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RESEARCH ARTICLE

CORRELATIVE STUDY OF SIZE AND MORPHOLGY OF SELLA TURCICA AND SKELETAL MATURITY INDICATORS WITH CERVICAL VERTEBRAE MATURATION INDICATOR (CVMI): A LATERAL CEPHALOMETRIC STUDY

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ABSTRACT

Background: Sella turcica and cervical vertebrae are recognized on lateral cephalometric radiographs and routinely traced for cephalometric analysis.
Aim: The purpose of present study was to measure the size and describe the morphology of sellaturcica and cervical vertebrae maturation indicator in different skeletal ages.
Materials and Methods: Lateral cephalometric radiographs of 200 subjects of which 100 males and 100 females in age group of 10-30 years included in the study. Linear dimensions which include length, depth and anteroposterior diameter are measured and shape of sella turcica and cervical vertebrae maturation was analysed in different skeletal age groups.
ANOVA and unpaired-T test were used for statistical analysis.
Results: In the present study, the different morphological shape of sella turcica seen are normal (upper contour of anterior wall of sella turcica appears to be perpendicular to floor) 49.3% followed by oblique anterior wall 20.7%,double contour of floor 18.7%, sella turcica bridge 6.7%, irregular dorsum sella 3.3%, pyramidal shape 1.3%. There was difference in the linear measurements of depth, and anterio-posterior diameter in each age group which increased as age increased and the difference was statistically significant with Pvalue < 0.05. Cervical vertebrae maturation indicator (CVMI) showed highly statistical
significant difference for males and females.
Conclusion: The most common shape of sella turcica in the study population was normal shape. There was gradual increase in the size of sella turcica as age advances. Cervical vertebrae maturation indicator showed that females mature at an early age as compared to males. Chronological age shows significant difference in comparison to skeletal age.

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INTRODUCTION

Tracing of cephalometric radiographs involves the use of many landmarks within the cranium. These landmarks are used to measure the relative position of maxilla and mandible to the cranium and to themselves. One such landmark is sellaturcica (sella point S) which has been routinely used in various cephalometric analyses (Satyanarayana *et al*., 2013). Sella turcica and cervical vertebrae are recognized on lateral cephalometric radiographs and routinely traced for cephalometric analysis. Sella turcica is a saddle-shaped concavity in the body of sphenoid bone situated in the middle cranial fossa of the skull. Sella turcica gets its name from Turkish language because of its similarity to the Turkish saddle. The depression in saddle is noted as pituitary fossa or hypophyseal fossa. The pituitary gland is situated in the hypophyseal fossa. It is limited by bony constituents of the sella turcica, anteriorly by tuberculum sellae, posteriorly by dorsum sellae and inferiorly by the bony roof of sphenoid air sinus (Fig-1 & 2). (Chaurasia, 2004; Subhadra Devi and Baburao, 2013). Sella turcica on lateral cephalometric radiograph can be observed clearly and consecutively traced during cephalometric analysis. The clinicians should be familiar with normal radiographic anatomy and morphological variations to identify any deviations that may reflect the pathological conditions even before they are clinically apparent. Research concerning the sellaturcica has focused on both size and morphology. A normal morphological variation

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of sellaturcica vary greatly from individual to individual (Satyanarayana *et al*., 2013; Andredaki *et al*., 2007).

CVMI (Cervical Vertebrae Maturity Indicators)

Human growth shows considerable variation in the chronologic ages at which individual children reach similar developmental events. Chronologic age alone is not sufficient for assessing the stage of development of a growing child. Accurate information is provided by developmental stages, such as skeletal maturation, secondary sexual characters, and maturation of different tissue system (Sachan *et al*., 2012). However, for assessing skeletal maturation, changing concavities on lower border of cervical vertebrae are also found to be a reliable method. Lamparski was a first person to utilize the cervical vertebrae radiographically for assessing skeletal age (Lamparski, 1972). The CVMI has an advantage for assessement of peak of growth (Hagg and Taranger, 1982). CVMI can be determined on lateral cephalometric radiograph. As chronological age cannot show accurate status of individuals skeletal age, skeletal age can be assessed by CVMI.

