SD: Standard deviation

Table 3: *T*-test for independent samples on both sides for male frontal sinus

Variables	Gender	*n*	*t*	Df	*P*	Significant
RFSL	Male	100	48.46	99	0.000	High significant
RFSW	Male	100	41.66	99	0.000	High significant
LFSL	Male	100	43.39	99	0.000	High significant
LFSW	Male	100	41.14	99	0.000	High significant

Source: Statistical package for social sciences output. RFSL - Right frontal sinus length, RFSW - Right frontal sinus width, LFSL - Left frontal sinus length, LFSW - Left frontal sinus width

Table 4: *T*-test for independent samples on both sides for female frontal sinus

Variables	Gender	*n*	*t*	Df	*P*	Significant
RFSL	Female	100	40.67	99	0.000	High significant
RFSW	Female	100	39.07	99	0.000	High significant
LFSL	Female	100	39.41	99	0.000	High significant
LFSW	Female	100	38.92	99	0.000	High significant

Source: Statistical package for social sciences output. RFSL - Right frontal sinus length, RFSW - Right frontal sinus width, LFSL - Left frontal sinus length, LFSW - Left frontal sinus width

Table 5: *T*-test for combine samples on both sides for male and female frontal sinus

Variables	Gender	*n*	*t*	Df	*P*	Significant
RFSL	Male	100	48.46	99	0.000	High significant
RFSW	Male	100	43.39	99	0.000	High significant
LFSL	Male	100	41.66	99	0.000	High significant
LFSW	Male	100	41.14	99	0.000	High significant
$RFSL_f$	Female	100	40.67	99	0.000	High significant
$RFSW_f$	Female	100	39.07	99	0.000	High significant
$LFSL_f$	Female	100	39.41	99	0.000	High significant
$LFSW_f$	Female	100	38.92	99	0.000	High significant

Source: Statistical package for social sciences output. RFSL - Right frontal sinus length, RFSW - Right frontal sinus width, LFSL - Left frontal sinus length, LFSW - Left frontal sinus width

Table 5 depicts the statistical *t*-test of both the right and left frontal sinuses between males and females. It was observed that both the males and females variables were highly statistically significant ($P = 0.000$). Furthermore, it was observed from Table 5 that the male frontal sinus length and width for the right and left sides was greater that the female frontal sinus length and width for the right and left sides. Thus, this implies that there is significant variation in the right and left frontal sinuses between male and females.

Discussion

The understanding of anthropometric dimensions of structures in the facial region with regard to different age and gender is important for correct reconstruction of the facial appearance for surgical and forensic purposes (Eboh 2013). It has been reported that no two individuals have similar frontal sinuses, as well as identical twins. It has also been reported that the areas and dimensions of the frontal sinus are rarely equal and in some cases may be absent (Belaldavar *et al.* 2014). The present study focused on the anthropometric measurements of the frontal sinus length and width of both sides. In a similar study in Brazil (Camargo *et al.* 2007), the mean values of the frontal sinus were larger in males than in females. As regards the parameters measured on both sides with respect to gender, Camargo *et al.* (2007) observed a mean difference between the right and left sides of the frontal sinus of males and females. From the study of Carmago *et al.* (2007), the males had mean values larger compared to the females.

It was also revealed from the present study that both the males and females variables were highly statistically significant ($P = 0.000$). Furthermore, when data on the right and left sides were combined for male frontal sinuses, the mean values of the right frontal sinus length and width were seen to be larger than the left frontal sinus length and width and these differences were highly statistically significant. The above finding is in agreement with prior studies conducted by Tattisumak and Angi (2011). Some other studies conducted by (Barghout *et al*. 2002; Rubira-Bullen *et al*. 2010 and Ponde 2003) also reported that males had larger frontal sinus dimensions than in females. Therefore, these variations observed in the frontal sinus dimensions of males and females should be considered for by forensic anthropologists and radiologists in the surgery of the face (Azaria *et al*. 2013).

Conclusion

In the present study, the right frontal sinus length and width of the male and female were seen to be larger than the left sides. Furthermore, the male right and left

frontal sinus length and width were larger than the female right and left frontal sinus length and width and this was highly statistically significant. The frontal sinus is a constant structure in human beings but shape and dimensions may vary among individuals such that no two individuals of same age group have the same frontal sinus shape and size, thus the dimorphic nature of the left frontal sinus dimensions has implications for human identification.

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Conflicts of interest
There are no conflicts of interest.

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