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Assessment of Sella Turcica Dimension Among Adults in Southern Ethiopia

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ABSTRACT

Sella turcica varies greatly among normal individuals and its deviation in size and shape is an indication of the pathology of the pituitary and craniofacial abnormality. Knowing the variations gives an important clues in the diagnosis of sellar pathologies and conditions that can affect the skull base. Data in the normal population gives clues in identifying those variations and there are no adequate data in Ethiopia for the morphology of sella turcica. This study aims to describe the morphology and variation of the sella turcica in Southern Ethiopian individuals. Morphometric analysis of the sella turcica was done on randomly selected 311 head Computer Tomography scanned images of individuals who visited Soddo Christian Hospital from September 2018 to August 2019. Measurement was done using the Radiant DICOM viewer. Data was entered to ms- excel 2016 and exported to SPSS version 23 for analysis. Independent-Samples t-test was conducted to compare means and chi-square was used to compare the variation of shape among sexes and one-way ANOVA was applied to compare the means among age groups. Mean length, depth, anteroposterior diameter, area, and volume with their standard deviation were 10.46 mm ± (1.65), 7.27 mm ± (1.26), and 12.22 mm ± (1.78), 90.05 mm2 ± (25.50), and 536.04 mm3± (321.15) respectively. A positive linear correlation was found between the age and length, anteroposterior diameter, area, and volume of the sella turcica. Depth was significantly different among males and females (p-vale < 0.05). 62.2 % of computer tomography scanned sella turcica images were U-shaped, 30.4 % were J-shaped, and 7.4% were shallow. Significant differences in depth were observed between sexes. A great variation in the shape of Sella turcica was observed. Further studies should be done to have an adequate data regarding morphology and variation of Sella turcica.

Keywords: Computer tomography, Linear dimension, Sella turcica.

Introduction

Sella turcica is a trough-like bony formation in the middle cranial base on the upper surface of the body of the sphenoid bone. Anteriorly represented by tuberculum sellae and posteriorly by dorsum sellae[1]. It hosts the pituitary gland and has anterior and posterior clinoid processes which project over the pituitary fossa. The anterior clinoid processes are formed by the medial and anterior projections of the lesser wing of the sphenoid bone and the posterior clinoid process by the dorsum sellae [1]. Embryologically, sella develops in the most anterior part of the germ sheet. It should be noted that the anterior and posterior walls of the sella turcica have different origins [2, 3]. The development of the pituitary gland is closely related to that of the Sella turcica [4, 5]. Remodeling of tuberculum sellae and the posterior border of the sella turcica continued up to 16–18 years of age [6]. Most investigators agree that the growth of the sella turcica decreases rapidly after the first years of life and increases in parallel to a growth spurt, but it slows down and ceases in early adulthood [7-9]. The morphological appearance of the sella turcica is established in early embryonic structure [10]. Variations in the dimension of the sella turcica have long been reported by many researchers. Based on studies on monozygotic twins, the shape and dimensions of the sella turcica are not only genetically determined but are also locally influenced [11]. Accepted normal maximum dimensions of the sella turcica are 5-16 mm for the anteroposterior diameter and 4-12 mm for the depth, for

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the width 9-18 mm and the volume 240-1150mm3 [12, 13]. The sella turcica volume increases as the age of the individual increases[14].

The shape of sella turcica is classified into circular, oval, and flattened shaped and most of the subjects had either a circular- or oval-shaped Sella turcica [15]. Some authors classified sella turcica into three groups; "U" shape in which the tuberculum and dorsum sellae are at the same height, "J" shape where the tuberculum sellae is lower than the dorsum sella, and "shallow"where the depth is minimum [16]. The floor of the sella turcica also may be concave, flat, or even convex [17].

Any pathologic or other abnormal status of the pituitary gland causes variation in the sella turcica shape and the secretion of the glandular hormone [18]. Clinicians should provide the basis for effectively investigating changes, even before the onset of symptoms of pituitary or craniofacial syndromes, which may reflect pathologic conditions, the variability of normal radiographic anatomy, and sella turcica [7].

Abnormalities in the shape of the sella turcica were detected antenatally in fetuses with spinal bifida, Down's syndrome, Seckel's syndrome, holoprosencephaly, anencephaly, trisomy 21 and 18, Meckel-Gruber syndrome, chondrodystrophy, hydrocephalus, cleft lip and palate, fragile-x syndrome, Turner syndrome, and postnatally Arnold-Chiari syndrome, cri-du-chat syndrome, velocardiofacial syndrome, Kallman syndrome also cause abnormalities in the morphology of the sella turcica [8, 19-21].

