

Morphometric Analysis of the Sella Turcica and its Variation with Sex and Age among Computed Tomography Scanned Individuals in Soddo Christian Hospital, Ethiopia

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ABSTRACT

Introduction: The sella turcica is an important anatomical landmark used for the diagnosis of sellar and parasellar pathology and the evaluation of craniofacial morphology. Sella turcica varies greatly in healthy individuals and a deviation in size and shape can be an indication of the pathology of the pituitary and craniofacial abnormality.

Aim: To assess the morphometry of the sella turcica among computed tomography scanned individuals in Soddo Christian Hospital, Ethiopia.

Materials and Methods: An institution-based retrospective cross-sectional study was conducted from September 2019 to October 2019. The data were collected from 496 randomly selected head computed tomography scanned images of individuals who visited the hospital from September 2018 to August 2019. Sella dimension was measured using the radiat DICOM viewer. Independent samples t-test was conducted to

compare means among sex and one-way ANOVA was applied to compare the means among age groups.

Results: The overall mean length, depth, and antero-posterior diameters were 10.226 mm, 7.124 mm and 11.892 mm, respectively. The evaluated mean length, depth and antero-posterior diameter of sella turcica among males were 10.262 mm, 7.015 mm and 11.849 mm and among females it was found 10.107 mm, 7.479 mm and 12.034 mm, respectively. In the present study, depth of the sella turcica had significant difference among males and females and also sella dimensions were seen to increase with age ($p > 0.05$).

Conclusion: Length and antero-posterior diameter were highest as compared to previous studies. Generally, the results of the present study were different from previous studies and further studies in different parts of the country needs to be done, to have normative data on the dimension of sella turcica in Ethiopia.

Keywords: Dorsum sellae, Linear dimension, Pituitary fossa, Tuberculum sellae

INTRODUCTION

Sella turcica, as an anatomical landmark, is used for the assessment of cranial morphology and jaw relations [1]. Sella turcica, meaning "Turkish saddle", is situated in the middle cranial fossa on the intracranial surface of the body of sphenoid bone. It has a close anatomical relationship with several key intracranial structures like the pituitary gland, internal carotid artery, cavernous sinus, cranial nerves III, IV, V1, V2, and VI [1,2]. Sella turcica is composed of anteriorly tuberculum sellae, floor is hypophyseal fossa, which houses the pituitary gland, and posteriorly dorsum sellae [3]. The floor of the sella turcica is related to the sphenoid sinus [4]. Over the pituitary fossa, two posteriors and two anterior clinoid processes are located.

Variations in the shape of sella turcica have been reported by many researchers [5-9] and morphological appearance has been established in early embryonic structure [10]. Sella turcica develops in the most anterior part of the germ sheet and the anterior wall develops from the neural crest cells, whereas the posterior wall develops from polar cartilages surrounding pituitary gland under the direct influence of notochord [11-13]. The development of the pituitary gland and sella are closely coordinated where pituitary gland development happened before sella turcica [14,15].

Tuberculum sellae and the posterior border of sella turcica remodeling continue up to 16-18 years of age. After 6 years of age, the anterior wall of the sella turcica remains stable and in cephalometric growth

analysis, used as a superimposing structure. Accepted normal dimensions of the sella turcica are 5-16 mm for the anteroposterior diameter and 4-12 mm for the depth [16-18].

The sellar and parasellar regions have complex anatomy where much neoplastic, infectious, inflammatory, developmental and vascular pathology develop [19]. Around 13% of brain tumor was found in the sella turcica [20]. Any pathologic condition in the pituitary gland could alter the sella turcica shape and the secretion of the pituitary gland hormone [21]. Literature also reports that hyper and hypo-functioning of pituitary gland affects the sella turcica dimension [10].

Great variations have been reported in the measurements of the sella dimension for gender, race and is genetically and locally influenced [22-25]. Since, sella turcica is a crucial intracranial structure that can be affected both by intrasellar and extra sellar pathological conditions, knowledge of this region's normal anatomy, variations or morphometry helps clinicians to identify abnormality in this area, and for the assessment of craniofacial morphology [8,18,26-30].

