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A Lateral Cephalometric Radiographic Analysis of Size and Shape of Sella Turcica: A Retrospective Observational Study

Suvarna Lakshmi Madamala [a++*], Tatapudi Ramesh [a#], Reddy Sudhakara Reddy [a†], Koneru Jyothirmai [a‡], Anand Babu Beeraboyina [a‡] and Swathi Gadadasu [b^]

[a] Department of Oral Medicine and Radiology, Vishnu Dental College, Bhimavaram, India.
[b] Department of Oral Medicine and Radiology, Anil Neerukonda Institute of Dental Sciences, Bheemunipatnam, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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[++] *Former Assistant Professor;*
[#] *Professor;*
[†] *Professor and Head of the Department;*
[‡] *Reader;*
[^] *Assistant Professor;*
**Corresponding author: Email: suvarnalakshmi.madamala@gmail.com;*

ABSTRACT

Objectives: To assess shape and size of Sella turcica on lateral cephalographs, and to find association of age and gender with shape and size of sella turcica.
Methods: Lateral cephalographs of 434 healthy subjects (254 females and 180 males) in the age group of 8-30 years were included in the study. Linear dimensions of sella turcica (length, depth, diameter) were measured and different shapes of sella (Normal, oblique anterior wall, bridging, double contour of floor, irregular dorsum, pyramidal) were analyzed. Student's t-test to calculate mean differences in linear dimensions with age and gender. Frequency distribution of shape analyzed through chi-square test. Inter and intra observer variability assessed through paired t-test.
Results: Normal shape of sella turcica was most common shape (52.5%). Linear dimensions were increased with age ($p>0.05$) and except for diameter, length and depth were greater in males compared to females ($p>0.05$). When intra and inter observer variability was assessed, high significant values obtained with respect to depth ($p=0.000$).
Conclusion: This study concluded that regardless of age and gender, normal shape of sella turcica (52.5%) was most common shape followed by sella turcica bridging (21.9%). Mean linear dimensions of sella turcica increased with age. Length and depth dimensions were larger in males comparative to females. This study provides baseline data for further research and clinical practice in fields of forensic medicine and epidemiology.

Keywords: Sella; Sella Turcica; shape; size; lateral cephalograph.

1. INTRODUCTION

Lateral cephalograph is a widely used extraoral radiograph in dentistry for various purposes including diagnosis, treatment planning and outcome of the treatment. Several landmarks on lateral cephalometric radiographs have been used as reference points in relation to the cranium or one landmark to another to determine the position of the maxilla and mandible. Sella point is the most commonly used landmark located at the center of sella turcica [1]. Sella turcica is the saddle-shaped bony structure on the superior aspect of the body of the sphenoid bone. It has anterior and posterior borders represented by tuberculum and dorsum sellae respectively (Fig. 2) [2].

This bony structure houses the pituitary gland, and any abnormality in the pituitary gland is directly related to the altered shape and size of sella turcica. Prenatal and postnatal formation of sella turcica and pituitary glands are complex processes. The development and growth process of sella turcica, pituitary gland and teeth are interrelated to each other. Hence it is essential to include abnormal morphology of sella turcica and cranial base in the postnatal evaluation of craniofacial malformations [3]. Early detection of abnormal morphology of sella turcica can eliminate severe consequences with pituitary gland related disorders. Frequently, the morphology of sella turcica is the only key to identify an abnormality in the cranium. Therefore, knowledge regarding both anatomical and radiological morphology of sella turcica is essential and plays a prominent role in assessing pituitary gland and craniofacial abnormality [4].

In forensic medicine, the examination of cadavers in the process of identification is challenging. In scenarios such as decomposition and skeletonization of corpses, identification becomes impossible. However, these skeletal components such as sella turcica can be used to evaluate age, gender, race and some other related characteristics as they can resist extreme environmental changes to some extent and do not change composition over some time. Hence, analysis of standard anatomical and radiological features of sella turcica can aid in the person identification process in forensic medicine, especially in situations where only the skeletal remains are available [5].

1.1 Aim

To determine morphology of sella turcica on lateral cephalometric radiographs of healthy individuals and to find out if there is any association with age and gender.

1.2 Objectives

- Assessment of different shapes of sella turcica on lateral cephalographs based on age and gender.

- Assessment of linear dimensions of sella turcica in terms of length,depth and diameter both age and gender wise on lateral cephalographs.

