

## Research Article

# Morphometric analysis of sella turcica in North Indian population: a radiological study

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## ABSTRACT

**Background:** The purpose of this study was to describe the morphology and measure the size of the sella turcica in North Indian population.

**Methods:** Lateral cephalometric radiographs of 180 individuals (90 males and 90 females) with an age range of 12 - 65 years were taken. Morphology of sella turcica was studied and various measurements were taken to determine the shape of the sella. Statistical analysis was done to calculate differences in dimensions and to establish if any, relationship exists between age, sex and the morphometry of sella turcica.

**Results:** The study found that sella turcica presented with a normal morphology in only 28 per cent of the subjects. A significant difference in linear dimensions between genders was found in sella height and width. When age was evaluated, some dimensions showed negative correlation with the age. Sella size of the older age group was as a rule larger than the younger age.

**Conclusion:** Pathological enlargement of the pituitary fossa can be detected by this technique and may also be helpful in providing data in the assessment of racial, gender, age specific variation in the skull.

**Keywords:** Morphometry, Sella turcica, Morphology

## INTRODUCTION

Sella turcica is located in the middle cranial fossa and lies on the intracranial surface of the body of the sphenoid and consists of a central pituitary fossa bounded anteriorly by tuberculum sellae and posteriorly by dorsum sellae. Two anterior and two posterior clinoid processes project over the pituitary fossa. The anterior clinoid processes are formed by the medial and anterior prolongations of the lesser wing of the sphenoid bone, and the terminations of dorsum sellae are present in the form of posterior clinoid processes.

Sella turcica is an important landmark readily seen on lateral cephalograms and acts as a noteworthy reference

point. It is traceable for metric analysis which makes it an excellent source of information related to the identification of pathologies of pituitary gland and various syndromes that affect the craniofacial region. Knowledge of the normal radiological anatomy and variations in the morphometry of this area are helpful as a tool to study growth in an individual, evaluation of orthodontic treatment results and to recognize and further investigate a variety of pathological situations.<sup>1-3</sup>

Normative data on the size of the sella turcica have been reported previously and typically range from 4 to 12mm for the vertical and 5 to 16 mm for the antero-posterior dimension<sup>4-6</sup> Changes in size of the sella turcica are frequently related to pathology; enlargement is the most

frequent finding but is frequently not accompanied by bone erosion. Any abnormality or pathology of gland can manifest<sup>7</sup> from an altered shape of sella turcica to a disturbance in the regulation of secretion of various glandular hormones leading to diverse problems like acromegaly, gigantism, hyperthyroidism, amenorrhoea etc. It has been suggested that cephalometric radiographs of subjects with these conditions may, in some instances, show an abnormal sella region, or vice versa i.e., subjects with an abnormal sella turcica may actually have an undetected underlying disease.<sup>8</sup> The immense improvement of imaging methods has made it possible to perform research that defines the morphology of the human body structures. Morphology may vary from one geographical region to other depending upon the type of skull. The establishment of normal standards in Indian population will aid in the process of eliminating any abnormality in such an important part of cranium. Therefore, the purpose of this study was to analyze the predominant morphological shape and measure the linear dimensions of sella turcica to determine if any difference exists due to gender or age in north Indian population.

## METHODS

This was a prospective study of patients seeking orthodontic treatment in North India. Lateral cephalogram of 180 patients (90 males and 90 females) aged 12 – 65 years were used in this study. All subjects were clinically healthy with no syndromes, clefts, or other malformations and were treated by orthodontics alone without surgical intervention. Radiographs showing sella turcica area with maximum clarity were selected.

