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Radiological Assessment of Frontal Sinus Morphometry in Sickle Cell Anaemia Subjects in Port Harcourt

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ABSTRACT

Sickle cell anaemia (SCA) subjects have been widely reported to present with various anthropometric deficits compared to their unaffected counterparts. This prospective comparative anatomo-radiologic study was carried out to determine whether there are differences in the morphometry of the frontal sinus between SCA and non-SCA (control) subjects in Port Harcourt. Plain radiographs of the paranasal sinuses (occipitofrontal and lateral views) of 129 non-SCA subjects (72 males and 57 females) sourced from the film library of 3 different hospitals, and 34 SCA subjects (24 males and 10 females) were exposed at the Radiology Department of the University of Port Harcourt Teaching Hospital (UPTH). Following ethical clearance, the radiological dimensions of the frontal sinuses (height of frontal sinus-HTFS, anteroposterior length of frontal sinus-APFS and width of frontal sinus-WDFS), using millimetre rule was measured. The data were analysed by calculating the minimum sample size obtainable, mean, standard deviation (SD) and Z-test (significant at $p \leq 0.05$). The mean dimensions determined for non-SCA and SCA males were HTFS: 23.17±8.52 and 21.92±10.32; APFS: 10.08±2.99 and 10.75±5.31; WDFS: 45.44±16.73 and 39.04±17.77 respectively, While mean dimensions determined for non-SCA and SCA females were HTFS: 24.28±9.80 and 21.20±15.13; APFS: 9.79±2.78 and 11.00±8.68; WDFS: 41.56±13.94 and 34.10±17.53 respectively. The results of this study showed no statistically significant difference in the dimensions of the paranasal sinus (frontal sinus) between SCA and non-SCA subjects. However the mean values of the dimensions of the APFS values were higher in the SCA subjects. These values will be useful in diagnosis and management of sickle cell anaemia patients by physicians.

Key Words: Anthropometry, frontal Sinus, Radiology, Sickle Cell Anaemia.

INTRODUCTION

Sickle cell anaemia disorder is a common condition amongst African and African-American races. This has been found to affect bone development such as decreased density of skull, decreased thickness of outer table of skull due to widening of diploe, hair on-end striations of the calvaria, osteoporosis leading to biconcave vertebrae and coarsening of trabeculae in long and flat bones. Each year, about 300,000 infants are born with major haemoglobin disorders – including more than 200,000 cases of sickle cell anaemia in Africa. High frequency of the mutant gene especially in areas of high malarial transmission has been observed. This reflects the fact that the sickle cell trait confers a survival advantage against malaria. In Nigeria alone, about 150 000 children are born annually with sickle cell anaemia. The pattern of death in persons who have sickle cell anaemia is bimodal, with the first peak occurring in childhood and the second occurring in the late 30s. Deaths during childhood are related to infectious causes, whereas those during adulthood are due to organ failure from repeated tissue destruction[1,2,3].

Ruiz and Wafae[4], radiologically evaluated the frontal sinuses of 50 adult human skulls, aged 19-70 years of both sexes, from two different ethnic groups in Brazil. The result of frontal sinus analyzed showed 18 cases (36%) with bilateral confluence, 30 cases (60%) with bilateral but no confluence and 2 cases (4%) with unilateral confluence. Septum was present in 40 cases (80%) and absent in 10 cases (20%). This septum was directed along the median line in 65% of the cases, the right side in 22.5% and to the left side in 12.5%. Arched sinus was seen in 68% of the cases.

[5]Kim carried out a morphological survey of the frontal and maxillary sinuses among Koreans in order to gather standard values of the size of the normal frontal and maxillary sinuses. 200 frontal sinuses (126 males and 74 females) between 14 and 40 years of age were measured. The heights of right and left frontal sinuses in males were 22. 67mm and 23mm respectively; that for females was 18.48 and 20-81mm respectively. The widths of the right and left frontal sinuses for males were 24.02mm and 24.11mm respectively; that for

females were 30.53mm and 31.66mm respectively. It was reported therefore that the size of the frontal sinuses was greater in men.

This comparative anatomo-radiologic study was aimed at determining whether there are differences in the morphometry of the frontal sinus between SCA and non-SCA subjects in Port Harcourt.