2. METHODOLOGY

The lateral cephalometric radiographs of 434 patients advised for diagnostic purposes were considered in the study. These radiographs were retrieved from the archives of the Radiology department, and case histories screened for any systemic conditions. Out of 434 lateral cephalographs, 254 female and 180 male subject radiographs within the age range of 8-30 years and divided into two age groups, 8-18 years and 19-30 years respectively. All the subjects were healthy without any systemic diseases. Individuals with congenital clefts and malformations, history of craniofacial fractures, disorders of bone, nutritional deficiencies and endocranial disturbances were excluded from the study. All the cephalographs were collected and taken using an X-mind panoceph machine using extraoral imaging plate cassette and photostimulable phosphor sensors under standard exposure conditions recommended by the manufacturer and then processed with Digora PCT scanner. The final images and respective linear measurements for size were obtained by accompanying software (Digora for windows 2.7 version) in digital imaging.

2.1 Shape of Sella Turcica

The shape of sella turcica was analyzed according to Axelsson et al. [6] it was categorized into 6 shapes (Fig. 1).

2.2 Size of the Sella Turcica

The linear dimensions of sella turcica in terms of length, diameter and depth were measured according to Silverman [7] and Kisling [8]. All three reference lines were located in the mid-sagittal plane (Fig. 2).

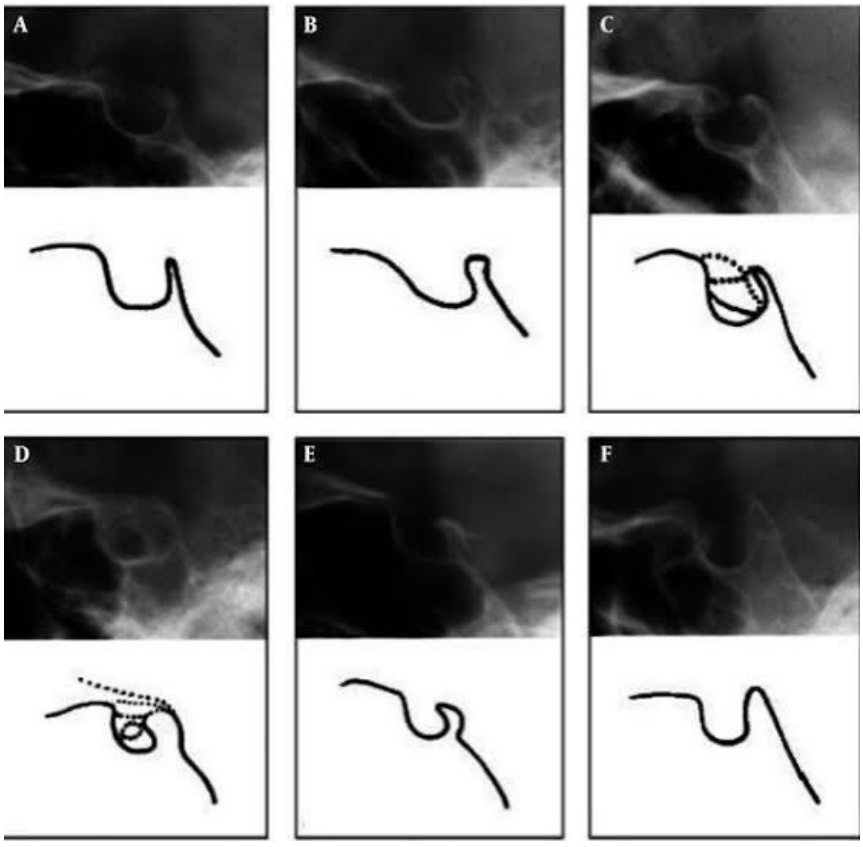


Fig. 1. Different shapes of sella turcica A) Normal B) Oblique anterior wall C) Sella turcica bridging D) Double contour of floor E) Irregularity (notching) in the posterior part of dorsum sellae F) Pyramidal shape

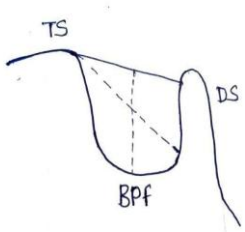


Fig. 2. Sella turcica
TS: Tuberculum Sella
DS: Dorsum Sella
BPF: Base of Pituitary Fossa

- Length - Distance between the tip of the dorsum sella to the tuberculum sella.
- Depth - Perpendicular to a line that represents length to the deepest point on the floor.
- Diameter -The line between tuberculum sella to the point on the posterior inner wall of pituitary fossa furthermost from sella turcica.