MATERIALS AND METHODS

The present radiographic study was conducted during a time period of 3 months, from November 2015 to January 2016.The study included a total of 200 digital lateral cephalometric radiographs of 100 males and 100 females (between 10 and 30 years of age) who attended the Department of Oral Medicine and Radiology, A.M.E.S Dental college and Hospital and Research centre, Raichur and were grouped into four categories based on age i.e., 10-15 years, 16-20 years, 21-25 years, 26-30 years.

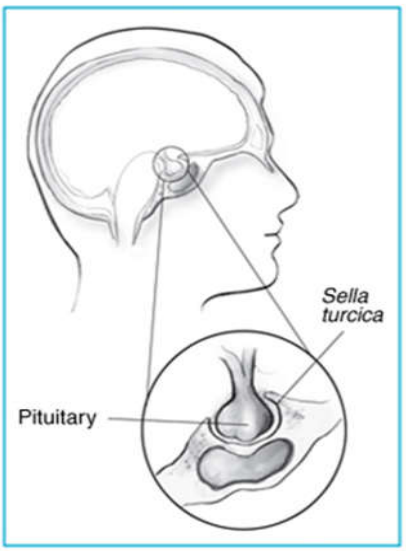
Inclusion criteria:

a. Patients in the age group of 10-30 years
b. Patients advised for lateral cephalometric radiographs for orthodontic treatment
c. Patients without any history of systemic diseases

Exclusion criteria:

a. History of trauma or surgery in the dentofacial region.
b. Patients suffering from disorders of bone, endocrainal disturbances, congenital abnormalities affecting growth and development, traumatic lesions of cervical vertebrae were excluded.

Digital lateral cephalometric radiographs were taken by using PLAMMECA Dimax-3 ceph- machine with a tube voltage of 68 kV, tube current of 5 mA and exposure time of 17 s. The diameters of sellaturcica were measured by tracing manually on x-ray viewer (fig-7). The length was measured as the linear distance from the superior most point on the tuberculum sella to the tip of the dorsum sella. The depth was measured as a line perpendicular from the line joining tuberculum sella and dorsum sella to the inferior most point on the floor. The anteroposterior diameter of sellaturcica is measured from the superior most point on tuberculum sella to the furthest point on the posteroinferior aspect of the hypophyseal fossa (figure-6 & figure- 7) Shape and morphological appearance of sella turcica were assessed according to the method described by Axelsson *et al*. (figure-5). According to Axelsson *et al*..the five morphological variations are oblique anterior wall, bridging of sella turcica, double contour of the floor, irregular surface (notch like depression) in the posterior aspect of the dorsum sella, and pyramid shape of dorsal sellae (Figure-5) (Axelsson *et al*., 2004). Skeletal maturation of cervical vertebrae seems to be involved in the pubertal growth spurt. The pubertal growth spurt was considered to be an advantageous period for various types of orthodontic therapies. The radiographic interpretation was made as per the system develop to interpret skeletal maturation given by Lamparski (1972) as given in (Fig-3 & Fig-4), on lateral cephalogram, the cervical vertebrae as cervical vertebrae maturity indicators as in Table-1.



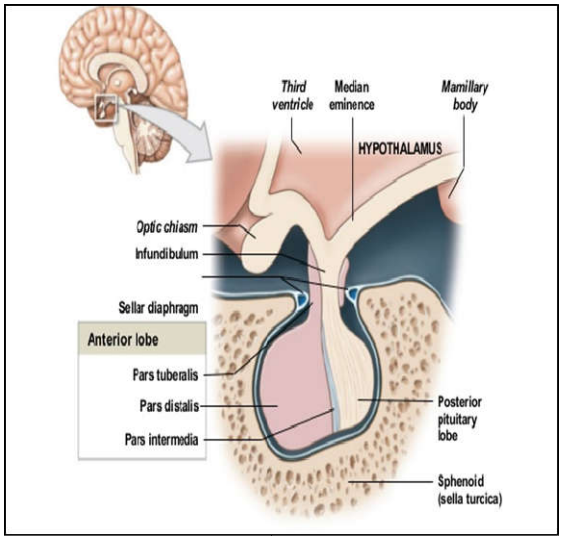
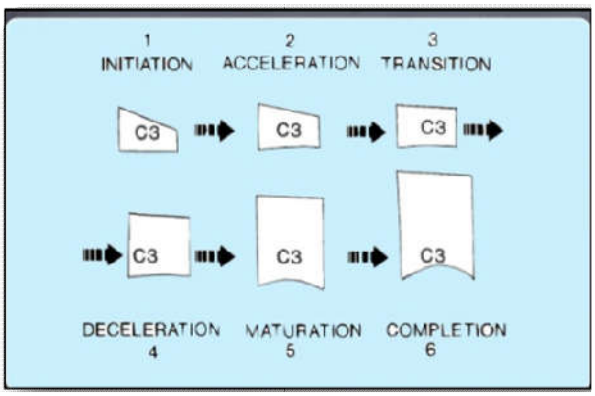


