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MEAN VOLUMETRIC DIMENSIONS AND PNEUMATIZATION TYPES OF SPHENOID SINUS IN A NIGERIAN POPULATION (A CROSS-SECTIONAL RADIOLOGICAL STUDY).

***Kpuduwei Selekeowei Peter Kespi[1,3], Oladipo Gabriel Sunday[1], Agi Chukuemeka Emmanuel[2], Ajoku Uchenna[4], Kiridi Enefia Kelvin[5], Oyakhire Michael Omonkheoa[1]**

[1]Department of Human Anatomy, University of Port Harcourt,
[2]Department of Radiology, University of Port Harcourt Teaching Hospital, Port Harcourt,
[3]Department of Surgery, Federal Medical Centre, Yenagoa,
[4]Neurosurgery Unit, Department of Surgery, University of Port Harcourt Teaching Hospital, Port Harcourt,
[5]Department of Radiology, Niger Delta University, Wilberforce Island, Nigeria.

***Corresponding Author: Dr. Kpuduwei Selekeowei Peter Kespi**
Department of Human Anatomy, University of Port Harcourt.

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ABSTRACT

Background: The sphenoid sinus is the most inaccessible among the paranasal sinuses. Nevertheless, it is of great surgical importance to both otorhinolaryngologists and neurosurgeons due to its role in chronic sinusitis and endonasal trans-sphenoidal skull base surgeries respectively. **Objectives:** This study was aimed at measuring the dimensions of the sphenoid sinus in adult Nigerians with the objectives of establishing mean values for anatomists and surgeons. It also attempted to find the commonest pneumatization types among the study population and whether there exit sexual differences in these parameters. **Materials and Method:** Since computerized tomography (CT) scan is the investigation of choice for bony structures, the evaluation was done using axial CT scans with 3D for precise assessment and measurement in bone window. Sixty-three adult subjects of both sexes of Nigerian descent residing in Port Harcourt and Yenagoa were used for the study. **Results:** The mean volume of the sphenoid sinus for males (14.62±6.24cm3) was found to be higher than that of the females (13.84±5.82cm3) however, this difference was not significant statistically ($p>0.05$). The sellar type of pneumatization was found to be predominant (70%), pre-sellar type was less (30%), while the conchal type was not found at all (0%). **Conclusion:** The present study suggests that although sexual differences do occur as documented they are not always significant. It also suggests that whereas, qualitative differences do occur as seen in the pneumatization pattern, the Nigerian population share some similarity in sinus size with other populations as documented in literature.

KEYWORDS: sphenoid, sinus, pneumatization, dimension, Nigerian, variation.

INTRODUCTION

The sphenoid sinus is a paranasal sinus deeply sited in the skull base and surrounded by vital structures of the cranium superiorly and laterally.[1,2,3,4]. It has proven its clinical importance to both ENT and neurological surgeons in the management of chronic sinusitis[5,6] and for access to the skull base for surgical procedures respectively.[7,8,9]. It has been noted that its structure varies widely in both pneumatization and dimensions.[10,11,12] Other variations may include septation patterns, Onodi cell distribution, lateral recess, etc. This variations make each sinus peculiar to the surgeon. Therefore, the importance of the structure in modern neurosurgery and otorhinolaryngology cannot be over emphasized. Racial or ethnic variations of the sinuses have been recorded in literature.[13,14,15] It is therefore worthwhile to have knowledge of its peculiarities in the Nigerian population. This study was aimed at appraising the radiological variations of the sphenoid sinus among Nigerians with the specific objectives of providing mean acceptable values of sinus dimensions for Nigerians and determining the commonest pneumatization types among adult Nigerians. From our literature search, similar studies done in Nigeria on living subjects were few and were retrospective Studies,[13,16] which necessitate a prospective study to properly select subjects. A similar study done by Idowu *et al* did not determine the mean sinus volume among Nigerians.[17]

MATERIALS AND METHOD

Since CT scan is the investigation of choice for bony Structures,[18] as the case with sphenoid sinus, a radiological study of the sinus will be more significant for use by clinicians as a non-invasive method of getting anatomical details. This study was limited to CT observations and measurements of the sphenoid sinuses of sixty-three (63) adult Nigerians. This study was carried out in Port Harcourt and Yenagoa cities in Nigeria. The cities were selected based on their heterogenous population, the feasibility of recruiting subjects for the study with minimal obstacles and also due to the availability of the diagnostic centres in these cities for the study.