MATERIALS AND METHODS

The study was carried out in the radiology department, University of Port Harcourt Teaching Hospital (UPTH), in collaboration with the department of Paediatrics and Child Health and the Department of Haematology, Immunology and Blood Transfusion of the same hospital. Thirty four (34) sickle cell anaemia (SCA) subjects (24 males and 10 females) between the ages of 4-20 were mobilized from the departments of paediatrics and child health and Haematology, immunology and blood transfusion, with consent from their parents. They were then taken to the department of radiology where plain x-rays of their paranasal sinuses were taken in three different standard projections: occipitofrontal, occipitomental (open-mouthed waters) and lateral. One hundred and twenty nine (129) radiographs showing frontal sinus of non-SCA subjects, with no known pathologies associated with the skull, were obtained and used as control. They were sourced from the radiology departments of the UPTH, Braithwaite Memorial Specialist Hospital (MBSH), all in Port Harcourt, Rivers State. Using Kim; Keats and Sistrum; Ruiz and Wafae and Rubira-Bullen et al., methods [5,6,4,7] the frontal sinus was measured from Cadwell and Lateral view radiographs as shown in the photoplates 1 -3.

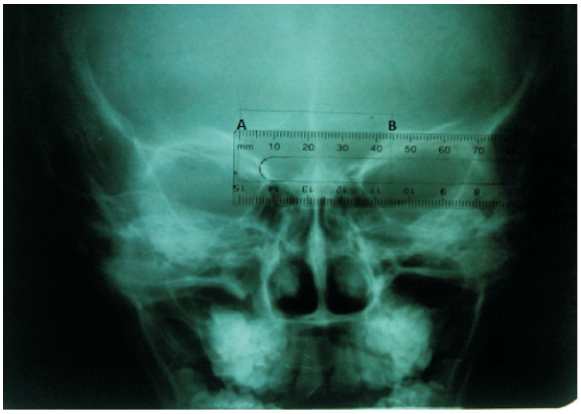

Photo plate 1: Showing Frontal Sinus Width Measurement (A-B)

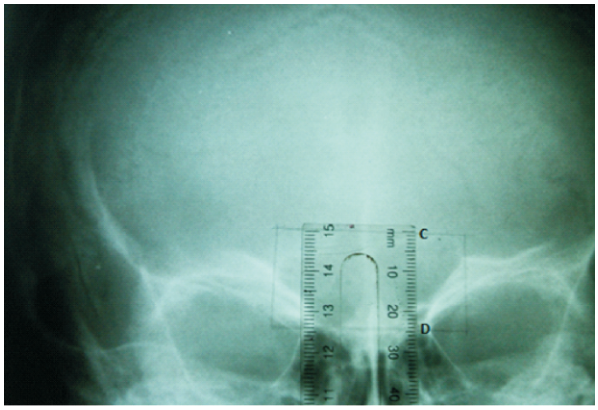

Photo plate 2: Showing Frontal Sinus Height Measurement (C-D)

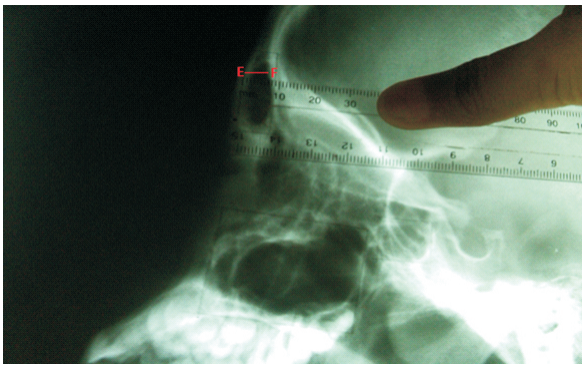

Photo plate 3: Showing AP Length of Frontal Sinus(EF)

The sample size was determined using the formular[8]: $N= (zi-a)^2 p (1-p) /d^2$, where: N =minimum sample size; a = significant level of effort tolerable for the study at 0.05 confidence level; zi-a =1.96 and p= best estimate of prevalence from literature review.

The data obtained from the measurement were analyzed using mean, standard deviation and standard error. Z-test was used to test for statistical significant difference between sickle cell anaemia subjects and non-sickle cell anaemia subjects.

RESULTS

The results shown in tables 1 – 4 indicated the dimensions of the frontal sinus determined.

The results of this study showed no statistically significant difference at 95% confidence level, between SCA and non-SCA (control) subjects in any of the dimensions of the frontal sinus determined as shown in tables 4 and 5.

Table 1: Mean Height, Anteroposterior Length, and Width of the Frontal Sinus against Age for Normal-Growing Male Subjects and Male Subjects with SCA.