The mid-sagittal enlargement was 110 per cent and all linear measurements were corrected for magnification differences prior to the statistical analyses. The radiographs were divided into two groups according to the subject's age: pre-pubertal (<15 years) and post pubertal (15 years or more). The distribution was made since earlier it has been reported that the morphology of sella turcica does not change considerably after 12 years of age;<sup>19,20</sup> females at approximately 15 years of age have finished their pubertal growth; sella turcica size in younger adult males and females have been reported to be almost the same, except during pregnancy.<sup>9,10</sup>

The radiographs were scanned at 150 dpi and the points shown in Figure 1 were digitized with viewbox 3 software. The contour of the sella turcica was traced between points tuberculum sella (TS) and posterior clinoid (PClin), and nine additional equally spaced points along this contour were located by the computer software. The total of these 11 points defined a smooth curve that represented the outline of the sella turcica from TS to PClin, and these were used for shape analysis. In addition, the outline was used to calculate the position of the most posterior point, the most anterior point and the deepest point of the sella (sella floor), using the Frankfurt plane (FH) as the horizontal reference direction.

The following measurements were computed:

1. Sella width: largest antero-posterior dimension, as measured parallel to the FH plane, from anterior to posterior.
2. Sella length: distance from TS to PClin.
3. Sella height anterior: The vertical distance, as measured perpendicular to the FH plane, from TS to the sella floor.
4. Sella height posterior: The vertical distance, as measured perpendicular to the FH plane, from PClin to the sella floor.
5. Sella height median: The vertical distance, as measured perpendicular to the FH plane, from the sella floor to a point midway between PClin and TS.

All measurements were taken after adjusting for the magnification of the radiographs. The statistical tests were run using SPSS software. Paired t-tests were employed to evaluate the system error if any.

## RESULTS

Sella dimensions were found to be usually more in females as a compared to males (Table 1).

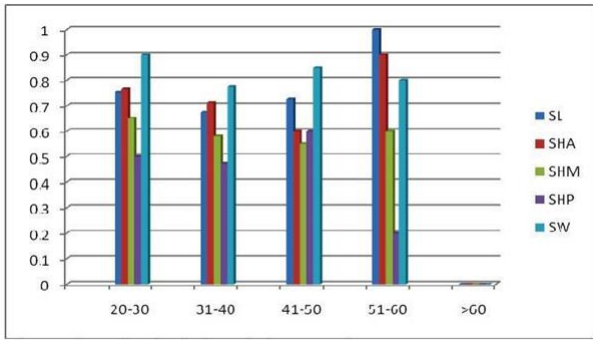
**Table 1: Average dimensions (mm) in males and females.**

	SL	SHA	SHM	SHP	SW
Females	7.53333	7.53333	7.53333	5.0	8.46667
Males	7.8	15.4	5.6	3.43333	7.36667

Significant statistical difference was seen in the sella height posterior and sella width in both the genders (P <0.01) (Figure 1). In males average sella length was 7.8mm which was found to increase with age but suddenly decreased after 60 yrs of age. Average sella

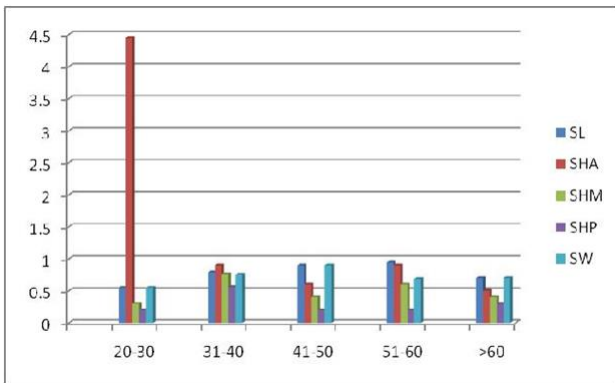
height anterior was 15.4mm. It consistently decreased with age where as median sella height first increased with age and after 40 yrs was found to be stationary, average dimensions being 5.6mm. Average sella height posterior was 3.4 mm and it was noted to be maximum in by 40 yrs

and reduced later. Whereas Sella width was maximum in the age group of 40-50 yrs (Figure 1, 2 and 3).