2.3 Reliability of Measurements

In order to reduce bias due to intra and inter examiner variability, 20 lateral cephalometric radiographs were randomly selected and re-evaluated by the same and another examiner respectively at fourth week after initial analysis. Paired t-test was used to assess the inter and intra examiner paired mean variability of size and shape of sella turcica.

2.4 Statistical Analysis

The obtained data analyzed by using social package sciences version 13.0 for windows (SPSS).Student's t-test was used to calculate the mean differences in linear dimensions of sella turcica with gender and age groups. The frequency distribution of the shape of sella turcica against age groups was analyzed through chi-square test.

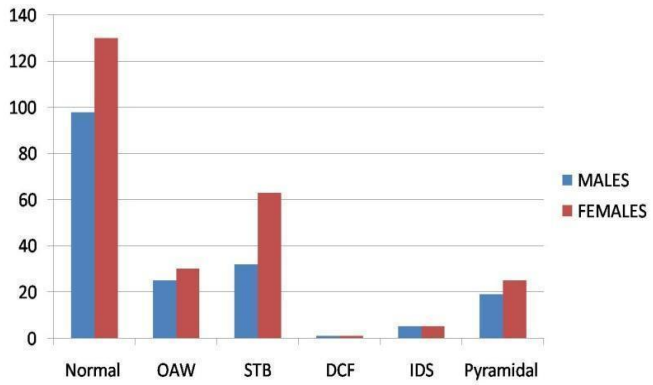
3. RESULTS

3.1 Shape of sella turcica

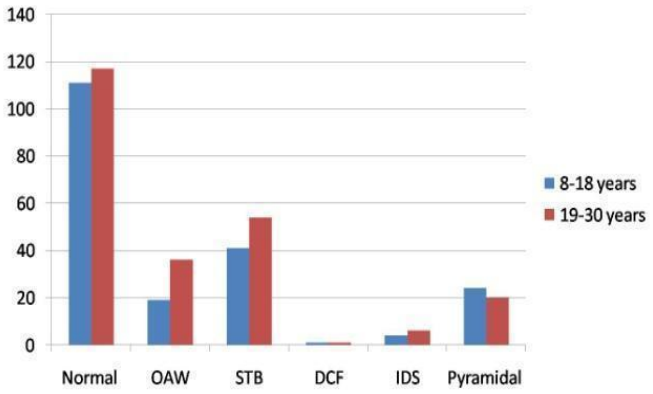
The shape of sella turcica in most of the samples appeared normal(52.5%). The remaining 47.5% of the samples had morphological variations. Sella turcica bridging was the second most common shape in the study population and double contour of floor was a rare shape of sella turcica in both gender and age groups (Graphs 1 and 2).

3.2 Size of the Sella Turcica

The size of the sella turcica in terms of mean linear dimensions of length, diameter and depth were increased with age ($p>0.05$) (Table 1). Irrespective of age, when linear dimensions of sella turcica compared between two gender groups, there was no statistically significant difference found. Length and depth dimensions were larger in males, whereas diameter was slightly larger in females (Table 2).



Graph 1. Frequency distribution of shape of the sella turcica according to gender



Graph 2. Frequency distribution of shape of the sella turcica according to age

3.3 Inter and Intra-observer Variability

No statistical significant difference was seen with respect to inter and intraobserver variability of shape and linear dimensions of length and diameter of sella turcica whereas high statistically significant difference was seen with respect to inter and intraobserver variability of the depth of sella turcica (p=0.000) (Table 3).

4. DISCUSSION

The complete development of sella turcica and pituitary gland (Prenatal formation and postnatal development) are complex processes. During embryonic development, sella point is a key site from which neural crest cells migrate to frontonasal and maxillary developmental fields [6]. There were several case reports in the literature that reveals close association of different morphological aberrations of sella turcica with syndromes and genetic disorders such as lumbosacral myelomeningocele (*Spina bifida*) [9], down syndrome [8], holoprosencephaly [10,11] and Williams syndrome [12].

Alkofide et al. [13] had conducted a study in 95 cleft and 190 non cleft subjects to evaluate morphology and size of sella turcica and concluded that cleft subjects showed abnormal appearance of sella turcica and small size, especially in terms of depth. The size of the sella turcica increases with age in both cleft and non cleft subjects.