The sella turcica is an important landmark for the assessment cranial morphology in the cephalometric analysis that can affect the diagnosis and management of orthodontic abnormalities [9]. The normal morphology and variation of the sella turcica should be studied, to assess the sellar region pathology. The sella turcica size and shape varies from person to person, and the knowledge of normal standards for clinicians will help to identify the abnormality. Indeed, changes in the sella are often the only indication of pathological cranial abnormality [22]. Morphometric knowledge is mandatory for neurosurgeons to choose the best operative approach [23] and several pathological conditions are associated with abnormal development of the sella and the pituitary gland. Morphology of the sella turcica also varies with factors such as gender, local factors, and race. Identification of the above morphological variations may give important clues in diagnosing sellar and parasellar pathologies and other conditions that indirectly affect the base of the skull. Normative data for each population is important to detect those variations in the measurements that represent pathology and those that are within acceptable limits. There is a lack of data that describes the morphology of Sella turcica in Ethiopia. This study aims to describe the morphology and variation of the sella turcica in the Ethiopian individuals and to compare them with available global data.

Methods and materials

Study setting

The study was conducted at Soddo Christian Hospital, Southern Ethiopia. The radiology department of the hospital uses a 16-slice CT scanner. This study was conducted from February 1-15 /2020.

Study design

The institutional-based cross-sectional study design was conducted.

Inclusion and exclusion criteria

All CT scanned images were interpreted by the radiologist. Patients with a CT scan image that had craniofacial syndromes, clefts, or other malformations, CT scan images of a patient that had history of surgery and pathological condition in the sellar/parasellar region, and scan that had traumatic involvement of the sella turcica were excluded from the study. CT scan images with maximum clarity of the sella turcica landmarks and those scans assessed/ commented by radiologists were included in the study.

Sample size

The sample size was determined by using single population proportion formula with a proportion of morphological variation of the sella turcica was 28.3% [24] and the assumption of 95% confidence level and 0.05 margin of error. Accordingly, the calculated sample size using the following formula

$$n = (Z\ \alpha/2)2\ p\ (1\text{-}p) / d2,$$

Where; n = Minimum sample size for a statistically significant survey

Z = Normal deviant at the portion of 95% confidence interval two-tailed tests are; = 1.96

P = the proportion normal sella turcica shape=28.3%

d = margin of error taken as 5%= 0.05 accordingly, n= 311

2.5. Sampling procedure

There were 1680 head CT scanned head images from September 2018 to August 2019. All data are available on institutional picture archiving and communication system with individuals' identification. The head CT scan images assessed by radiologists were selected. A total of 1400 head CT scanned images have fulfilled the inclusion criteria. A serial number was given from 1 to 1400 and used as a sampling frame. Using a random number generator computer-based application 311 images were selected randomly to get the study participants' images.

Data collection instrument and data collection

Sella turcica was measured by using the latest version of the RadiAnt DICOM Viewer 5.0.2 software from the institutional picture archiving and communication system (PACS). A radiologist was recruited and orientation was given on the objective of the study and the procedures by the principal investigator before the actual date of data collection. The data collection tool was a checklist and extracted data were documented on personal computers.

Data analysis

The measurements done was entered to the epi-data 3.1, checked for its completeness, and corrected as necessary, and exported to SPSS version 23 software. Using the SPSS version 23 software, the normality of the data was checked and data were normally distributed. Frequency and percentage were used to describe shape variation and mean and the standard deviation was also used as a summary measure for data on linear dimensions of the sella turcica. Independent-samples t-test conducted to compare the mean

among sex and One-way ANOVA applied to compare the mean of sella turcica among an age group. A Chi-square test was done to compare the shape of Sella turcica among the sex category. T-test, F statistics, and x2 test calculated, and P-value < 0.05 was taken as statistically significant. A Chi-square test was used to see the relation of the shape of Sella turcica with sex. Pearson's correlation coefficient was calculated to assess how the variables relate to each other.

The following are the definition of terms and measurements used.

1. Sella length: the distance from tuberculum sellae to posterior clinoid process [25].
2. 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 [25].
3. 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 [25].
4. Sella area: anteroposterior diameter multiplied by depth (26).
5. Sella volume: volume = 0.5 × (length) × (width) × (depth) [26]

Ethical clearance

Ethical clearance was taken from the institutional review board of collage of medicine and health science, Arba Minch University

Results

Sociodemographic characteristics of the study participants

A total of 311 study participants was included in the study with a response rate of 100% with a mean age of 35.7+ 17.14 (SD) years. The majority of the study participant were males 229(73.6%), age group >40 which is 101 (32.5%) (Table 1).

The dimensions of sella turcica among the study participants

The mean length, depth, APD, area, and volume of the Sella turcica were 10.46 mm, 7.27 mm, and 12.22 mm, 90.05 mm2, and 536.04 mm3 respectively (Table 2).

Comparison of linear dimensions of Sella turcica between sex

The mean depth of sella turcica was larger in females than males, but the mean length, anteroposterior diameter, area, and volume similar among males and females (Table 3).