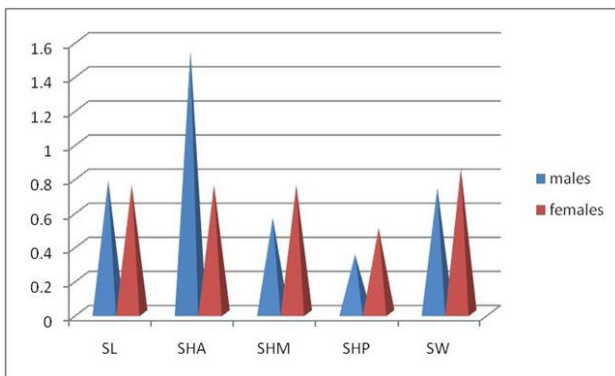


SL- Sella Length, SHA- Sella height anterior, SHM- Sella height median, SHP- Sella height posterior, SW- Sella width

**Figure 1: Comparative analysis of various dimensions (mm) in different age groups in females.**



**Figure 2: Comparative analysis of various dimensions (mm) in different age groups in males.**

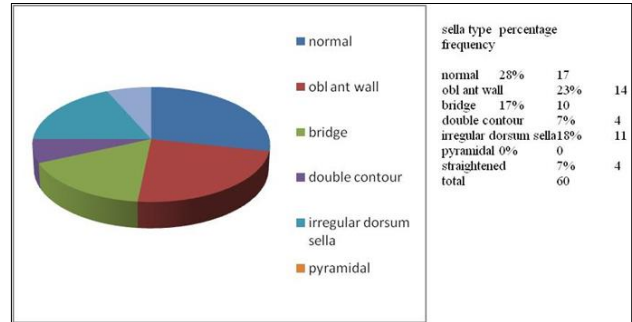


**Figure 3: Metric analysis of sella dimensions (mm) in males and females.**

In females average sella length was found to be 7.5mm and was largest in >60 yrs of age. Average sella height median was also 7.5mm and was seen to decline with age and in >50 yrs was again seen to increase in dimension. Average sella height posterior was 7.5mm, was maximum in the age 40-50 yrs and gradually declined

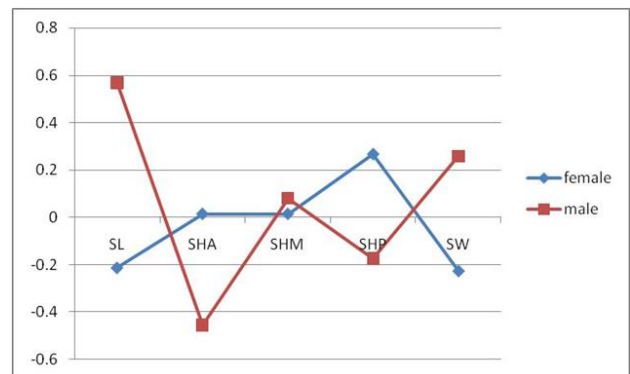
thereafter. Average sella width was 8.4mm being highest in 20-30 yrs followed by a gradual decline.

Morphology of sella turcica was found to be typical in just 28% of cases. Within the atypical sellae most had oblique anterior wall (23%), followed by irregular sellae (18%). None of the sella was seen to be pyramidal in type in this population (Figure 4).



**Figure 4: Incidence of different morphological types of sella turcica.**

When Pearson’s coefficient of correlation was found to be negative for sella length and sella width in females whereas it was negative for sella height anterior and sella height posterior in males (Figure 5).



**Figure 5: Pearson’s coefficient of correlation in age vs. sella turcica dimensions in males and females.**

**DISCUSSION**

Shape variation in the sella turcica have previously been reported by few researchers.<sup>11-13</sup> Gordon and Bell (1922) examined the radiographs of children 1 - 12 years of age and classified the sella turcica into circular, oval, and flattened, or saucer shaped.<sup>11</sup> They concluded that most of the subjects had either a circular or oval-shaped sella, and noted that even with this broad classification, difficulty was found in placing some cases into one of the three categories. Davidoff and Epstein (1950) used the term ‘J-shaped sella’,<sup>14</sup> while ‘omega sella’<sup>15</sup> was introduced by Fournier and Denizet (1965). But these definitions were later termed radiological myths by a study by Kier,<sup>16</sup> who suggested disregarding both of these since these were

used to characterize abnormal pathology as well as normal developmental patterns. Other descriptions of the sella turcica have been proposed based on the appearance of flatness or concavity of the contours of the sella floor, the angles made by the contours of the tuberculum sella, the contours of the anterior and posterior clinoid processes, and the fusion of both processes which is termed a 'sella turcica bridge'.<sup>17</sup>