Table 1. Linear dimensions of sella turcica according to age

Size	Age groups	N	Mean ± S.D	P-value
Length (mm)	8-18yrs	200	10.28 ± 2.45	0.399
	19-30yrs	234	10.89 ±2.53	
Depth (mm)	8-18yrs	200	7.85 ± 1.76	0.574
	19-30yrs	234	11.54 ±55.14	
Diameter (mm)	8-18yrs	200	10.04 ± 1.48	0.386
	19-30yrs	234	10.57 ±1.51	

Table 2. Linear dimensions of sella turcica according to gender

Size	Gender	N	Mean ± S.D	P- value
Length (mm)	Males	180	10.97 ± 2.64	0.484
	Females	254	10.36 ± 2.38	
Depth (mm)	Males	180	12.26 ± 62.89	0.159
	Females	254	8.13 ± 1.82	
Diameter (mm)	Males	180	10.29 ± 1.52	0.663
	Females	254	10.36 ± 1.52	

Table 3. Intra and interobserver variability of shape and size of sella turcica

Intra vs Inter	Paired Differences					T	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Shape	0.32000	0.90000	0.18000	-0.05150	0.69150	1.778	24	0.088
Length	0.26400	1.62851	0.32570	-0.40822	0.93622	0.811	24	0.426
Diameter	0.12480	1.02234	0.20447	-0.29720	0.54680	0.610	24	0.547
Depth	-1.40440	1.24118	0.24824	-1.91673	-0.89207	-5.658	24	**0.000****

***p-value is highly statistically significant*

Table 4. Showing a comparison of the shape of sella turcica with findings of the previous similar studies

Studies	Shape					
	Normal (%)	Oblique anterior wall (%)	Sella bridging (%)	Double contour of floor (%)	Irregular dorsum (%)	Pyramidal (%)
Axelsson et al [6] Norwegian population	71	23	26	3	11	5
Alkofide et al [1] Saudi Arabian population	66.7	9.4	1.1	8.9	11	2.8
Shah et al [14] Islamabad population	66	4	0	5.5	16.7	7.7
Satyanarayana et al [3] South India population	61	5	8	5.5	15	5.5
Chauhan et al [15] Indian population	28	23	17	10	18	0
Nagaraj et al 2015 [16] Indian population	46.5	29	7.5	3.5	7	3.5
Konwar et al [17] Indian population	78	8	4	1	5	4
Shrestha et al [18] Nepali population	60	5.8	11.6	1.6	15	5.8
Motwani et al [19] Indian population	39.5	5.5	19.5	1.5	3	11.5
Sinha et al [20]	56	11.3	10	5.3	10	6.6
Arthisri et al [21]	46	7	11.5	5.5	15.5	14.5
Surana et al [22]	43.3	28	8.3	5	8.3	6.6
Present study	52.5	12.7	21.9	0.5	2.3	10

4.1 Shape of Sella Turcica

Gordon and Bell in [23], studied radiographs of children between 1-12 years of age and classified shapes of sella turcica into circular, oval and flattened/saucer shapes. They concluded that oval was a common shape among the three shapes, and it was not easy to categorize into any of these three types in the classification.As per Table 4, the normal shape of sella turcica is the most common shape in different populations. In the current study, normal sella was found in 52.5% of subjects in accordance with all the studies except Chauhan et al. [15] only 28% of subjects showed normal sella.According to Motwani et al [19], Normal sella found in 39.5% of the study population and remaining 60.5% showed morphological aberrations.

Sella turcica bridging in normal individuals is a common morphological variation found approximately 5.5-22% [6,24,25]. In the current study, about 21.9% of subjects had sella turcica bridging similar in range to that of Axelsson et al. and Chauhan et al. [15] whereas no bridging was found in a study conducted by Shah et al. [14]. When gender was considered, bridging was frequently found in females compared to males, similar to that of Axelsson et al. [6] it was the second most common shape in the present study(21.9%) and in study conducted by Motwani et al (19.5%) whereas least frequently found in the Saudi Arabian population (1%) [1,19].

It was found that there was strong association exists between Sella turcica bridging and orthodontic patients especially in cases of hypodontia(congenitally missing maxillary lateral incisors) and abnormal eruption patterns of anterior teeth [26-28]

Oblique anterior wall shape of the sella turcica had been found in normal as well as pathological conditions such as lumbosacral meningomyelocele and Seckel syndrome [9,29]. In the present study,12.7% of subjects had this morphological variation similar in the range of Alkofide et al. whereas study conducted by Surana et al found that oblique anterior wall was found in 28% of the study population which was second most common shape [1,22].

Double contoured floor and irregular dorsum sellae shapes were least frequently found shapes and seen in 0.5% and 2.3% of the present study population respectively whereas irregular dorsal sella shape was second most common shape found in 15% of the Nepali population [18], 10% in study conducted by Sinha et al. [20] and 15.5% in Chennai population [21] (Table 4).According to Alkofide et al. [13], in contrast to the present study, irregular dorsum sellae and double contoured floor of the sella turcica were most common in cleft subjects.