Materials used were a GE Light Speed Ultra Computer Tomography scanning machine (2008), QXi, MDAS8, tube MX_200MCT, filter Helios G1, slice thickness 3.7mm, axial scan and a GE medical system Workstation Application software set H3M5 (IRIX) for 3D reconstruction into 1mm slice in bone window. Primary data was obtained from individuals aged 18 to 80 years, who came for cranial CT for reasons other than skull fracture, brain tumour, brain bleeds, paranasal sinus diseases, and those with previous history of cranial surgeries that could affect the structure of the sphenoid sinus. Approval to carry out this research was granted by the Research Ethics Committee of the University of Port Harcourt. Written informed consents were obtained from all subjects. Data obtained were computed on Microsoft Excel version 2013 and were analyzed using IBM statistical program for social sciences (SPSS) version 23.0. Measurement of length, width and height of the sinus in straight line was made from the farthest points in any dimension, from which volume was calculated. In the case of length of sinus, the ostium was considered as the point of reference. The mean, standard deviation, T-test and rank correlation test for inferences were calculated. Tables, figures and charts were drawn from the analysis.

RESULTS

From the 63 subjects studied, 31 were males and 32 were females. Their ages ranged from 18 to 80 years with a mean age of 55.32 years for males and 48.25 years for females.

Table 1a shows the mean ± SD of the sinus parameters for both sexes. Left sinus length in cm (male=2.19±0.6, female=2.05±0.69), left sinus height in cm (male=1.67±0.40, female=1.62±0.40), left sinus width in cm (male=1.57±0.51, female=1.62±0.49), left sinus volume in cm3 (male=6.53±4.33, female=5.95±3.77), right sinus length in cm (male=2.20±0.76, female=2.45±0.68), right sinus height in cm (male=1.790±0.41, female=1.81±0.32), right sinus width in cm (male=1.78±0.52, female=1.70±0.38), right sinus volume in cm3 (male=8.09±5.57, female=8.14±4.29), and total sinus volume in cm3 (male=14.62±6.24, female=13.84±5.82). The mean values of all parameters for males were higher than females, however there was no statistical significance ($p>0.05$) to indicate sexual dimorphism of the sinus dimensions in either sides as shown in Table 1b. Figure 2 shows the distribution of the types of pneumatization among the sampled population. The sellar type was the commonest with forty-four (70%) and the pre-sellar less common with nineteen (30%), however there was no registered conchal type.

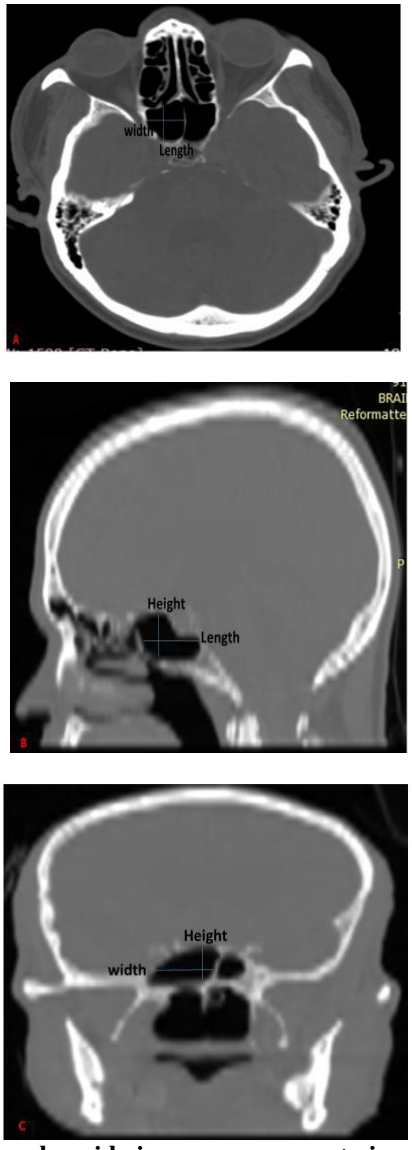

Figure 1: sphenoid sinus measurements in axial (A), sagittal (B) and coronal (C) views