In a study<sup>18</sup> the shape of the sella turcica was categorized into six main types; normal sella turcica, oblique anterior wall, double-contoured sella, sella turcica bridge, irregularity (notching) in the posterior part of the sella, and pyramidal shape of the dorsum sellae. Their results show that normal sella turcica morphology was seen in two-thirds of the subjects, while the remainder showed variable morphological appearances.

In the current study, only 28% per cent of the subjects appeared to have a normal shaped sella turcica, while 72% per cent presented with different shapes. The finding of an irregular notching of the dorsum sellae was approximately 18% in the present study (Figure 6) which was more frequent than other study,<sup>18</sup> while a pyramidal shape of the dorsum was reported more frequently in the former investigation as compared to the present study where there was no case detected with pyramidal dorsum sella. A doubled contour floor was present in 7 per cent of the subjects of the current study (Figure 7), which is much higher than that reported by same study.



**Figure 6: Bridging of Sella turcica.**



**Figure 7: Double contouring of sella turcica.**

The presence of a sella turcica bridge in normal individuals has been shown to occur in 5.5 - 22 per cent of subjects,<sup>18</sup> with an increased incidence in patients with craniofacial 461 deviations.<sup>17</sup> In the current study, a sella bridge (Figure 8) was found in the same range as other studies (17%). An oblique anterior wall has also been documented in normalas well as medically compromised subjects such as children with lumbosacral meningomyelocele and seckel syndrome.<sup>18-20</sup> The current study showed only 23% per cent of subjects with an oblique anterior wall which was almost at par (26%) with the study by Axelsson et al.<sup>18</sup>



**Figure 8: "Irregular" sella turcica with same range as other studies.**

When the linear dimensions of length, depth, and diameter of the sella turcica in the present study were compared with other investigations,<sup>18,21</sup> significant difference between measurements was noted. Quakinine and Hardy (1987)<sup>21</sup> performed a microsurgical anatomical study on 250 sphenoidal blocks obtained from cadavers of different ages. They found that the average transverse width of the sella turcica was 12mm, the length (antero-posterior diameter) 8mm, and the average height (vertical diameter) 6mm. Whereas average height was found to be more in the present study by approximately 1.7 mm (Table 1). But height of the gland was usually 2 mm shorter than the actual depth of the sella (the gland does not fill the whole volume of the sella turcica) and this should be taken into consideration during measurements. Similar results were also found in a Norwegian sample.<sup>18</sup> The linear dimensions in this Saudi sample were on average 2.02 - 2.73mm larger than those in the Norwegian subjects.

In the current study there was highly significant difference between males and females in the sella turcica height posterior and sella width ( $p < 0.01$ ). In a study by Silverman (1957)<sup>5</sup> on radiographs of 320 individuals, 1 month to 18 years of age, the mean sella area was calculated (length and depth). The findings revealed that

the pituitary fossa of males tended to be larger than that of females from about 1 - 13 years of age. Due to the pubertal growth spurt in females which begins 2 years earlier than males, a significant change in pituitary fossa size occurs in females from 11 to 15 years of age. Thereafter, growth acceleration in males, which is usually 2 - 3 years later than that in female, results in an approximate equalization in sella area in both genders. On the other hand, Haas (1954) compared the mean size in square millimeters of the sella area of boys and girls aged 3 - 17 years and found some differences due to gender.<sup>22</sup> He reported that the sella turcica of boys was greater than girls, but after 17 years of age, the sella of females were slightly larger than that of males when the effect of age on sella turcica size was studied, the sella sizes of the older age group in the present investigation were more or less larger than the younger group. Similar findings were reported by Preston (1979) who found a close correlation between the area of sella and age. His findings on 182 lateral radiographs of individuals aged 5 - 17 years revealed that the pituitary fossa increased in size with age, which reflects the adolescent growth spurt of females that occurs at an earlier age.<sup>23</sup>