Age	Mean Height of Frontal Sinus		Mean AP Length of Frontal Sinus		Mean Width of Right Frontal Sinus	
	SCA	Non-SCA	SCA	Non-SCA	SCA	Non-SCA
4	5.00	16.40	4.00	5.40	15.00	27.00
5	9.50	17.40	4.00	7.40	14.00	32.80
6	23.00	15.20	7.00	8.20	30.00	27.40
7	13.50	19.00	7.50	6.60	26.00	37.80
8	19.50	17.80	11.00	9.20	45.00	40.40
9	27.00	20.40	12.33	10.60	46.33	41.40
10	23.00	22.00	11.00	11.50	30.00	43.50
11	23.00	21.17	8.50	10.50	47.25	42.17
12	29.00	22.67	12.50	12.00	37.50	43.67
13	-	24.50	-	10.00	-	45.50
14	-	24.00	-	11.00	-	42.25
15	-	25.67	-	10.67	-	47.00
16	22.00	31.33	15.00	12.00	40.00	52.67
17	-	30.00	-	10.75	-	64.00
18	-	29.25	-	10.75	-	60.50
19	53.00	42.75	26.00	15.00	80.00	85.00
20	-	29.00	-	13.60	-	58.40

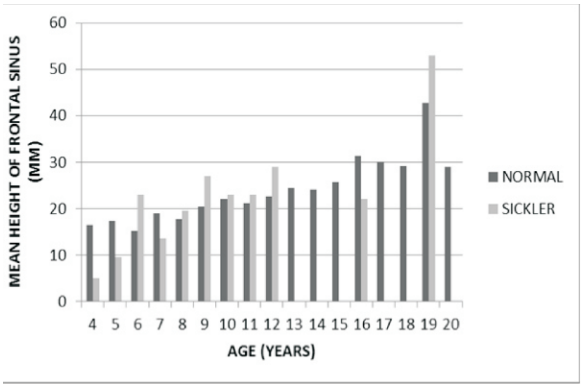

Figure 1: Mean Height of Frontal Sinus against Age for Normal-Growing Male Subjects and Male Subjects with SCA.

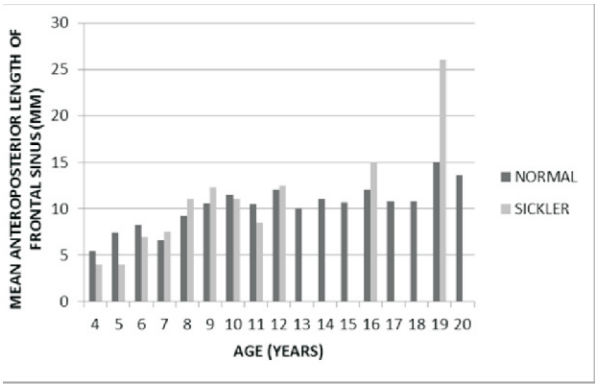

Figure 2: Mean Anteroposterior Length of Frontal Sinus Against Age for Normal Growing Male Subjects and Male Subjects with SCA

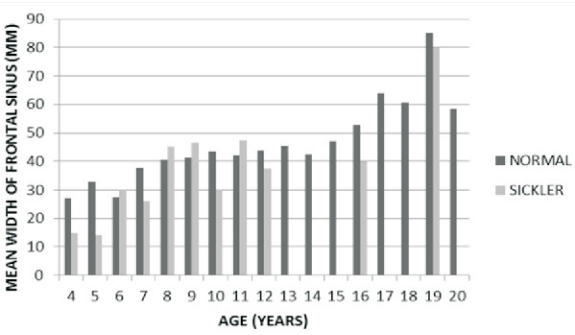

Figure 3: Mean Width of Frontal Sinus against Age for Normal-Growing Male Subjects and Male Subjects with SCA.

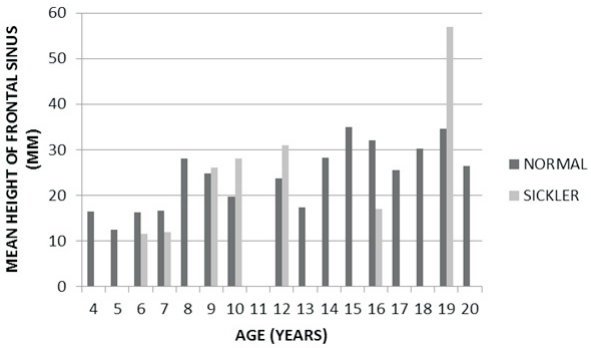

Figure 4: Mean Height of Frontal Sinus against Age for Normal-Growing Female Subjects and Female Subjects with SCA.

Table 2: Mean Height, AP Length and Width of Frontal Sinus against Age for Normal-Growing Female Subjects and Female Subjects with SCA.