Figure 1 & Figure 2. Sella turcica and its components



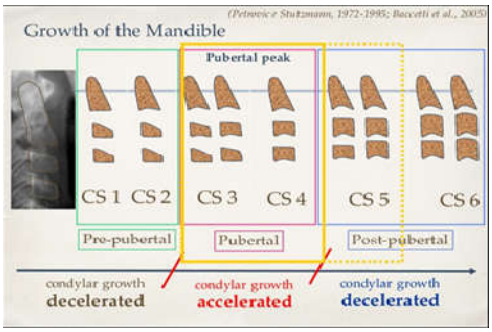


Figure 3 & Figure 4. Cervical vertebrae maturation indicators using c3 as a guide

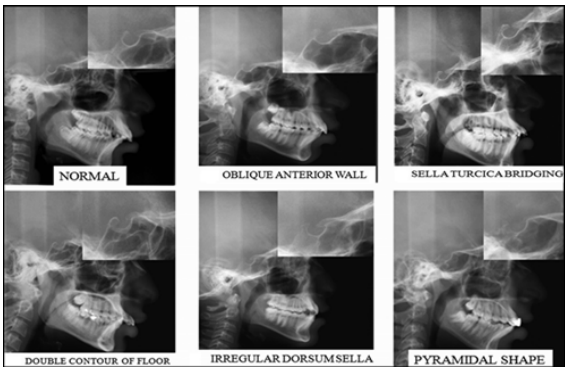
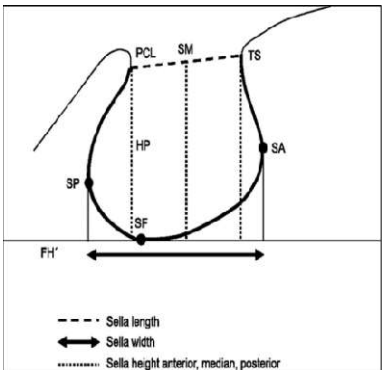


Figure 5. Different morphological shapes of sella turcica

A)Normal. B)oblique anterior wall. C) sellaturcica bridging.

D)double contour of floor E)irregular dorsum sella F) pyramidal shape



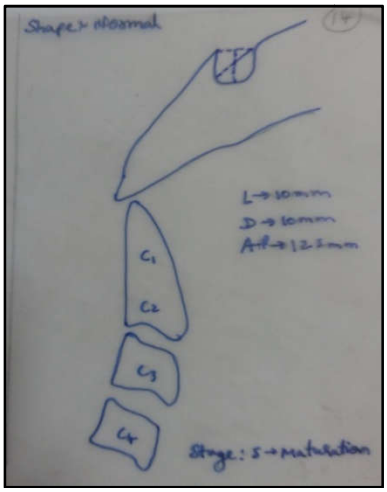


Figure 6 & Figure 7. Linear measurements of sellaturcica . L-Length, D-Depth, APD—Anteroposterior diameter

Statistical analysis

Data was entered in Microsoft excel and analyzed using SPSS (Statistical Package for Social Science-20) package. Differences in linear measurements of size of sellaturcica between males and females calculated using Unpaired-T test and according to age groups using ANOVA test.

RESULTS

The different morphological shape of sella turcica seen are normal (upper contour of anterior wall of sella turcica appears to be perpendicular to floor) 49.3% followed by oblique anterior wall 20.7%, double contour of floor 18.7%, sellaturcica bridge 6.7%, irregular dorsum sella 3.3%, pyramidal shape 1.3%.The normal shape of sella turcica was seen more commonly in females. And other morphological variations like oblique anterior were more seen in males. Double contour and bridging were more in females. The least common type of sellaturcica in study population found to be irregular and pyramidal shape of 3.5% and most common type was normal type of 49.3% are given in (Graph-1). The linear dimensions of sellaturcica in different age groups are given in (Table-2.) The patients were grouped into five different categories, 10-15 years, 16-20 years, 21-25 years, 26-30 years. There was difference in the linear measurements of depth, and anterio-posterior diameter in each age group which increased as age increased and the difference was statistically significant with $P < 0.05$. The difference in the length of different age groups was not significant. Cervical vertebrae maturation indicator (CVMI) showed highly statistical significant difference for males and females are illustrated in (Table-3). However, females showed maturation at an early age as compared to males. Chronological age shows significant difference in comparison to skeletal age.