Even though there are a number of studies conducted in many countries, there is lack of adequate information on sella turcica dimension in African populations specifically in Ethiopia [22,31]. Thus, establishing normative data that will be applicable in an African population is advisable. Sella turcica is one of the radiologic landmarks in clinical practice and knowing its normal shape and size is crucial. Sella turcica is a multidisciplinary anatomical

structure where data on its normal size and shape will have valuable significance for clinicians and anatomists.

There is no similar study done in Ethiopia; hence, the finding of this study will be used as baseline information for further studies in this area. The aim of this study was to determine the linear dimension of sella turcica and compare variation with sex and age.

MATERIALS AND METHODS

An institution-based retrospective cross-sectional study was conducted. All head CT images in the Soddo Christian Hospital, Southern Ethiopia scanned from September 1/2018 to August 31/2019 were taken and 496 randomly selected head CT scanned images were analysed from September to October 2019. Ethical clearance (Ref. No:12B/125/12) was taken from institutional review board of College of Medicine and Health Science, Arba Minch University. The study ensured confidentiality and de-identified the study participants.

The CT images were retrieved from picture archiving and communication system of Soddo Christian hospital and sella turcica were measured in mid axial plane using RadiAnt DICOM viewer 5.0.2.

The data were collected by two radiography technologists having four years of experience and then the average from two data collectors was taken. All images were interpreted by the radiologist.

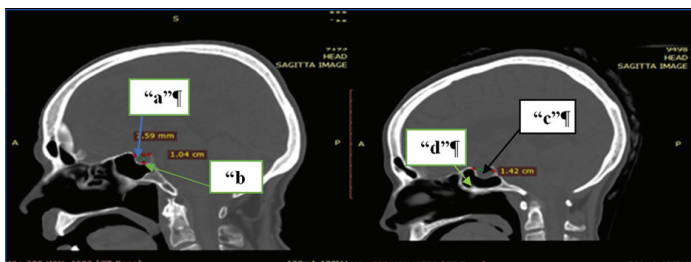
Inclusion criteria: Head CT scanned images showing the mid-sagittal section of sella turcica with maximum clarity and having complete age and sex registration were included in the study.

Exclusion criteria: Patients with the following conditions were excluded from the study.

1. Scan that had craniofacial syndromes, clefts, or other malformations,
2. Scan that had a patient history of surgery and pathological condition in the sellar/parasellar region,
3. Scan that had traumatic involvement of sella turcica.

The following measurements were obtained in mid-sagittal section according to Silverman and Kisling methods [8,32,33].

- a. **Sella length:** The distance from tuberculum sellae to dorsum sellae [10,34].
- b. **Sella depth:** The length of the line drawn vertically from the deepest point of the sella turcica in the direction of the sella turcica length [10,34].
- c. **Antero-posterior diameter:** The distance measured from the tuberculum sellae to the backmost point in the interior surface of the posterior wall of the pituitary fossa [Table/Fig-1] [10,34,35].



[Table/Fig-1]: Sagittal head CT image obtained from Soddo Christian Hospital, 2019. Label "a" indicates the length, "b" indicates the depth, "c" indicates the anteroposterior diameter of sella turcica, and "d" indicates the sphenoid sinus.

STATISTICAL ANALYSIS

The data were entered to Microsoft Excel 2016, checked for its completeness and consistency and exported to SPSS version 23.0 statistical software for analysis. Normality of the data was checked using the Shapiro-Wilk normality test. Data were normally

distributed. Independent samples t-test was used to compare mean among both genders and one-way ANOVA was applied to compare the mean of sella turcica among different age group. A 95% CI with p-value <0.05 was considered as statistically significant.

RESULTS

Socio-demographic characteristics: A total of 496 head CT scanned images were included in the study. The majority of the participants were males {380 (76.6%)} with a mean age of 32.4 ± 18.6 (SD) years while age group greater than 30 accounted for 43.8% of the study participants [Table/Fig-2].

Age groups (in year)	Sex		Total %
	Female	Male	
0-6	8	29	7.5%
7-12	7	19	5.2%
13-18	7	47	10.9%
19-24	13	50	12.7%
25-30	20	79	20%
>30	61	156	43.8%
Total	116	380	100%
Total %	23.4%	76.6%	100%

[Table/Fig-2]: Age and sex distribution.

