The Size and Morphology of Sella Turcica in Different Skeletal Patterns among South Indian Population: A Lateral Cephalometric Study

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ABSTRACT

Objective: The purpose of the study was to measure the size and describe the morphology of sella turcica in different skeletal types.

Materials and methods: Lateral cephalometric radiographs of 180 subjects (91 males, 89 females) in the age group of 9 to 27 years were grouped into skeletal Class I, II, III (60 subjects in each group). Linear dimensions which include the length, depth and anteroposterior diameter were measured and the shape was analyzed. A student t-test was used to calculate the difference in linear dimensions and one-way analysis of variance (ANOVA) was done to study the relationship between sella turcica size and skeletal types.

Results: Considering the age groups, linear dimensions were larger in older group than in younger group (p < 0.01). Significant difference was noted in length between males and females (p < 0.05). When skeletal types were compared to the sella size, significant difference was found in the length and diameter. The shape of sella turcica appeared normal in majority of the subjects (61%).

Conclusion: Linear dimensions and shape of sella turcica in the current study can be used as reference standards for further investigations involving the sella turcica in South Indian population.

Keywords: Sella turcica, Sella size, Sella shape, Lateral cephalogram.

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. Studying these structures assists in orthodontic diagnosis, to assess the growth through superimposition on a longitudinal basis and to evaluate orthodontic treatment results. One such landmark is sella turcica (sella point S) which has been routinely used in various cephalometric analyses.1

This additional diagnostic information can be used for analyzing pathologies of the pituitary gland or several syndromes affecting the craniofacial region. So it is essential for the orthodontists and other clinicians to be familiar with the normal radiographic anatomy and morphological variations of this region to identify any deviations that may reflect the pathological conditions even before they are clinically apparent.1-3 Sella turcica is a saddle-shaped structure located in the middle cranial fossa on the intracranial surface of the body of the sphenoid bone. Sella turcica consists of two anterior and posterior clinoid processes, the tuberculum sellae, pituitary or hypophyseal fossa covered by the diaphragma sellae. The prenatal and postnatal formation of pituitary gland and sella turcica are complex processes. The two important structures are located in the boundary region, separating tissues of different origin and development. During embryological development, the sella turcica area is the key point for the migration of the neural crest cells to the frontonasal and maxillary developmental fields.4 Formation and development of the anterior part of the pituitary gland, sella turcica and teeth share in common, the involvement of neural crest cells, and dental epithelial progenitor cells differentiate through sequential and reciprocal interaction with neural crest derived mesenchyme.5,6 The posterior part develops from the para-axial mesoderm which is closely related to notochordal induction.7,8

Size of the sella turcica is variable with normal dimensions ranging from an anteroposterior diameter of 5 to 16 mm and depth of 4 to 12 mm.9-13 Bridging of sella turcica is the fusion of the anterior and posterior clinoid process. Bridging is considered as an anatomical abnormality and has been reported to occur in skeletal, dental malformations and in several syndromes.14,15

Since there is an increasing interest in the study of human craniofacial dysmorphology, it is essential to establish the
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The cephalometric norms for the normal growth and development of sella turcica. Normal standards are essential for describing abnormal morphology in several craniofacial aberrations and syndromes.

Therefore, purpose of this study was to assess the linear dimensions and morphological shape of sella turcica in subjects with different skeletal patterns.

MATERIALS AND METHODS

This retrospective study was carried out in Sri Ramachandra University, Chennai, India. Individuals with major illness or medical conditions were excluded from the study. Diagnostic records which included upper and lower study models, panoramic and cephalometric records were obtained. The cephalometric radiographs of 180 patients (91 males, 89 females) aged 9 to 27 years were used in this study.

All the radiographs were taken in the same cephalostat by a single operator. Only lateral cephalograms that had the clearest reproduction of the sella turcica were used for the study. Lateral cephalograms were distributed according to the skeletal class and gender. Sixty Class I, 60 Class II, 60 Class III cases were collected with an approximately equal distribution of males and females in each class (Table 1). The lateral cephalograms were divided into two groups according to the subject’s age: Prepubertal (9-14 years), during or postpubertal (15 years or above). Based upon the ANB angle, subjects were classified into Class I, II and III. ANB angle of ± 2° belongs to Class I skeletal base. ANB angle of > 4° belongs to Class II skeletal base. ANB angle of < 0° belongs to Class III skeletal base. In addition to overcome the limitations of ANB angle, wits analysis was used.

Cephalometric Tracing of Sella Turcica

Outline of the sella turcica on each lateral cephalometric radiograph was traced using an acetate paper under optical illumination by the author. Measurements were made according to the method described by Silverman. The outline of the sella turcica which consisted of the tuberculum sella, floor, dorsum sella, anterior and posterior clinoid processes was drawn.

