

Computed Tomography Evaluation of Sella Turcica Dimensions and Relevant Anthropometric Parameters in an African Population

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Abstract: A structural change from normal dimensions of sella turcica could be an indication of a pathological condition of the structure itself, the pituitary gland or the extra-sellar structures. The sella turcica is a groove in the sphenoid bone which contains the pituitary gland and this crucial intracranial structure affected both by intrasellar and extrasellar pathological conditions. This study was conducted to find out the normal dimensions of sella turcica among adult Nigerian population in South Western Nigeria with the aid of computed tomography and assess if the dimensions of sella turcica vary with age, gender and some anthropometric parameters. This prospective study evaluated the normal adult sella turcica dimensions from the computed tomography head images of 197 patients that presented at a foremost public tertiary hospital in Lagos State. Other anthropometric data (biparietal diameter, occipito-frontal diameter and patient's height) were also measured. The data obtained was analyzed with SPSS Windows Version 17.0 (SPSS Inc.). The results shows that the sella turcica has mean length of 9.8 mm, AP diameter of 11.5 mm, and depth of 8.6 mm. The results illustrates that there is no difference between sella turcica dimension and the gender of the patient and there is no relationship between age and sella turcica dimensions. However, a positive correlation was established between sella turcica dimensions and height of the subjects. Linear regression prediction models were developed for the purpose of predicting the dimensions of sella turcica from patients' height. The baseline sella turcica data obtained would be applied for the more objective evaluation and detection of pathological conditions of the sella turcica and adjacent structures within population studied. The predictive equations established between sella turcica dimensions and height could be used to predict normal sella turcica length and AP diameter in the assessment of the existence of possible intra- and extra-sellar pathologies.

Keywords: Sella Turcica, Pituitary Gland, Computed Tomography, Sellar Diseases

1. Introduction

The sella turcica is a saddle-shaped depression in the sphenoid bone which contains the pituitary gland. A deviation from normal dimensions of sella turcica could be an indication of a pathological condition of the structure itself or the pituitary gland [1]. A large size might be an indication of pituitary tumor which causes over-production of hormones such as adrenocorticotrophic hormone (ACTH), prolactin and growth

hormones, thyroid stimulating hormone and vasopressin leading to Cushing's syndrome, amenorrhea, acromegaly [1]. According to Famini and Maya [2], the most common sella and parasellar masses identified by magnetic resonance imaging (MRI) include prolactinoma (40%), nonfunctioning adenoma (37%), and adenoma (13%). Metastases accounts for 5% of pituitary lesions and breast cancer is the most common primary source. On the other hand, a smaller size can lead to decreased pituitary function causing symptoms such as short stature, retarded

skeletal growth (Meyer-Marcotty *et al.*, 2010). Intracranial hypertension has a well-established association with another condition of the sella turcica called the empty sella syndrome (Lupi *et al.*, 2011). Another important pathological condition of the sella turcica is intrasellar infection which is characterized by pituitary dysfunction and damage to surrounding structures and may eventually lead to increase in sella size [3]. In addition, Russell and Kjaer [4] found that the size and shape of sella turcica can also be affected by hereditary disorders such as Down syndrome, Williams syndrome, Seckel Syndrome and lumbosacral myelomeningocele.

It is obvious that the sella turcica is a crucial intracranial structure that can be affected both by intrasellar and extrasellar pathological conditions [1, 3, 5 - 7]. Secondly, it is important to note that the sella turcica is also used as an important reference point in orthodontics and the cephalometric analysis of the neurocranial and craniofacial complex [8 - 9]. Despite the clinical relevance of this structure which cuts across disciplines (radiology, neurology, endocrinology, dentistry/orthodontics), there is an overt dearth of adequate information on sella turcica of indigenous African populations. Studies done on sella turcica dimensions in the past may have given inaccurate values because nearly all were done using plain radiography method which has drawbacks such as superimposition of structures and possible geometric unsharpness with resultant magnification traditionally associated with 2D imaging system [11, 12]. Thirdly, since studies have shown there are appreciable variations between sella turcica values of Caucasians [13, 14] and non-Caucasians [11, 12], it has become imperative to establish indigenous normogram that will be applicable in an African setting instead of using the Caucasian normograms. Consequently, this study was designed to establish the normal sella turcica normogram with computed tomography (CT) in an African population in South-western Nigeria and subsequently determine if there are existing relationships between relevant anthropometric parameters and the normal sella turcica normograms with the intention to establish predictive models from the data obtained, if there were correlations between relevant variables, for the purpose of diagnosis, especially in remote rural clinical settings.

