

Review Article

Sella turcica-Its importance in orthodontics and craniofacial morphology

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ABSTRACT

The sella turcica is a structure which can be readily seen on lateral cephalometric radiographs and sella point is routinely traced for various cephalometric analyses. The search was carried out using the following key words (sella turcica, bridging of sella, size, shape of sella turcica) and with the following search engine (Pubmed, Cochrane, Google scholar). The morphology is very important for the cephalometric position of the reference point sella, not only for evaluating craniofacial morphology, but also when growth changes and orthodontic treatment results are to be evaluated. This makes it a good source of additional diagnostic information related to pathology of the pituitary gland, or to various syndromes that affect the craniofacial region. Clinicians should be familiar with the normal radiographic anatomy and morphologic variability of this area, in order to recognize and investigate deviations that may reflect pathological situations, even before these become clinically apparent. 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. The neural crest cells are involved in the formation and development of sella turcica and teeth. The size of sella turcica ranges from 4 to 12 mm for the vertical and 5 to 16 mm for the anteroposterior dimension. There are many classification systems regarding the shape of sella turcica. Majority of the studies show that about 67% of the subjects had normal appearance and about 33% showed variations. The prevalence of sella turcica bridging is high in class III malocclusions and dental anomalies.

Key Words: Morphology, sella point, sella turcica, size

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INTRODUCTION

Sella turcica is an important structure in radiographic analysis of the neurocranial and craniofacial complex. In orthodontics, sella point which is located at the center of sella turcica is one of the most commonly used landmarks in cephalometrics. Such landmarks located within the craniofacial region are used to measure the positions of maxilla and mandible in relation to the cranium and to themselves. The

benefits gained from studying these structures range from assisting the orthodontist during diagnosis, as a tool to study growth in an individual through superimposition of structures on a longitudinal basis, and during evaluation of orthodontic treatment results.^[1] Since sella area is an important region, and morphology may vary from individual to individual, establishing normal standards will aid in the process of eliminating any abnormality in the size or shape of sella turcica.^[1] There is an increasing interest in the study of human craniofacial dysmorphology, but there are few cephalometric standards available in growth and development.^[2]

The literature search for sella turcica was carried out with the following key words (sella turcica, bridging of sella, size, shape of sella turcica) and with the following search engines (Pubmed, Cochrane, Google scholar). The purpose of this study was to discuss the

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importance of studying the sella turcica in the analysis of craniofacial region.

ANATOMY OF SELLA TURCICA

It is a saddle-like bony formation on the upper surface of the body of sphenoid bone. The anterior border of the sella turcica is represented by the tuberculum sellae and the posterior border by the dorsum sellae. The pituitary gland is surrounded by the sella turcica, whereas two anterior and posterior clinoid processes 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 posterior clinoid process by the endings of dorsum sellae. Any abnormality or pathology in the gland could manifest from an altered shape of sella turcica, to a disturbance in the regulation of secretion of glandular hormones, prolactin, growth hormones, thyroid stimulating hormone, follicular stimulating hormone, and so on.^[1] The anatomy of sella turcica has been described as variable. Sella turcica was divided into three segments, consisting of an anterior wall, a floor, and a posterior wall. Morphologically, there are three basic types — Oval, round, and flat of which the first two types are more common.

EMBRYOLOGY

The prenatal and postnatal formation of pituitary gland and sella turcica are complex processes. These two important structures are located in the boundary region, separating tissues of different origin and development. Origin of the pituitary gland is a result of interaction between oral ectoderm which gives rise to anterior pituitary and neural ectoderm gives rise to posterior pituitary. The pituitary fossa differentiates directly from the hypophyseal cartilage which in turn is derived from the cranial neural crest cells of the early chondrocranium.

During embryological development, sella turcica area is the key point for the migration of the neural crest cells to the fronto nasal and maxillary developmental fields. 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.^[3,4] Posterior part of the pituitary gland develops from the paraxial mesoderm which is closely related to notochordal induction.^[5]

A close interrelationship exists between the development of brain tissue and the bones surrounding the Brain-neurocranium. Any congenital malformations in the development of brain may be detected by analyses of bones in the neurocranium. Abnormal morphology of the cranial base and the sella turcica should be included in the postnatal evaluation of craniofacial malformations. The term neuroosteology is a scientific discipline which links the osseous and neurological analyses.^[6]

THE POSTNATAL DEVELOPMENT OF SELLA TURCICA

The changes that take place in the size and shape of sella turcica during growth have been well-documented in the literature. Deposition of bone on the anterior part of the interior surface of the sella turcica ceased at an early age, whereas resorption on the distal part of the sella floor and on the posterior wall continued for a longer period of time. Deposition of bone was seen on the tuberculum sellae and resorption at the posterior boundary of sella turcica up to 16-18 years of age. The sella point is displaced backward and downward during growth and development.^[7]