Choi et al. (2001) concluded that the linear dimensions of sella turcica had a positive linear tendency until 25 years of age. After 26 years of age, no significant increase could be found in sella turcica size.<sup>24</sup> Contrary to these findings, Elster et al. (1990), in a magnetic resonance imaging study of 169 patients aged 1 - 30 years, found that during childhood there was no difference between males and females, but that dramatic changes took place during puberty with swelling of the gland.<sup>12</sup> When studying the effects of gender and age, on the size of the sella turcica, the results show that age was significantly related to the dimensions of sella, which were larger in older subjects, irrespective of gender. No similar studies comparing these factors with sella size in north Indian population could be found in the literature. The linear dimensions obtained from the current study can be used to approximate the size of the pituitary gland, and may aid the clinician when confronted with an abnormally large sella turcica on lateral cephalograms. The orthodontist should also be familiar with the different shapes of the sella area, in order to help distinguish pathology from normal developmental patterns.

Choi et al. (2001) measured volume in addition to width and height in a cross-sectional sample of orthodontic patients.<sup>24</sup> They found an increase in sella dimensions with age, from the 6 - 10 to the 21 - 25 age group. However, the change in height was minimal and probably not statistically significant (no SD values were given). It should be noted that an age-related increase of sella turcica size is expected because its contents, i.e. the hypophysis, have been shown to increase in size with age.<sup>25</sup>

The search for establishment of normative values is based on the assumption that pathological conditions will be

identified with sufficient sensitivity once such values are available. However, it is becoming more evident that what appear to be 'abnormalities' in shape may not always reflect underlying pathology. For example, although asymmetry (double outline) and cortical erosion of the sella floor are often considered signs of increased pathological significance,<sup>26</sup> it is arguable because such signs have been observed in a relatively large percentage of asymptomatic subjects, without being related to the presence of pituitary tumours. Conversely, pathology may exist without osseous manifestations. The largest percentage of intrasellar tumours is microadenomas (adenomas smaller than 10 mm in diameter), often too small to cause sella enlargement or shape change. In fact, it is estimated that 10 - 20 per cent of the population may harbour microadenomas, most often asymptomatic.<sup>27</sup> Moreover, even considerable enlargement of the pituitary gland may not produce osseous changes evident on routine films of the skull because the pituitary gland occupies only part (approximately 80 per cent) of the volume of the sella turcica.<sup>28</sup> Further studies are needed to assess the sensitivity and specificity of cephalograms for detection of pituitary pathology. Of course, cephalograms do not constitute the radiological method of choice for diagnosis of a suspected pituitary tumour. Computed tomography and magnetic resonance imaging provide much greater sensitivity. However, incidental findings noted by the orthodontist may lead to further investigation of undiagnosed or subclinical conditions.<sup>1-3</sup> Although enlargement of the sella turcica may be a sign of an intrasellar tumor or juxtaseellar tumor asymptomatic enlargement of sella turcica may occur. Plain film radiographs have a relatively high sensitivity for detecting sella change at between 67% and 77% of positive findings and clinicians should be suspicious when any of the sella turcica dimensions exceed the upper limits of normal.

It is well known that pathological enlargement of the pituitary fossa may often be distinguished at a glance. Many such cases show erosion of the bone. In a study of lateral skull films of patients suffering from tuberculous meningitis, measurement has shown that in some adults the fossa increases in size to a degree which is significant when the errors of the method are considered. In a few young children also, the fossa has been found to show a greater increase in size than might have been expected in the normal growth processes. In none of these cases has there been any bony erosion, or any other sign of enlargement which attracts the unaided eye. Therefore it is concluded that, in doubtful cases, pathological enlargement of the pituitary fossa may be detected by this technique provided that serial films are taken while the enlargement is going on.

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