2. Methods

This non-experimental and prospective study was carried out in a foremost teaching hospital in South-western Nigeria. A total of 197 patients, who met the inclusion criteria, were recruited and studied from January 2016 to December 2016. The CT images were obtained with 128-Slice Toshiba Alexion CT machine. Members of staff in radiology department were involved in the research. The radiographers discussed the research with the patients at the CT Suite before the CT scan. The age, gender and height of the patients was taken before the CT scan. After scanning the patients, the consultant radiologists reported the examination. When the report indicates that the examination was normal, then the biometric dimensions (length, AP diameter and

depth) of the sella turcica were measured using the software measuring tools in the computers of the CT workstation [15]. Finally, the head biometry (biparietal diameter, head circumference and occipito—frontal diameter) was measured using the software measuring tools in the computers of the CT workstation. Data collected were statistically analyzed for correlations between variables using Statistical Package for Social Sciences software (SPSS v. 17). The confidence level was set at 95% for the statistical tests and probability values $p < 0.05$ were regarded as statistically significant.

3. Results

The results illustrate that out of the 197 subjects studied, 51% of them were males while 49% were females. It also showed that greatest percentage of subjects are between the age range of 30-39 years ($n = 56$, 28%) while the least percentage are between the age range of 80-89 years ($n = 2$, 1%) as depicted in Table 1.

Table 1. Distribution of age/gender of the patients.

Age (years)	Gender		Total	
	Male	Female	Freq	(%)
	Freq	Freq		
20-29	17	14	31	16
30-39	30	26	56	28
40-49	25	24	49	25
50-59	12	14	26	13
60-69	7	9	16	8
70-79	9	8	17	9
80-89	1	1	2	1
Total	101 (51%)	96 (49%)	197	100

For the total sample size studied, the sella turcica has a mean length of 9.8 mm, mean diameter of 11.5 mm, and a mean depth of 8.6 mm. Males has mean length of 10.1 mm, mean diameter of 11.14 mm, and a mean depth of 8.3 mm while females has mean length of 9.5 mm, mean diameter of 11.3 mm, and a mean depth of 8.9 mm.

Table 2 shows that individuals within age group 20-30 years have mean length of 10.7 mm, mean diameter of 11.91 mm, and a mean depth of 8.73 mm while individuals within age group 80-89 years have mean length of 8.17 mm, mean diameter of 10.8 mm, and a mean depth of 7.98 mm

Table 2. Age and dimensions of Sella turcica.

Age		Length	AP Diameter	Depth
20-29	Mean	10.21	11.57	8.41
	N	31	31	31
30-39	Mean	10.17	11.91	8.73
	N	56	56	56
40-49	Mean	9.91	11.30	8.44
	N	49	49	49
50-59	Mean	9.45	11.18	8.26
	N	26	26	26
60-69	Mean	9.31	11.29	8.51
	N	21	21	21
70-79	Mean	9.19	11.13	8.18
	N	12	12	12
80-89	Mean	8.17	10.8	7.98
	N	2	2	2

The mean value of various anthropometric parameters obtained were thus: BPD = 13.5 cm, OFD = 18.3 cm, CI = 73.4%, Height = 168 cm. Student's T-test was performed for difference between sella dimensions and gender and the p-value for the length, AP diameter and depth were 0.93, 0.052, and 0.39 respectively. Therefore no relationship was found at $p < 0.05$. Analysis of variance was conducted to determine any difference between the dimensions of sella turcica and age, p - value of 0.987 was obtained showing that there is no statistically significant difference at $p < 0.05$.