SIZE OF SELLA TURCICA

Data on the size of the sella turcica have been well-reported in the literature. The size of sella turcica assessed from radiographs can be either linear or various methods of area and volume measurements. It typically ranges from 4 to 12 mm for the vertical and from 5 to 16 mm for the anteroposterior dimension.^[8-10] The variations between various measurements are probably due to the use of different landmarks, radiographic techniques, and degree of radiographic enlargement. Any change in the size of the sella turcica is more frequently related to pathology, enlargement is the most frequent finding but is usually not accompanied by bone erosion. A microsurgical anatomical study on 250 sphenoidal blocks from cadavers of different ages was performed by Quakinine and Hardy and found that the average transverse width of sella turcica was 12 mm, length was 8 mm, and the average height was 6 mm.^[11] Silverman^[8] in his extensive longitudinal radiographic investigation of 320 subjects from 1 month to 18 years of age reported that sella turcica was larger in males than in females except during puberty as this occurred

about 2 years earlier and more pronounced in females than in males. Axelsson *et al.*,^[2] studied the size of Norwegian males and females longitudinally from 6 to 21 years of age with normal facial appearance and normal occlusion. The depth and diameter in males and females were similar but the length was larger in males. Alkofide^[1] studied the lateral cephalograms of 180 Saudi subjects with an age range of 11-26 years with different skeletal types. Linear dimensions of length, depth, and diameter of sella turcica was measured [Figure 1]. Diameter of sella turcica was larger in class III subjects and smaller in class II subjects. It was found that there were no statistically significant differences between males and females in all the three linear dimensions. When linear dimensions were compared with age, the size of sella turcica was larger in older age group than in the younger age group. According to Preston,^[12] pituitary fossa increased in size with age and found a positive correlation of the area of the sella to age. After 26 years of age, no significant increase was observed on the size. Elster *et al.*,^[13] in a magnetic resonance imaging study of 169 patients aged 1-30 years, found that there was no difference in the size between males and females in childhood and dramatic change occurs at puberty with swelling of the gland. Pituitary gland was 7-10 mm in females while in males it was 7 mm, both being larger than in childhood or young adult hood. They also concluded that young adults had slightly but significantly smaller glands than adolescents of the same gender. The dimensional changes in the sella turcica had a significant positive linear trend to length, depth, and diameter until 25 years of age. After 26 years of age, no significant increase was found in sella turcica dimensions.^[10]

The most common causes of enlargement of sella turcica are the presence of intrasellar adenomas (e.g., prolactinoma)^[14-16] and empty sella syndrome (intrasellar herniation of the suprasellar subarachnoid space).^[14,17] Other rare conditions like Rathke's cleft

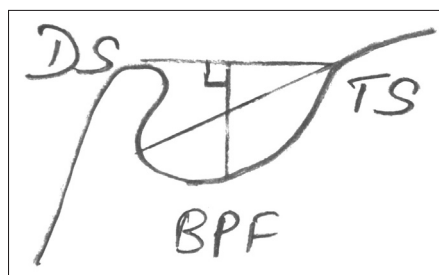


Figure 1: Reference lines for measuring the sella size

cysts and aneurysms can also cause enlargement.^[15] The size of sella turcica is smaller in primary hypopituitarism, growth hormone deficiency, Williams' syndrome,^[18] Sheehan's syndrome, the necrosis of the pituitary from infarction after a complicated delivery.^[19,20] Most of these conditions are not immediately life-threatening but some can lead to pituitary apoplexy (necrosis and haemorrhage), which requires urgent management.^[21]

SHAPE OF SELLA TURCICA

Morphological appearance of sella turcica is established in early embryonic structure. Variations in the shape of sella turcica have long been reported by many researchers. The shape of sella turcica was classified into circular, oval, and flattened or saucer-shaped and majority of the subjects had either a circular or oval shaped sella. Other 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.^[10,22] Axelsson *et al.*,^[2] categorized the shape of sella turcica into six main types-Normal sella turcica, oblique anterior wall, double contoured sella, irregularity (notching) in the posterior part of the sella, pyramidal shape of the dorsum sellae, and sella turcica bridge [Figure 2]. In his study, normal morphology was found in 71% of males and 65% of females. He concluded that sella turcica bridge was evident as early as 6 years of age.