Comparison of linear dimensions of sella turcica with different age group

Statistically significant variation ($p<0.05$) was observed at length and anteroposterior of Sella turcica whereas depth, area and volume of Sella turicca was not significantly varying among age categories of study participants who were undergone a head CT scan at Soddo Christian Hospital. The lowest value was recorded in age groups of 10-20 years old's and the highest is above 40 years old. This shows that as the age of an individual's increase almost all dimensions of Sella turcica were found to increase constantly (Table 4).

The shape of the sella turcica among study participants

In this study, the most frequently observed shape of the sella turcica was a round shape, followed by flat and oval shapes and the majority of the sella turcica were U-shaped on the other classification (Fig.1.)

3.6. Correlation of the shape of the Sella turcica with sex

Chi square test for shape of Sella turcica showed that there is no significant correlation in the fossa and the sella turcica shape among males and females ($p>0.05$).

3.7. Correlation between sella turcica dimensions

Age had a significant correlation with anteroposterior diameter, volume, area, and length, but not with depth. It was positively correlated with length, anteroposterior diameter, area, and volume of sella turcica with r=0.262, 0.156, 0.125, and 0.114 respectively (table 8)

Discussion

Determining the Sella turcica morphology was valuable in the assessment of pituitary pathology and craniofacial assessment. The findings of this study can give important information on the morphology of sella turcica which may help the clinician to have an appropriate knowledge of the different shapes and dimensions of the sella turcica to distinguish pathological and normal physiological patterns [7, 27].

Cephalometric analysis was a standard device for orthodontic treatment for a long time, even though geometric twisting and superimposition of structures on the radiographs were main drawbacks. Three-dimensional imaging modalities have played an essential part in clinical practice nowadays with the advent of so many 3D imaging software which gives more accurate measurements of craniofacial structures. Though, most of the studies done using lateral cephalogram, CT has more accurate and better resolutions for bony landmarks [28]. Hence, this study was relayed on head CT scanned images of study participants.

The mean depth of sella turcica was 7.27 mm ± 1.27 (SD) and is in line with a study conducted in India, while higher than studies conducted in Brazil, Jordan, and Nepal but lower than studies conducted in Turkey and Nigeria. The mean anteroposterior diameter of sella turcica was 12.22 mm ± 1.68 (SD) which is higher than studies conducted in India, Jordan, Nepal, Malaysia, Turkey, and Iraqi and Nigeria [28-33] which is higher than all the study which was reviewed.

The overall mean length of sella turcica in the present study was 10.46 mm (±1.65 SD), which is in line with a study conducted in Turkey [27] and lower than a study documented in Nigeria [34], but higher than reports in Jordan, India, Nepal, Malaysia, and in Iraqi [28-30, 32, 33] while we compare the area of sella turcica was higher than all literature's that we reviewed.

The possible reason for the difference in sella turcica dimensions may be due to race, genetically and locally influenced and attributed to environmental factors, the difference in composition of study groups and sample size difference and defference in measurement methods used by the different author's [8, 25].

When comparing sella turcica dimension with sex, the results of this study showed that depth was higher in females which shows significant variation. The fact that pubertal growth spurt in females begins earlier than males and significant growth of the pituitary gland in females than males, which increases the sella turcica in females [35] our finding support this the depth of sella turcica was higher in female than male. This was in line with the study done in northern India [32] which showed depth was larger in females than males. Depth in males and females in this study is higher than a report from Nigeria while lower than studies from India, Nepal, India, and Turkey [10, 27, 34, 36, 37]. But the length, anteroposterior diameter, area, and volumes have no significant variation between males and females.

In this study, length for males and females were higher than studies from India, Nepal, Greece, Malaysia, Iraqi, and Bangladesh [7, 24, 33, 36-38] and lower than study in Nigeria [39] but in line with a report from Turkey [27]. When we see the anteroposterior diameter in both sexes, it is in line with a study in turkey [27] while higher than studies from India, Nepal, Nigeria [36, 37, 40] but lower than a report from India [10]. Area of the sella turcica in males and females in this study is higher than studies from Turkey, Jordan, Iraqi, and Bangladesh [24, 25, 30, 33]. The possible reason for the difference is local environmental factors, race, and the difference in methods used while measuring sella turcica dimensions.

The findings in this study indicated that only depth of the Sella turcica was significantly different among sex which is similar to studies in Saudi and Serbia [18, 41]. This sex difference of depth of Sella turcica may be attributed to the growth of pituitary glands, height than its length and width [35]. While studies in India and Turkey [25, 29] found that length was significant compared with sex. Another study in Turkey [42] reported Sella diameter was significantly greater in females ($p<0.05$) but in Malaysia, [33] the report indicated that there is no significant variation of the linear dimension of sella turcica with gender. The possible reason for this difference may be due to the difference in environmental factors and the sample size of the study groups.