AGE	MEAN HEIGHT OF FRONTAL SINUS		MEAN AP LENGTH OF FRONTAL SINUS		MEAN WIDTH OF FRONTAL SINUS	
	SCA	NORMAL	SCA	NORMAL	SCA	NORMAL
4	-	16.40	-	5.20	-	23.60
5	-	12.50	-	6.50	-	27.50
6	11.50	16.25	9.00	6.00	21.00	33.00
7	12.00	16.67	8.00	8.67	30.00	33.00
8	-	28.00	-	9.67	-	45.67
9	26.00	24.75	10.00	11.50	40.00	35.75
10	28.00	19.67	11.00	11.67	51.00	35.00
11	-	-	-	-	-	-
12	31.00	23.67	10.00	11.00	42.00	42.00
13	-	17.33	-	9.33	-	35.33
14	-	28.33	-	11.00	-	46.33
15	-	35.00	-	12.00	-	58.50
16	17.00	32.00	8.00	11.25	31.00	45.75
17	-	25.50	-	10.50	-	51.00
18	-	30.29	-	12.00	-	57.00
19	57.00	34.60	35.00	11.40	71.00	50.00
20	-	26.50	-	10.50	-	51.50

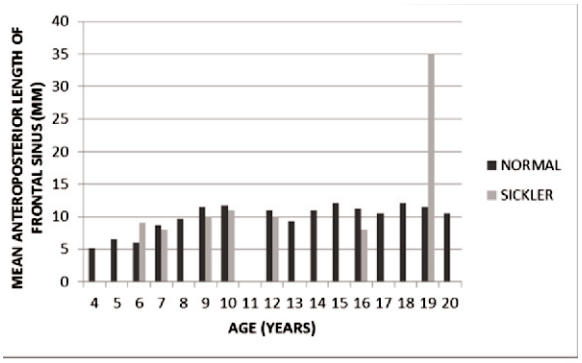

Figure 5: Mean Anteroposterior Length of Frontal Sinus Against Age for Normal-Growing Female Subjects, and Female Subjects with SCA

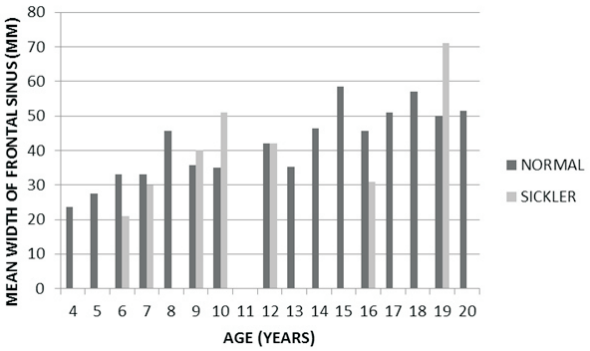

Figure 6: Mean Width of Frontal Sinus Against Age for Normal-Growing Female Subjects and Female Subjects with SCA.

Table3: Z-test showing statistical significant difference of frontal sinus between male SCA and male non-SCA subjects

	HTFS	N	AP Length of Frontal sinus	N	WDFS	N
Mean ± SD male-SCA	22.72 ± 12.02	21	10.86 ± 6.33	21	38.10 ± 16.65	21
Mean ± SD male non-SCA	23.17±8.52	72	9.17 ± 2.99	72	45.44 ± 16.73	72
Z-critical	1.96		1.96		1.96	
Z-calculated	0.160		1.186		1.776	
Inference	Not significant		Not significant		Not significant	

Table4: Z-test showing statistical significant difference of frontal sinus between female SCA and female non-SCA subjects

	HTFS	N	AP Length of Frontal sinus	N	WDFS	N
Mean ± SD of female-SCA	24.50 ± 15.53	8	12.50 ± 9.17	8	38.38 ± 16.98	8
Mean ± SD of female non-SCA	24.28 ± 9.80	57	9.79 ± 2.78	57	41.56 ± 13.94	57
Z-critical	1.96		1.96		1.96	
Z-calculated	0.039		0.831		0.506	
Inference	Not significant		Not significant		Not significant	

DISCUSSION

The results of this study showed no statistically significant different at 95% confidence level, between SCA and non-SCA (control) subjects in any of the dimensions of the paranasal sinuses. This may be attributed to the fact that subjects used for this s study, being regular visitors of the SCA clinic of the department of paediatrics and child health of the UPTH received proper medical attention and expert advice from the physicians. It is known that several factors influence the manifestation of SCA[9,10].

Although there was no statistically significant difference between the SCA and non-SCA subjects, the mean values of the anteroposterior length of the frontal sinus were generally higher in the SCA subjects reflecting an increase in the size of these sinuses. This is in agreement with the findings of Cooley and Lee [11], Cooley et al.[12,13,14] and Jeno et al., which all confirmed diploetic expansion of the skull, initially occurring in the frontal area, leading to frontal bossing, later

followed by expansion in the parietal area.

CONCLUSION

This study has shown that the frontal sinus anteroposterior length dimensions of sickle cell anaemia subjects are higher (although not statistically significant) than the non-sickle cell anaemia subjects. These values will be useful in the treatment plan of sickle cell anaemia patients.

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