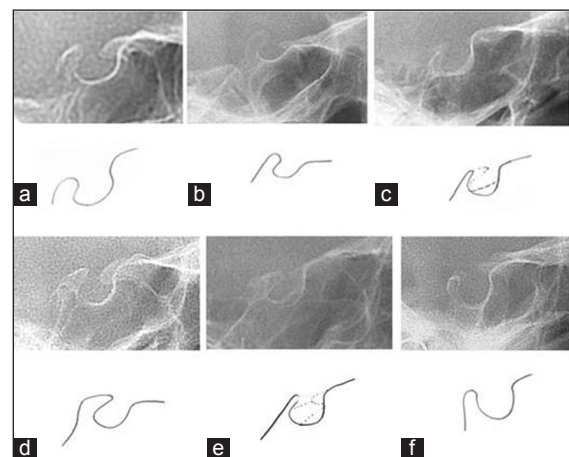


Figure 2: Different morphological types of sella turcica: (a) Normal sella turcica, (b) oblique anterior wall, (c) double contour of the floor, (d) irregularity (notching) in the posterior part of sella turcica, (e) sella turcica bridge, (f) pyramidal shape of dorsum sellae

Literature indicates the occurrence of sella turcica bridge as a radiographic feature in basal cell carcinoma, Reigers syndrome.^[23] Kjaer *et al.*,^[24] studied the lateral cephalometric radiographs of 16 patients with myelomeningocele and found that alteration in the shape of sella was seen during foetal life in all the patients. Kjaer *et al.*,^[25] found that in a foetus with holoprosencephaly, the area of sella turcica displayed malformations.

Meyer-Marcotty *et al.*,^[26] found that in all investigated patients with Axenfeld-Rieger syndrome; presence of abnormal sella turcica morphology in association with sella turcica bridge was seen. They concluded that these abnormal features could be primary indicators for diagnosis of Axenfeld-Rieger syndrome. Variations in the shape of sella turcica can be misleading since it may be present in normal subjects and in medically compromised conditions such as in spina bifida.^[27] A change in the shape of sella turcica was evident prenatally and continued postnatally in patients with Fragile X syndrome and Down syndrome.^[28,29]

BRIDGING OF SELLA TURCICA AND VARIOUS MALOCCLUSIONS

Anatomical and radiographic studies showed that the occurrence of sella turcica bridging ranges from 5.5% to 22% in normal population.^[2,27] Becktor *et al.*,^[22] studied 177 lateral cephalometric radiographs and found that 18.6% of subjects had sella turcica bridging. Jones *et al.*,^[30] found that incidence of bridging in patients treated by combined surgical orthodontics was 16.7%, where as 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 the three skeletal classes 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%).^[31]

Marsan and Oztas^[32] studied the incidence of bridging in 61 skeletal class III Turkish adult females and compared with 57 skeletal class I females. His findings was that 18% of class III subjects had bridging whereas it was 5% in class I subjects. Meyer-Marcotty *et al.*,^[33] studied the prevalence of sella turcica bridging in a homogenous group of patients with skeletal class I and class III

malocclusions and found 16.8% and 9.4% of patients with skeletal class III and class I malocclusion had bridging, respectively. Alkofide^[1] described the shape of sella turcica in class I, class II, and class 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.^[1] Becktor *et al.* studied 177 lateral cephalograms of subjects with severe skeletal malocclusion who required combined orthodontic and surgical treatment and reported that 18.6% of subjects had sella turcica bridging. He concluded that bridging occurs more frequently in subjects with craniofacial deviations compared to normal subjects.^[22]

BRIDGING OF SELLA TURCICA AND DENTAL ANOMALIES

Intracranial calcifications occurring in subjects with various dental anomalies are highly suggestive of a genetic etiology underlying both these conditions.

Leonardi *et al.*,^[34] studied the lateral cephalometric radiographs of 34 subjects with dental anomalies like palatally displaced canine and second mandibular premolar aplasia and compared with the 135 subjects in the control group. Complete calcification of interclinoid ligament was present in 17.6% of subjects with dental anomalies and 9.9% in control group. Partial calcification of the interclinoid ligament was seen in 58.8% of subjects with dental anomalies compared with 33.7% in the control group. They concluded that early appearance of sella turcica bridges during development should alert the clinicians to possible tooth anomalies in life later.

An association between sella turcica bridging and dental transposition was also studied by Leonardi *et al.*,^[35] The results were that complete calcification was seen in 33% subjects with dental transposition and 5% in controls.

CONCLUSION

The linear dimensions of sella turcica can be used to approximate the pituitary gland size. The orthodontist should be familiar with different morphologies of the sella turcica to differentiate normal from abnormal appearance.

Lateral cephalograms can be suggested for children, if there is a family history of impacted teeth, signs of ectopic eruption, and other dental anomalies so that treatment can be diagnosed and treated early.

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