Size of Sella Turcica

The linear dimensions (length, depth and anteroposterior diameter) were measured according to the method given by Silverman and Kisling. All the reference lines used in this study were in the midsagittal plane and the measurements were made with digital sliding calipers. The length was measured as the linear distance from the tuberculum sella to the tip of the dorsum sella. The depth was measured as a perpendicular from the line above to the deepest point on the floor. The anteroposterior diameter of sella turcica is measured as a line drawn from the tuberculum sella to the furthest point on the posterior inner wall of the fossa (Fig. 1).

Shape of the Sella Turcica

Shape and morphological appearance of sella turcica were assessed according to the method described by Axelsson et al. According to Axelsson, the five morphological variations are oblique anterior wall, sella turcica bridging, double contour of the floor, irregularity (notching) in the posterior part of the dorsum sella and pyramid shape of dorsal sellae (Fig. 2).

Assessing the Errors of the Methods

Twenty lateral cephalograms were chosen at random and traced by the same operator on two separate occasions at least 3 weeks apart. The measurement errors were estimated using Dahlberg formula. The coefficient of reliability and the variance of the duplicate measurements were also calculated as suggested by Houston. The errors of duplicate measurements among three groups were small with a range of 0.0 to 0.5 mm. The reliability measurements were between 0.84 and 1.00, which showed good reproducibility of the retraced cephalometric radiographs.

Table 1: Subjects grouped on the basis of age, gender and skeletal type

<table>
<thead>
<tr>
<th>Skeletal class</th>
<th>Males</th>
<th></th>
<th>Females</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>16</td>
<td>15</td>
<td>9-14</td>
<td>14</td>
</tr>
<tr>
<td>Class II</td>
<td>15</td>
<td>13</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Class III</td>
<td>16</td>
<td>16</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

Fig. 1: Linear dimensions of the sella turcica: L: Length; APD: Anteroposterior diameter; D: Depth

Fig. 2: Different morphological types of the sella turcica
Statistical Analyses

Data from all measurements were transferred to a statistical package of social sciences (SPSS 15.0). A Student’s t-test was used to calculate the mean differences in linear dimensions of sella turcica between males and females and between different age groups at a significance level of 0.05. The relationship between skeletal type and size of sella turcica was assessed using one-way ANOVA test and to distinguish which skeletal class showed the most significant difference in linear dimensions. Regression analyses were also used to test the interrelationship of gender, age, skeletal type, with the linear dimensions.

RESULTS

Size of Sella Turcica

When the linear dimensions were compared with age, there was a statistically significant difference (p < 0.001, 0.02; Table 2) between the two groups in all three linear dimensions. The size of sella turcica was larger in older age group than the younger age group.

The linear dimensions and the average length, depth, anteroposterior diameter for males and females are shown in Table 3. When linear dimensions were compared between males and females, there was a statistically significant difference in length (p < 0.03) whereas depth and anteroposterior diameter was not statistically significant.

One-way ANOVA was done to determine if there was any difference in the linear dimensions among different skeletal patterns, irrespective of age and gender. A significant difference was noted between skeletal class and length and anteroposterior diameter of sella turcica (p-value of 0.004, 0.008; Table 4).

Shape of Sella Turcica

Appearance of sella turcica was found to be normal in majority of subjects (61%). The morphological variations were found in 39% of the subjects. Irregularity in the posterior wall was seen in 15%; oblique anterior wall was seen in 5%; sella turcica bridging was seen in 8% of the subjects; double contour of the floor was seen in 5.5% while pyramidal shape was present in 5.5% of the subjects (Table 5).

On assessing the morphology of sella turcica of each of the three skeletal types, the results were as follows: in skeletal Class I patients, 75% of patients had normal sella and 25% of the patients had variations. In skeletal Class II patients 60% of the patients had a normal sella and 40% of the patients had variations in the morphology. In skeletal Class III patients, 48%
of the patients had a normal sella and 52% of the patients had variations in the morphology. The most common variation seen in all the three skeletal types was the irregularity in the dorsum (Table 5).

When the morphology was assessed in males and females irrespective of age and skeletal class, sella turcica appeared normal in 59 to 63% of the subjects (Table 6). Between the two age groups, sella turcica appeared normal in 65% in younger group and 57% in older group. Sella turcica bridging was also increased in older age group (Table 6).

**DISCUSSION**

This study describes the linear dimensions and morphological appearance of the sella turcica in subjects with different skeletal patterns.