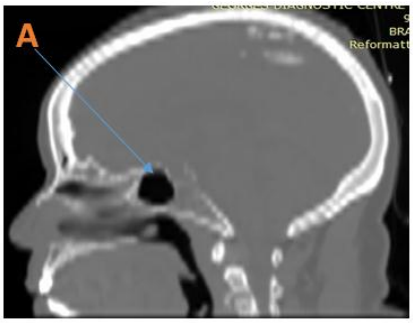

Fig.2A: Pre-sellar pneumatization of sphenoid sinus

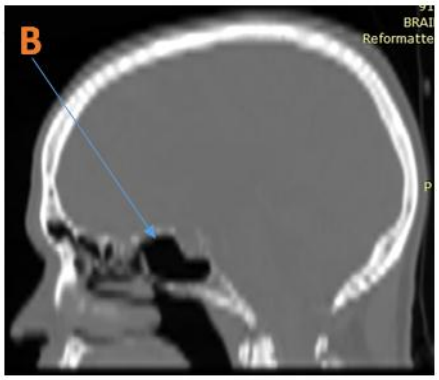

Fig.2B: Sellar pneumatization of sphenoid sinus

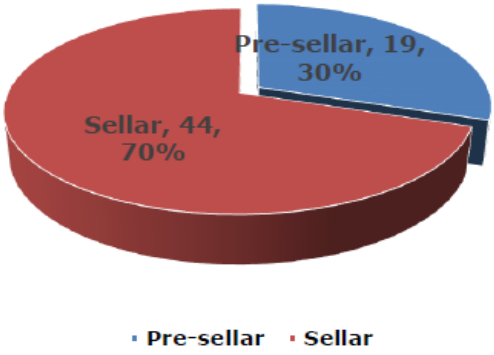

Figure 3: Distribution of sinus pneumatisation

Table 1a: Descriptive characteristics of measured sinus parameters

PARAMETERS	Sex	N	Mean	Std. Deviation	Std. Error Mean
Age (yrs)	Male	31	55.32	16.36	2.94
	Female	32	48.25	19.62	3.47
Left Length (cm)	Male	31	2.19	0.63	0.11
	Female	32	2.05	0.69	0.12
Left Height (cm)	Male	31	1.67	0.40	0.07
	Female	32	1.62	0.40	0.07
Left Width (cm)	Male	31	1.57	0.51	0.09
	Female	32	1.62	0.49	0.09
Left sinus volume (cm3)	Male	31	6.53	4.33	0.78
	Female	32	5.95	3.77	0.67
Right Length (cm)	Male	31	2.20	0.76	0.14
	Female	32	2.45	0.68	0.12
Right Height (cm)	Male	31	1.79	0.41	0.07
	Female	32	1.81	0.32	0.06
Right Width (cm)	Male	31	1.78	0.52	0.09
	Female	32	1.70	0.38	0.07
Right Sinus Volume (cm3)	Male	31	8.09	5.57	1.00
	Female	32	8.14	4.29	0.76
Total sinus Volume (cm3)	Male	31	14.62	6.24	1.12
	Female	32	13.84	5.82	1.03

Note: M.D=Mean difference, S.E.D=Standard error of the difference, P-value=Probability value, t-value=t-test calculated value, Inf.=Inference (S=Significant, NS=Not Significant)

Table 1b: Evaluation of sex difference using t-test of mean difference

Parameters	M.D±S.E.D	t-value	P-value	Inf.
Left Length (cm)	0.14±0.17	0.842	0.403	NS
Right Length (cm)	-0.26±0.12	-1.425	0.159	NS
Left Height (cm)	0.05±0.10	0.516	0.608	NS
Right Height (cm)	-0.02±0.09	-0.257	0.798	NS
Left Width (cm)	-0.05±0.10	-0.385	0.702	NS
Right Width (cm)	0.08±0.12	0.714	0.478	NS
Left sinus volume (cm3)	0.58±1.02	0.567	0.573	NS
Right Sinus Volume (cm3)	-0.04±1.25	-0.035	0.972	NS
Total sinus Volume (cm3)	0.79±1.52	0.517	0.607	NS

Note: M.D=Mean difference, S.E.D=Standard error of the difference, P-value=Probability value, t-value=t-test calculated value, Inf.=Inference (S=Significant, NS=Not Significant)

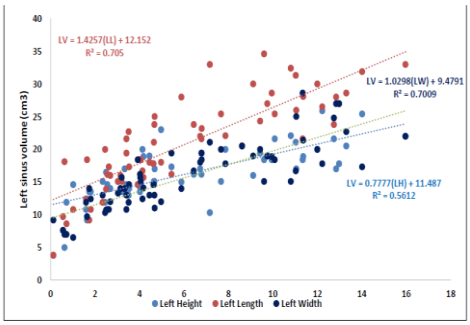

Figure 4: Scatter plot of the left sinus height, length and width against left sinus volume (with regression equations)

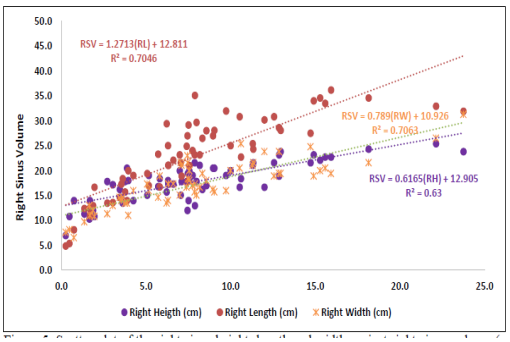

Figure 5: Scatter plot of the right sinus height, length and width against right sinus volume (with regression equations)

DISCUSSION

Volume measurement has been the main objective of paranasal sinus dimensional studies[19] and remains the most important index in these studies.[20] Although other qualitative parameters of the sinus anatomy are of clinical importance.[21] Several studies on the volumetric dimensions of the paranasal sinuses have been carried out in other climes. However, no similar study has been carried out in the Nigerian population in attempt to provide mean volumetric values for adult Nigerians.