4.2 Size of Sella Turcica

Quakinine and Hardy [30] had conducted microsurgical anatomical study on 250 sphenoidal blocks of the cadavers of different age groups and concluded that the transverse width of sella turcica was 12mm, length (anteroposterior diameter)was 8mm and height(vertical diameter) was 6mm. These dimensions were approximately 1.5-3mm less than the current study results.

According to the longitudinal study conducted by Axelsson et al. [6] in the Norwegian population, there was no significant difference between gender regarding depth and diameter of sella turcica in all age groups whereas the length of sella was greater in males and increases with age. These results were also in agreement with Silverman et al. [7], in which 320 subjects from 1 month to 18 years were assessed and concluded that length was greater in males than females except during the puberty period. As far as the linear dimensions of length were considered, the present study showed a similar pattern with former studies.

Sinha et al(2020)analysed mean linear dimensions found that length and diameter values were larger in males compares to females and depth was larger in female gender but in current study only diameter slightly larger in females. [20]

A similar study was conducted by Alkofide et al. [1] in the Saudi Arabian population, it was concluded that there was no significant difference found regarding gender groups whereas the dimensions were statistically greater in older age subjects than in the younger population.

According to Choi et al. [31], the linear dimensions of sella turcica were measured in 200 Korean subjects within the age range of 6-42 years and concluded that these dimensions increased up to 25 years and later onwards, no significant increase in size was

found. However, this study was not comparable to the present study as there was a difference in landmarks used for calculations.

Shrestha et al. [18] measured linear dimensions of sella turcica in Nepali population (Mean length = 8.13 ± 2.03, Diameter = 9.60 ± 1.43,Depth = 6.40 ± 1.21) and all these values were comparatively smaller than present study due to differences in ethnicity,genetic and environmental factors.

According to Nagaraj et al. [16], *depth and diameter significantly increased with age whereas in the current study, all the three linear dimensions were increased with age with no statistical significance.When gender was considered, no statistically significant differences were found in all the three linear dimensions as that of the present study results.*

Motwani et al. assessed linear dimensions of sella turcica in Indian population and found mean length - 8.4mm,depth - 5.5mm and Diameter - 9.94mm and these values were slightly smaller than present study . Length of the sella turcica increases with age (p= 0.0096)and mean length measurements were greater in males compared to females indicates wider sella in males as accordance with present study whereas both depth and diameter were larger in females [19].

Satyanarayana et al. [3] measured linear dimensions in the south Indian population and Muhammed et al. [2] in Bosnian and Iraqi populations. In both the studies, all linear dimensions statistically increased with age, and length was larger in males compared to that of females, in agreement with the current study except for statistical significance.

Konwar et al. [17] showed a similar pattern of linear dimensions with age and gender as in the present study. In both studies, there were no statistically significant differences found when linear dimensions were compared with age and gender.

According to Arthisri et al mean dimensions of length=9.03 mm, depth=7.34 mm and Diameter = 10.91mm and male population had larger length and depth as accordance with present study [21].

5. CONCLUSIONS

- Normal sella shape (52.5%) was most common shape followed by sella turcica bridging (21.9%) and Double contour of floor (0.5%) was least common shape in both age and gender groups of the study population.
- All linear dimensions of sella turcica in terms of length,diameter and depth increased with age so that size of the sella turcica can be used in assessment of growth.
- Both length and depth were larger in males compared with females which indicates male population had comparatively wider sella.
- The results of the present study can aid as reference values in radiological analysis of shape and linear dimensions of sella turcica, especially in the diagnosis of any pathological disorders related to the pituitary gland and craniofacial disorders in the Andhra Pradesh population of India and also helps in forensic science regarding person identification and act as baseline data in the Indian population.
- Further longitudinal studies which includes both cadaver and three dimensional radiological assessment of sella turcica in different populations of India will be required in order to acquire accurate standardization of sella turcica.

6. LIMITATIONS

As this study uses lateral cephalometric radiographs which are two dimensional representation of three dimensional skull, chances for superimposition and magnification of structures are more and difficult to identify precise landmarks which results in intra and interobserver variability and bias.

CONSENT

As per international standard or university standard, patients'as well as parental written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

It was a retrospective observational study approved by the institutional ethical committee (IECVDC/20/PG01/OMR/IVT/12).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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