Table 1. Stages of cervical maturation indicators

1.INITIATION.(1-8yrs)
- Very significiant amount of adolescent growth expected.
- C2,c3 and c4 inferior vertebral body borders are flat.
- Superior vertebral borders are tapered posterior to anterior.

2.ACCELERATION.(9-11 yrs)
- Significiant amount of adolescent growth expected.
- Concavities developing in lower borders of c2 and c3.
- Lower border of c4 vertebral body is flat.
- C3 and c4 are more rectangular in shape .

3.TRANSITION. (12-14 yrs)
- Moderate amount of adolescent growth expected.
- Distinct concavities in lower border of c2 and c3.
- C4 developing concavity in lower border of body.
- C3 and c4 are rectangular in shape.

4.DECELERATION.(15-16 yrs)
- Small amount of adolescent growth expected.
- Distinct concavities in lower borders of c2,c3and c4.
- C3 and c4 are nearly square in shape.

5.MATURATION.(17-19 yrs)
- Insignificiant amount of adolescent growth expected.
- Accentuated concavities of inferior vertebral body borders of c2, c3 and c4. C3 and c4 are square in shape.

6. COMPLETION.(20 and above).
- Adolescent growth is completed.
- Deep concavities are present for inferior vertebral borders of c2,c3 and c4.
- C3 and c4 heights are greater than widths.

DISCUSSION

This study describes the morphological variations in structure and size of the sella turcica of both genders under a wide range

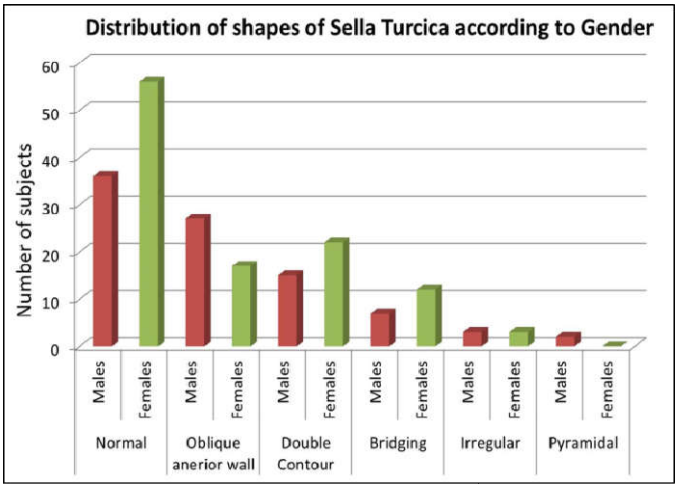
Table 2. Age-wise distribution and Linear measurements of sellaturcica parameters

Size	Age-groups	Mean	Standard Deviation	95% Confidence Interval for mean		F	P
				Lower	Upper		
Length	10-15	12.7419	3.29614	11.5329	13.9510	1.551	0.204
	16-20	11.6140	2.51250	10.9474	12.2807		
	21-25	12.2931	2.98539	11.5081	13.0781		
	26-30	13.7500	2.87228	9.1796	18.3204		
Depth	10-15	7.8065	1.24231	6.9840	8.6289		
	16-20	8.7982	1.70047	8.3470	9.2494	3.876	0.006
	21-25	8.4914	1.74841	8.0317	8.9511		
	26-30	8.5000	1.7300	3.7263	13.2737		
Antpost	10-15	13.9355	1.99650	12.8364	15.0346		
	16-20	14.0000	1.10960	13.1749	14.8251	6.649	0.002
	21-25	13.7931	1.00881	13.0020	14.5842		
	26-30	16.0000	1.08248	9.5039	22.4961		

Table 3. Distribution of stages of cervical vertebrae …. according to age-groups

Age groups (years)	Stages					X^2	P
	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6		
10-15	4	18	8	1	0		
15-20	0	0	5	43	9	222.195	0.000
21-25	0	0	2	0	56		
25-30	0	0	0	0	4		