Table 3. Pearson's Correlation for sella turcica dimensions and height of patients.

	Length	AP Diameter	Depth
Pearson Correlation (r)	0.9311	0.7754	0.2461
r^2	0.8781	0.6012	0.5567
Sig (2 tailed) (p - value)	0.023	0.0405	0.5416
N	197	197	197

Pearson's Correlation was conducted to determine any relationship between the dimensions of sella turcica and head biometric parameters, the p - value for the length, AP diameter and depth were 0.787, 0.866, and 0.502 respectively when the BPD was analyzed. The OFD data shows the p - value for the length, AP diameter and depth were 0.0709, 0.0827, and 0.0656 respectively. Therefore, no positive correlation was found between sella dimensions and head biometric parameters at $p < 0.05$.

Table 2 shows the results of Pearson's Correlation conducted to determine any relationship between the dimensions of sella turcica and height, the p-value for the length, AP diameter and depth were 0.0023, 0.00405, and 0.5416 respectively. Therefore correlation was found at $p < 0.05$ between length and AP diameter dimensions and height of the subjects. There was no relationship between sella depth and height at $p < 0.05$.

Figure 1 illustrates the linear regression graph for sella turcica length and heights of subjects. A linear association was found between the variables ($r = 0.9311$, p value = 0.023). A regression equation, y (ST Length) = 0.08030 (Height) - 3.698, was derived for the predication of sella turcica length from the height of subjects.

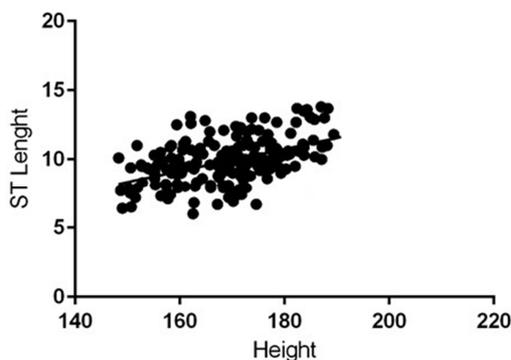


Figure 1. Linear regression graph for Sella Turcica Length and Heights of Subjects.

Figure 2 depicts the linear regression graph for sella

turcica length and heights of subjects. A linear association was found between the variables ($r = 0.7754$, p value = 0.0405). A regression model, y (ST AP Diameter) = 0.1208 (Height) - 8.959, was derived for the predication of sella turcica AP diameter from the height of subjects.

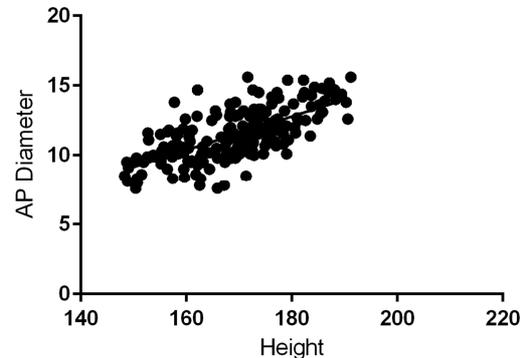


Figure 2. Linear regression graph for Sella Turcica AP Diameter and Heights of Subjects.