The depth of Sella turcica was not varied significantly across age groups ($p>0.05$). This was consistent with studies done in Nigeria and Iraqi [33, 40, 43] but different from studies in India, Malaysia, and Turkey [25, 36, 42, 44].

The length of the sella turcica was increased as age increases ($p< 0.05$). This in line with studies done in Iraqi, India, and Malaysia [33, 36, 42], whereas in Nigeria and Turkey the sella turcica length has no significant association with different age groups [25, 43, 44].

The anteroposterior diameter of sella turcica was not significantly varied with age ($p>0.05$). This is consistent with studies in Nigeria and Iraqi, (33, 40) the sella turcica diameter has no significant association with different age groups but different in reports from India, Malaysia, and Turkey which shows significant increase with age [25, 36, 42, 44].

The study conducted in India has indicated that there is an increase in dimensions of sella turcica with age, but significantly correlated only in the age group below 18 years [29], and a study done in Korea stated that the change in the dimensions of sella turcica with age significantly increased up to 25 years only [14]. The increase in dimensions of Sella turcica with age is possible because of the increase of the size of the pituitary gland with age, especially during puberty and after puberty, sella turcica growth may be due to bone remodeling [30].

Comparing basic shapes (oval, round, and flattened) of Sella turcica the findings of this study Which was found that nearly proportional distribution with the round to be the most frequent shape in the overall assessment accounting 37.5% with a 95% confidence interval (31.8, 43.2) which is lower than reports in Turkey, whereas higher than reports in Bangladesh and Nigeria [24, 27, 45]. The proportion of oval sella turcica was 30.2% with a 95% confidence interval (25.1, 36.1) which is lower than Nigeria and Bangladesh whereas higher than report in Turkey [24, 27, 45] while flat shape account 32.1% with 95% confidence interval (26.7, 37.8) which was consistent with Turkey and Bangladesh whereas higher than study in Nigeria [24, 27, 45]. The possible difference was the high variations in Sella turcica shape with person to person, with ethnicity and environmental factors [24, 30].

In other classification, the proportion of U shaped sella turcica was 62.2 % with a 95% confidence interval (56.2, 67.6) and this is consistent with a report in Malaysia whereas higher than in studies in India, Iraqi, and Brazil [16, 29, 33, 38]. The proportion of J shaped Sella turcica 30.4 % with a 95% confidence interval of (25.8, 36.5) which was consistent with a study in Iraqi, higher than from reports India and Malaysia but lower than study in Brazil [16, 29, 33, 38]. The proportion of shallow shaped Sella turcica 7.4 % with a 95% confidence interval (4.6, 10.4) which was lower than studies done in Iraqi, Brazil, Malaysia, and India [16, 29, 33, 38]. Even though all studies reported that U shape accounted for a higher proportion followed by J shape and shallow shape, there was less similarity in their proportion from one study to another. This difference may be due to the high variability of Sella turcica shape from person to person with race and environmental factors [24, 30].

The floor of the Sella turcica in this study was 83.6 % concave and 16.4% flat which was different from a report from Nigeria [43] which convex floor of the sella turcica accounts the majority 75% followed by flat 16% and concave 9% with a convex floor varies significantly between sexes. Bruneton et al. [17] showed the incidence of the normal variants of anatomical shapes of the sella turcica floor observed in both series are similar in relative frequency; which is concave the most frequent, followed by flat and then convex while no convex sella floor reported in our study, but differ in terms of their prevalence rates. In this study, the prevalence of the concave type of the sella turcica floor is 83.6%, which is higher than the 58% reported by Bruneton et al. [17]In both series, the flat type of the sella turcica floor appeared second, with a prevalence of 32% reported by Bruneton et al. [17] which is higher than in the present study which was 16.4%.

Conclusion

The mean length, depth, anteroposterior diameter, area, and volume of sella turcica were 10.46 mm, 7.27 mm, 12.22 mm, 90.06 mm2, and 536 mm3 respectively. Only depth showed a significant morphometric difference in CT scanned skull images between sexes. Only depth and anteroposterior dimension of Sella turcica increases significantly with age. Great variation in the shape of Sella

turcica but not varied between sexes. We recommend further studies in Ethiopia to have a normative baseline data about morphology and its variation of the sella turcica.

Limitation of the study

Non-proportional allocation of male and female study participants.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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AUTHORS CONTRIBUTION

Getachew Abebe contributes in the Design, acquisition of data, drafting of the manuscript while Teshale Fekadu did Data analysis/interpretation, critical revision of the manuscript, and Alehegn Bekele did Critical revision of the manuscript and approval of the article and finally Lemlem Yilma Critical revision of the manuscript.

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