**Size of Sella Turcica**

When the linear dimensions (length, depth and diameter) of sella turcica were compared with other studies, a difference between measurements was noted. A microsurgical anatomical study of 250 sphenoidal blocks obtained from cadavers done by Quakinine and Hardy showed that the average width of sella turcica was 12 mm, length (anteroposterior diameter) was 8 mm and height (vertical diameter) was 6 mm. Same authors stated that the height of sella turcica was 2 mm shorter than the width which infers that the gland does not fill the whole volume of sella turcica.17

Axelsson et al studied the size of sella turcica in a Norwegian sample longitudinally between the ages of 6 to 21 years. His findings were that the length was almost constant throughout the observation period where as the depth and diameter increased with age. He also found that there was no significant difference in depth and diameter between males and females while the length was larger in males.12 When our results were compared with the Norwegian sample, the difference in the linear dimensions were between 0.3 and 1.1 mm. Comparison of the study done by Alkofide in Saudi subjects1 shows that the linear dimensions in the Indian population sample were on average 1.7 to 2.9 mm smaller than those of the Saudi subjects. Shah et al studied the size and shape of sella turcica among patients above 15 years of age from Islamabad and reported that mean length and anteroposterior Diameter in females was 11.3 and 14 mm and in males it was 11.4 and 13.8 mm respectively. The authors concluded that there was no statistically significant difference among all three linear measurements in both genders and in different skeletal patterns and b.18 Filipović et al analyzed the size of the sella turcica in 90 Nisi subjects with various skeletal malocclusions between the age group of 18 to 22 years and found that the length, width and anteroposterior diameter was 9.2, 8.3 and 10.9 mm respectively. The authors also concluded that the size was smaller in Class II malocclusions and larger in Class III malocclusions and there was no difference between the two sexes.19 Comparison of the size with our study population shows that the lengths were similar where as depth and diameter were larger in nisi subjects. The probable reasons for these differences in the values can be attributed to ethnicity or in the method of measurements.

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**Table 5:** Frequency distribution of different shapes of sella turcica in skeletal Class I, II and III

<table>
<thead>
<tr>
<th>Sella shape</th>
<th>Class I</th>
<th></th>
<th>Class II</th>
<th></th>
<th>Class III</th>
<th></th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percentage</td>
<td>Frequency</td>
<td>Percentage</td>
<td>Frequency</td>
<td>Percentage</td>
<td>Frequency</td>
<td>Percentage</td>
</tr>
<tr>
<td>Normal sella turcica</td>
<td>45</td>
<td>75</td>
<td>36</td>
<td>60</td>
<td>29</td>
<td>48</td>
<td>110</td>
<td>61</td>
</tr>
<tr>
<td>Oblique anterior wall</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>5%</td>
</tr>
<tr>
<td>Sella turcica bridge</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>15</td>
<td>14</td>
<td>8%</td>
</tr>
<tr>
<td>Double contour</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>4</td>
<td>7</td>
<td>10</td>
<td>5.5%</td>
</tr>
<tr>
<td>Irregular dorsum sella</td>
<td>7</td>
<td>12</td>
<td>10</td>
<td>17</td>
<td>10</td>
<td>17</td>
<td>27</td>
<td>15</td>
</tr>
<tr>
<td>Pyramidal shape</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>4</td>
<td>7</td>
<td>10</td>
<td>5.5%</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
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<td>60</td>
<td>100</td>
<td>60</td>
<td>100</td>
<td>180</td>
<td>100</td>
</tr>
</tbody>
</table>

**Table 6:** Frequency distribution of different shapes of sella turcica among both genders and in two age groups

<table>
<thead>
<tr>
<th>Sella shape</th>
<th>Gender</th>
<th>Age</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>10-14 years</td>
<td>Frequency</td>
<td>Percentage</td>
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<tr>
<td></td>
<td></td>
<td>Age</td>
<td>Frequency</td>
<td>Percentage</td>
</tr>
<tr>
<td>Normal sella turcica</td>
<td>54</td>
<td>59</td>
<td>56</td>
<td>63</td>
</tr>
<tr>
<td>Oblique anterior wall</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5.5</td>
</tr>
<tr>
<td>Sella turcica bridge</td>
<td>11</td>
<td>12</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Double contour</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Irregular dorsum sella</td>
<td>11</td>
<td>12</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Pyramidal shape</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>5.5</td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
<td>100</td>
<td>89</td>
<td>100</td>
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When determining if there was any difference in the size of sella turcica between males and females, significant difference for length was found in both the groups. Contrary to our results, a study done by Israel which showed that the size of sella was almost the same in males and females but the size tends to increase in males with age. Silverman studied the radiographs of 320 subjects from 1 month to 18 years of age and calculated the mean sella area. The findings of the study was that pituitary fossa of males were larger in males than in females from 1 to 13 years of age. Since the pubertal growth spurt occurs approximately 2 years earlier in females than in males, the size increases from 11 to 15 years of age. The size of the sella becomes equal in both genders due to the growth spurt occurs approximately 2 years earlier in females. Haa studied the mean sella area in males and in females of 3 to 17 years of age and reported that the size was slightly larger in boys than in girls up to 17 years after which the size was greater in females.