Interpretation: There was highly significant difference in stages of..between the Age groups (p=0.000)



Graph 1. Distribution of shapes of sella turcica according to Gender

of age group. In a study done by Sathyanarayana *et al*, showed 61% of the subjects had normal morphology whereas the remaining 39% had variations in the shape, lowest being oblique anterior wall in 5%, double contour of the floor in 5.5%, pyramid like shape of the dorsum sellae in 5.5%, bridging of sellaturcica in 8% of subjects, irregularity (notch like depression) in the posterior surface of the dorsum sellae in 15% of study population (Satyanarayana *et al*., 2013). In our study normal subjects were 49.3% followed by oblique anterior wall 20.7%, double contour of floor 18.7%, sellaturcica bridge 6.7%, irregular dorsum sella 3.3%, pyramidal shape 1.3%. In a study done by Chauhan *et al*. showed morphology of sellaturcica to be typical in just 28% of cases. Within the atypical sellae most had oblique anterior wall (23%), followed by irregular sellae (18%) bridging in 17% of cases, double contour of floor 10%. None of the sella was seen to be pyramidal in type in north Indian population (Hassel and Farman, 1995). In our study, the normal type of sellaturcica is 49.3% of the study population, morphological variations were 50.7% with pyramidal shape 1.3%. In the study by Axelsson *et al*. (2004) results found that the length of sellaturcica was almost constant throughout the observation period where as the depth and diameter increased with age. Similarly, statistically significant values ($P < 0.05$) were derived from present study where the depth and anteroposterior diameter gradually increased with age, and regarding length there is no significant increase with age. The average length, depth, and anteroposterior diameter ranged as 7-17 mm, 4-11mm, 9-21mm respectively. Based on the above result, growth of the individual can be assessed based on the size of the sellaturcica at different age periods. In our study, there was no significant difference in all three dimensions in males and females. This results is correlating with studies done by Yassir *et al*. 2010 in Iraq population, Shah *et al*. 2011 in Pakistan population, Chavan *et al*. 2012 in Maharashtra population, Osunwoke *et al*. 2014 in Nigerian population, where between genders no significant difference was found in terms of length, depth, and diameter. (Shah *et al*., 2011; Yassir *et al*., 2010; Osunwoke *et al*., 2014) Cervical vertebrae--Human growth shows considerable variations in the chronologic ages at which individual children reach similar developmental events. Chronological age alone is not sufficient for assessing the stage of development of a growing child. Accurate information is provided by skeletal maturation which have been used to identify stages of growth (Sachan *et al*., 2012).

However, for assessing skeletal maturation, changing concavities on lower border of cervical vertebrae are also found to be a reliable and valid in assessment of skeletal and somatic maturation (Sachan *et al*., 2012). Lamparski was a first person to utilize the cervical vertebrae radiographically and found them to be as reliable and valid as the hand-wrist radiography for assessing skeletal age. This view was supported by Fishman *et al*. in their study they confirm skeletal age is more advance than chronological age (Lamparski, 1972). When correlative study is done, strong correlation was found out between age by SMI and age by CVMI in both males and females (0.849** and 0.932**). This suggests that as SMI used for assessing skeletal age CVMI can also be used for assessing skeletal age. This study is supported by Lamparski and Hassel and Farman (1995). In our study Cervical vertebrae maturation indicator (CVMI) showed highly statistical significant difference for males and females. However, females showed maturation at an early age as

compared to males. Chronological age shows significant difference in comparison to skeletal age. The CVMI can be applied to determine the optimal treatment time in orthodontics to eliminate exposing an extra hand-wrist radiograph. The CVMI has an advantage for the assessment of the peak of growth (Sachan *et al*., 2012). The CVMI can be determined on the lateral cephalometric radiograph, which is a radiograph regularly being used in orthodontics for other treatment planning purposes.

Conclusion

The most common morphological shape of sella turcica was normal shape of about 49.3%. There was a significant increase in the depth and anteroposterior diameter of sellaturcica as age increases. There was no difference in the size of sellaturcica between males and females. Normal shape of sella turcica was seen more commonly in females than males. As chronological age cannot show accurate status of individuals skeletal age. CVMI can also be used as for assessing skeletal maturity. Skeletal age is more advance than chronological age and can be assessed by CVMI. The results can be used as a reference in future studies with larger study population.

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