The linear dimensions of sella turcica: The mean length, depth, and APD of the sella turcica were 10.23 ± 1.73 mm, 7.12 ± 1.34 mm and 11.89 ± 1.94 mm, respectively [Table/Fig-3].

Variables	Minimum	Maximum	Mean, SD (mm)	SEM	95% Confidence interval	
					Lower bound	Upper bound
Length	6.1	14.9	10.23 ± 1.73	0.08	10.07	10.38
Depth	2.8	13.4	7.12 ± 1.34	0.06	7.00	7.24
APD	6.2	17.5	11.89 ± 1.94	0.09	11.49	12.06

[Table/Fig-3]: Linear dimensions of sella turcica.

APD: Antero-posterior dimension

Comparison of linear dimensions of sella turcica between sex:

The mean depth of sella turcica was larger among females, that was statistically significant ($p=0.002$). But length and antero-posterior were not statistically significant in both the sexes [Table/Fig-4].

Variables	Gender	Mean±SD	95% Confidence interval		t-test	p-value
			Lower bound	Upper bound		
Length	Male	10.26 ± 1.78	10.08	10.46	0.9	0.369
	Female	10.10 ± 1.57	9.83	10.36		
Depth	Male	7.01 ± 1.31	6.89	7.15	3.296	0.002
	Female	7.48 ± 1.38	7.21	7.76		
APD	Male	11.85 ± 1.98	11.66	12.06	0.941	0.348
	Female	12.03 ± 1.80	11.70	12.31		

[Table/Fig-4]: Independent Samples t-test analysis gender-wise comparison of linear dimensions of sella turcica among study population.

APD: Antero-posterior diameter

Comparison of linear dimensions of sella turcica with different age group:

Significant difference was observed in linear dimensions of sella turcica among different age group. The lowest value was recorded in age groups of 0-6-year-old and highest in above 30-year-old.

As the age of individuals increased, almost all linear dimensions of sella turcica were found to increase constantly. However, the length has shown a minor decrease from the age group 13-18 to 19-24. Similarly, the depth has also shown a minor decrease in the age group from 19-24 to 25-30 [Table/Fig-5].

Dimension	Age groups (years)	N	Mean±SD (mm)	95% Confidence interval		F	p-value
				Lower bound	Upper bound		
Length	0-6	37	8.70±1.48	8.21	9.19	14.17	<0.05
	7-12	26	9.15±1.96	8.35	9.94		
	13-18	54	9.88±1.58	9.45	10.31		
	19-24	63	9.88±1.85	9.41	10.34		
	25-30	99	10.38±1.75	10.03	10.73		
	>30	217	10.73±1.49	10.53	10.93		
	Total	496	10.23±1.73	10.07	10.38		
Depth	0-6	37	5.76±1.03	5.42	6.11	12.16	<0.05
	7-12	26	6.63±1.00	6.23	7.04		
	13-18	54	6.90±1.93	6.64	7.17		
	19-24	63	7.31±1.46	6.94	7.68		
	25-30	99	7.12±1.36	6.85	7.40		
	>30	217	7.41±1.29	7.24	7.59		
	Total	496	7.12±1.34	7.01	7.24		
APD	0-6	37	9.13±1.83	8.52	9.74	28.08	<0.05
	7-12	26	10.34±2.00	9.53	11.15		
	13-18	54	11.72±1.68	11.26	12.18		
	19-24	63	11.98±1.92	11.50	12.47		
	25-30	99	12.28±1.86	11.91	12.65		
	>30	217	12.39±1.54	12.18	12.59		
	Total	496	11.89±1.94	11.72	12.06		

[Table/Fig-5]: One-way ANOVA age-wise comparison. APD: Antero-posterior diameter; N: Number; F: Frequency

DISCUSSION

This study described the size of sella turcica. It compared difference in the linear dimension of sella turcica between genders and different age groups. Variations in the measurements of the length, depth and antero-posterior diameter of sella turcica were noted among the present and other related studies. In this study, the values were higher in each of the observed parameters as compared to most studies. The difference was possibly due to race and an environmental factor since sella turcica were locally and genetically influenced and varies greatly with these factors [23-25]. Besides, difference in composition of study groups, like age group, and sample size could also contribute for the differences across studies [Table/Fig 6-8].