In this study, when the effect of age on the size of sella was compared, the size was greater in older group than in the younger group. Preston et al in his study on 182 lateral cephalometric radiographs in subjects with the age group of 5 to 17 years also found a close correlation between the sella area and age which shows that size of pituitary fossa increases with age. This might be because of the adolescent growth spurt of females that occurs earlier than males. Choi et al also found that the linear dimensions of sella turcica increased up to 25 years of age. There was no increase in size after 26 years of age. In contrast to the above findings, study done by Elster et al on 169 subjects aged 1 to 30 years with magnetic resonance imaging found that there was no difference in childhood between males and females, and changes occurred only at puberty. The height of the pituitary gland was 7 mm in males and 7 to 10 mm in females. They also found that young adults had smaller glands than adolescents.

There are only few studies in the literature which have evaluated the relationship between the size of sella turcica and skeletal type. In this study, the size of sella turcica was larger in skeletal Class III subjects. Alkofide found that the size was smaller in skeletal Class II subjects and larger in skeletal Class III subjects. In contrast, Preston et al divided the cephalometric radiographs into 3 groups (5-9, 10-14, 15-17 years) based on the age, and according to their skeletal type (Class I, II and III) and found no significant correlation between skeletal type and sella area. When age, gender and skeletal type were compared to the size of sella turcica, age was significantly related to the length of sella, size being larger in older group than in younger group irrespective of gender and skeletal type.

The linear dimensions (length, depth, and diameter) can be used to predict the size of the pituitary gland. It might be of clinical importance when an abnormally large sella is found on the lateral cephalogram.

**Shape of Sella Turcica**

Variations in the shape of sella turcica have been well reported in the literature. Classifications were based on the contours of the sella floor, the angles formed by the contours of anterior and posterior clinoid processes and tuberculum sellae and the fusion of both clinoid processes as sella turcica bridge. Axelson et al studied the morphology in a Norwegian sample and classified them in to six types. Seventy five percent of the subjects had a normal morphology while the remaining subjects showed an abnormal morphology. Alteration in the shape can also be seen in normal subjects, those with medically compromised conditions such as spina bifida and craniofacial deviations. Jones et al found that incidence of bridging in patients treated by combined surgical orthodontics was 16.7% whereas it was present in 7.3% of patients treated with orthodontics alone. When different skeletal classes were analyzed for bridging, Abdel Kaber studied the prevalence of a sella turcica bridge in relation to skeletal Class in Saudi subjects and found a higher percentage of sella turcica bridges in orthognathic–surgical patients with a skeletal Class III malocclusion (10.71%) as well as in orthodontic patients with a Class III malocclusion (7.14%). In total, the prevalence of a sella turcica bridge in 83 patients of that study with a skeletal Class III or a Class III malocclusion was 17.85%.

In this study, 61% of the subjects had normal morphology whereas the remaining 39% had variations in the shape. Alkofide described the shape of sella turcica in Class I, II and III Saudi subjects and found that 67% of subjects had normal morphology and 33% of subjects had variation in the morphology. Irregularity in the dorsum sella was found in 11.1%, oblique anterior wall in 9.4%, pyramidal shape in 2.8% and sella turcica bridging in 1.1% of the subjects regardless of the gender, age or skeletal type. The results obtained in this study coincide with that of studies done by Axelson et al and Alkofide et al.

Shah et al described the morphology of sella turcica and his findings were that morphology was normal in 66% of the subjects and variation was present in 34% of the subjects. Among the variations, irregular dorsum was seen in 16.7%, pyramidal shape in 7.7%, double contour of the floor in 5.5%, oblique anterior wall in 4% and sella turcica bridging in 0.8%. The only difference observed was that sella turcica bridging was seen in 8% of the patients in our study.

The findings from the present study can be used to estimate the approximate size of the pituitary gland which may help the clinician to identify an abnormally large sella turcica on a lateral cephalogram. It is also important for the orthodontist to be familiar with morphology of sella turcica in order to differentiate the pathology from normal developmental patterns.

**CONCLUSION**

1. There was a significant difference in the size of sella in older and younger age groups in all three-dimensions and size was larger in older subjects.
2. There was significant difference in length and diameter of the sella turcica between the two genders.
3. When sella size was compared with skeletal type, there was a significant difference between Class II and III subjects. Size was larger in Class III subjects.
4. When the age, gender and skeletal type was correlated to the dimensions (length, depth and diameter), age was significantly correlated to the sella size.
5. Shape of the sella turcica was normal in 61% of the subjects. Results from this study can be used as reference standards for studying the sella turcica morphology in South Indian subjects.

REFERENCES