We set out to investigate the mean dimensions, and the common types of pneumatization of the sphenoid sinus with respect to sex among adult Nigerians. In the general sampled population the mean left sinus volume= 6.24±.4.03cm3 and mean right sinus volume=8.12±4.92cm3. However, the mean total sinus volume was 14.23cm3. These values are higher than the ones obtained in cadaveric studies: in Nigeria by Amusa et al (left sinus volume = 4. 23 ± 1. 99 cm3 and right sinus volume = 5.08 ± 5.64 cm3) [22] and in India by Sareen *et al* (mean volume = 5.8 ml).[23] In our opinion, in a cadaveric study, details of past medical history of subjects are not known, therefore compliance with inclusion/exclusion criteria laid out to achieve accurate results becomes difficult. Interestingly, the values obtained from this study are comparable to those obtained in the modern living Japanese population by Kawarai *et al* (17.1±7.4 ml in males and 13.7±6.2 ml in females) [24] and living Brazilian population by Oliveira *et al* (male 15.40±5.59 and female 10.88±3.83)25. In our index study, the results of total sinus volume for the different sexes were varied (male=14.62±6.24cm3, and for female=13.84±5.82cm3). The mean values of all parameters for males were higher than females, however there was no statistical significance ($p>0.05$) to indicate sexual dimorphism of the sinus dimensions as shown in Table 1b. The mean left sinus volume is 6.53±4.33cm3 for males and 5.95±4.77cm3 for females, while that of the right sinus volume is 8.09±5.57cm3 for males and 8.14±4.29cm3 for females with no statistical significance in sex difference. Other authors[25] have also observed higher values of the sphenoid sinus in males than in females, however, these have not translated to statistical significance[17] to state sexual dimorphism of forensic importance. As the females had wider range of values (very low and very high) than males, which maintain steadily high values leading to overall higher values.[25] This was the pattern we also observed in our study. This may suggest that the Nigerian population has sphenoid sinus dimensions (quantitative parameter) similar to those of other racial populations. We believe that even though ethnic differences in sphenoid sinus volume do occur due to genetic factors, an individual's genetic growth potential could be modified by the several factors that influence his or her somatic growth and maturation[26] which could account for these similarities. After all, modern Nigerian population is exposed to same modified food products as in the western world.

Pneumatization is a concern to any author working on the sphenoid sinus. Because atypical pneumatization (pneumatization into surrounding structures) is of great clinical importance.[27] Over increased pneumatization tend to distort the anatomy of the sinus and can mislead the Surgeon[10]. In our study we used the classification by Hammer & Radberg to classify the sphenoid sinus, which provides three classes[28] We observed mostly sellar types of pneumatization (44, 70%) and pre-sellar (19, 30%). There was no conchal type. The sellar type remained the commonest followed by pre-sellar among the researched population. Our findings were similar to those of Amusa *et al*, Idowu *et al* and Kajoak *et al*,[22,17,29] who also did not find any conchal type in African subjects (qualitative parameter). Our opinion is that the conchal type of sphenoid pneumatization may be uncommon among the Nigerian population from our index research and from other available literature.

CONCLUSION

It is possible that variations of the sphenoid sinus exist due to racial or ethnic differences as well as environmental factors like nutrition and urban or rural areas on the growth of the paranasal sinuses.[30] However, craniofacial changes do occur anatomically that has a morphological by-product in all humans and not peculiar to a particular race.[31] And these appears to make sense as our quantitative parameters (size) have appreciated in values. The present study suggests that although sexual differences do occur as documented they

are not always significant. It also suggests that whereas, qualitative differences do occur as seen in the pneumatization pattern, the Nigerian population share some similarity in sinus size with other populations as documented in literature. These variations can be markedly distinct even among individuals and sexes of same race in the course of their development.[32] These should be taken into consideration when surgeons are dealing with the sphenoid sinus of Nigerians either to access the base of the skull or to treat sinus pathologies.

In the light of the above, we recommend these values as acceptable mean values of the dimensions of the sphenoid sinus among Nigerians. In addition to that, we strongly recommend pre-operative evaluation of cranial CT scans with 3D reconstruction to extensively visualize the sinuses.

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CONFLICT OF INTEREST

The authors declare they have no conflict of interest.

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