3. Discussions

For the whole population studied, the sella turcica has mean length of 9.8 mm, AP diameter of 11.5 mm, and depth of 8.6 mm. In addition, some relevant anthropometric parameters were also obtained and their means values are as follows – BPD, 13.5 cm; OFD, 18.3 cm, Cephalic Index, 73.4% and Height, 168.1 cm. The sella turcica values in this research are smaller when compared with that of Camp [14]. The same observation is noted with Asad and Hamid [13] who reported that the mean length of sella turcica in subjects of the De Montmorency College is 14.9 mm, and Axelsson *et al* [9] who reported dimensions even larger than the values reported in Camp [14]. This observed discrepancy in sella turcica values of Caucasian population and the indigenous populations can be partly attributed to the shortfall of the radiographic method – superimposition - which was used in these Caucasian studies [9, 13]. The aforementioned drawback of radiographic method was one of the main reasons that motivated the researchers to conduct this research using the computed tomography which is not susceptible to the flaws of 2-D imaging systems in order to obtain the exact measurements sella turcica dimensions (Singh, 2014). Secondly, the differences in values obtained in this research and that of Caucasian populations could be also attributed to the obvious difference in races [11, 12].

Although there is no statistically significant relationship between the sella values and gender, there is a very slight observable difference between the sella dimensions of males and females. Males have slightly higher values for length and AP diameter of sella turcica than females while males have smaller depth dimension than females. Kari and Inger [16] noted this slight difference while and Silverman [17] in his study stated that the length of the sella turcica was larger in males, while the depth and greatest diameter were almost similar for both genders. The result of ANOVA conducted to determine any difference between the dimensions of sella

turcica and age reported p-value of 0.987 showing that there is no statistically significant difference at $p < 0.05$. This result is in consonant with the reports of Melsen [18], Choi *et al* [19] and Elster [20]. However, there is an observable slight depreciation noted across all the sella turcica dimensions as the age range increases. Only Silverman [17] noted the same remark in his study.

There is no relationship between head biometry and sella dimensions. From literature search, no study has examined the relationship between sella dimensions and head biometry. A positive correlation was found between length and AP diameter dimensions and height of the subjects. This is in line with Ali (2013) who reported that the sella dimensions increase as the height of the subjects increases. This relationship between sella dimensions and height could be attributed to the fact the pituitary gland which secretes the growth hormone is situated inside sella turcica [3]. Kucharczyk and Hazewinkel [21] have shown that there is positive correlation between pituitary gland dimensions with height and further suggested the gland can be estimated from the dimensions of the sella turcica. This then implies that both sella turcica dimensions and pituitary gland size can be estimated from the height of adult individuals. Regression analysis for sella turcica length and heights of subjects shows a linear association between the two variables and a regression equation, y (ST Length) = 0.08030 (height) - 3.698, was derived for the prediction of sella turcica length from the height of subjects. Another regression analysis for sella turcica length and heights of subjects shows a linear association between the variables and a regression model, y (ST Diameter) = 0.1208 (Height) - 8.959, was derived for the prediction of sella turcica length from the height of subjects. This means that sella dimensions values obtained from these equations (\pm SD of mean values in this study) will give an estimated values of the patient's sella turcica dimensions. If the final values obtained are not within the acceptable range, it implies the patient's sella turcica is abnormal and there is possibility of an underlying pathology. The result of this study can be applied in clinical and research settings for a more objective evaluation and detection of pathological conditions of the pituitary gland. Furthermore, Kucharczyk and Hazewinkel (2008) reported that the size of pituitary gland can be roughly estimated from the dimensions of sella turcica obtained from radiological methods since disease conditions of the pituitary gland ultimately affect the size of the sella turcica. Computed tomography gives more accurate values than radiographical method [21].

4. Conclusion

This research established the normogram of sella turcica dimensions within an indigenous African population and found that the sella turcica has mean length of 9.8 mm, mean diameter of 11.5 mm, and a mean depth of 8.6 mm. The baseline data obtained would be applied for the more objective evaluation and detection of pathological conditions of the sella turcica and adjacent structures in clinical settings

within Lagos metropolis. A positive correlation was established between sella turcica dimensions and height of the subjects. The predictive equations established between sella turcica dimensions and height could be used to predict normal sella turcica length and AP diameter in the assessment of the existence of possible intra- and extra-sellar pathologies.

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