Studies	Length (mm)	Depth (mm)	Antero-posterior diameter (mm)	Method
Present study	10.23	7.12	11.89	A
Saudi [33]	11.0	9.1	13.9	B
Jordan [23]	7.55	6.32	-----	A
India [34]	9.51	7.39	10.13	A
Nepal [36]	8.13	6.40	9.60	A
Malaysia [37]	8.46	7.44	10.79	A
Brazil [18]	10.31	6.33	----	A
Turkey [38]	9.18	7.87	11.48	A
Iraqi [39]	8.46	7.44	10.79	A
Nigeria [40]	9.8	8.6	11.5	A

[Table/Fig-6]: Comparison of different studies for sella turcica linear dimensions a) [18,23,33,34,36-40].

A: Computed tomography; B: Lateral cephalogram

This study showed that the sella depth in females was higher than males and is consistent with the study done in northern India [27]. This difference between males and females may be because of the pubertal growth spurt in females begins 2-3 years earlier than males which starts late and significant growth of pituitary gland in females than males. Whenever, the size of the pituitary gland changes, there is a corresponding change in the size of the sella turcica [42,43].

Studies	Male			Female			Significance
	Length	Depth	APD	Length	Depth	APD	
Present study	10.26	7.01	11.85	10.10	7.48	12.03	p<0.05 for depth
Saudi Arabia [33]	11.0	9.1	13.9	10.7	9.1	14.0	No significance
Malaysia [37]	10.26	6.61	-----	10.45	6.66	---	No significance
Iraqi [39]	10.79	7.44		10.47	7.07		No significance
Turkey [38]	9.64	7.79	11.73	8.5	7.98	11.11	<0.05 for length
Bangladesh [41]	8.367		9.92	8.219		9.784	No at all
India [34]	9.87	7.42	10.0	9.1	7.36	10.25	<0.0001 length
Nigeria [40]	10.1	8.3	11.14	9.5	8.9	11.3	No significance
Nigeria [28]	10.48	6.9	9.12	9.93	7.18	9.28	No significance
India [10]	12.6	9.2	14.45	12.9	9.4	14.4	No significance
North India [27]	7.8	5.6		7.53	7.53		p<0.05 for depth

[Table/Fig-7]: Comparison of different studies for sella turcica linear dimensions with genders [10,27,28,33,34,37-40]. APD: Antero-posterior diameter

Studies	Age group included	Difference in age
Present study	0-83 years	p<0.05 for all age groups
India [34]	1-93 years	p<0.05 for age <18 years
Korea [42]	6-42 years	p<0.05 for age <25 years
Nigeria [40]	20-89 years	p<0.05 for length
Nigeria [44]	All age group	p<0.05 for depth
Iraq [39]	1-70	p<0.05 for age
Malaysia [37]	0-35 years	p<0.05 for age

[Table/Fig-8]: Age-wise comparison of different studies for sella turcica linear dimensions [34,37,39,40,42,44].

This study found that all length, depth, and APD of sella turcica were increased as age increases (p<0.05). The mean dimension in the older age group was greater than the younger age groups and the difference was significant except in the age group 19-24 for length and 25-30 age groups for depth where the changes were insignificantly decreased. The increase in dimensions of sella turcica with age is possible because of the increase of the size of the pituitary gland with age and somatic growth patterns, especially during puberty. Sella turcica also rapidly grows in early life to age 6 or 7 years with neural growth pattern and after puberty, sella turcica growth may be due to bone remodeling [45].

Several other studies had also mentioned an age-related increase in the size of sella turcica, which is in line with our findings [21,38,46,47]. The increase of the sella dimension with age especially after puberty is reasonably happened because of bone remodeling which may not show a significant increase even though older age groups had larger sella size than younger ones.

Limitation(s)

Female study participants were very few in number when compared with males.

CONCLUSION(S)

The mean length, depth and anteroposterior diameter of sella turcica were 10.226 mm, 7.124 mm and 11.892 mm, respectively. Only depth indicated significant morphometric difference among sex. Also, there was a significant increase in the sella turcica dimension among different age group and the sella dimension was positively correlated with each other and age. This study gives baseline information for clinicians and academicians about morphometric variation and linear dimensions of sella turcica for Ethiopian which helps in the diagnosing of sellar pathologies.

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