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Sellar dimension in skeletal class II subjects with different growth patterns



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ABSTRACT

Objectives: The purpose of this study was to evaluate and compare size and shape of the sella in skeletal class II subjects with normodivergent, hypodivergent and hyperdivergent growth patterns.

Materials/methods: Standardized pre-treatment lateral cephalograms of 90 patients (45 males and 45 females) were selected based on values of five parameters. The sample consisted of 3 groups (normodivergent, hypodivergent and hyperdivergent) having 30 subjects each. The measurements included width, height, length and width/height (W/H) ratio. Student's t-test was used to calculate the differences in sella measurements among males and females of the same group, while one-way analysis of variance was used to determine the relationship between sella measurements and skeletal pattern. W/H ratio was used to assess the shape of the sella turcica. Values of W/H ratio were divided into 3 equal ranges: average, horizontally elongated or flat, and vertically elongated shapes. The shape of the sella turcica in groups was studied with the chi − square test and post-hoc analysis.

Results: The results showed that the W/H ratio was maximum for hypodivergent and minimum for the hyperdivergent group. ($p = 0.000$). The average shape of sella turcica was most common among all the groups. No significant difference in mean sella turcica length, width and height was found between the groups. The sella turcica length in males of hypodivergent group was significantly higher as compared to the females of the same group ($p = 0.038$).

Conclusions/implications: Sella turcica shape and dimensions can be used for the future studies as reference when comparing the same with the skeletal growth pattern.

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1. Introduction

Malocclusions due to the craniofacial skeletal components originate through variations in the normal growth and development process leading to unfavourable influences. The effect of dysmorphology in a particular area has secondary impacts on craniofacial structures resulting in different types of skeletal malocclusions. The middle cranial base completes its development earlier, hence the stability of the middle cranial base after the age of 8 years makes it an excellent baseline for the study of facial growth.[1] The neural crest cells are involved

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in the formation and development of both sella turcica (mainly anterior part) and nasomaxillary complex. In orthodontics, Importance of the configuration of the sella turcica is not only in evaluating craniofacial morphology, but also in assessing growth changes and treatment results. Therefore, the clinicians should be familiar with the normal radiographic anatomy and morphological variability of this area, in order to recognize and investigate deviations that may reflect the pathological situation, even before these become clinically apparent.[2] Study of the variations of sellar morphology due to its relatively early fixation allows us to investigate its correlation with other facial dimensions such as growth pattern in the present study. As the morphology of the sella turcica is established at an early age, this correlation can potentially be used as an early criterion to predict growth patterns in skeletal class II patients and may have an impact on the treatment plan.

2. Aims and objectives

To evaluate and compare dimensions, and shape of the sella turcica in skeletal class II subjects with normodivergent, hypodivergent and hyperdivergent growth patterns.

3. Material and methods

1. Sample for the study was drawn from the pre-treatment radiographs of orthodontic patients from our department. An informed consent from orthodontic patients was given. All radiographs were taken in a standardized manner with the same machine (Panex EC, Morrita, Japan) and by the same radiographer. A 8″ x 10″ Kodak diagnostic films and Kiran intensifying screens were used in flat 8″x 10″ aluminum film cassette. The radiographs were taken with the patient standing in an upright position in natural head position, in centric occlusion, with the lips at repose or relaxed position with the left side facing the cassette. All the radiographs were exposed at 80 Kvp, 9 mA for 1.25 s.

Selection criteria included the following:

- Subjects, aged between 14 and 24 years, having pre-treatment lateral cephalogram of good quality, especially in the sella turcica region
- No history of orthodontic treatment and surgical intervention in the craniofacial region
- No syndromes, cleft lip and palate or trauma

The radiographs were evaluated on a masked, illuminated view box in a room with reduced ambient light and were manually traced using a 3H drawing pencil on 0.003″ thick and 8″ x 10″ wide acetate paper.

Based on the values of ANB, Wit's ratio, FMPA, SNGoGn, and Jaraback's ratio, 90 cephalograms were finally chosen for the study and three study groups were formed (Table 1).

3.1. *Measurement of sella turcica dimensions*

After formation of the groups, the area below the FH plane was masked on the cephalograms so as to blind the investigator to the malocclusion present. The linear values for sella turcica dimensions were measured and contour of sella turcica was traced between tuberculum sella (TS) and dorsum sella (DS). The outline was used to identify the position of most posterior point (sella posterior), the most anterior (sella anterior), and the deepest point of the sella (sella floor), using the Frankfort plane (FH) as the horizontal reference direction. The following linear measurements were made (Fig. 1).

1. Sella width (W): The greatest antero-posterior dimension, as measured parallel to the FH plane, from sella posterior to sella anterior.
2. Sella length (L): The distance from Tuberculum sella To Dorsum Sella.
3. Sella height (H): The vertical distance, as measured perpendicular to the FH plane from SF (deepest point of sella) to the line joining dorsum sella and tuberculum sella

Table 1 – Group-wise distribution of the sample based on cephalometric parameters with mean age.

Sr. No.	Group	Cephalometric parameters (Angle in degrees)	Sample		Total	Mean Age
			Male	Female		Years
1	Group-A (Normodivergent)	ANB angle >4°, Wit's ratio > 2 mm FMPA 20°–30°, Jaraback's ratio-62–65% SNGoGn angle 30°–34°	15	15	30	17.77
2	Group-B (Hypodivergent)	ANB angle >4°, Wit's ratio >2 mm FMPA <20°, Jaraback's ratio->65% SNGoGn angle <30°	15	15	30	18.07
3	Group-C (Hyperdivergent)	ANB angle >4°, Wit's ratio >2 mm FMPA >30°, Jaraback's ratio-<62% SNGoGn angle >34°	15	15	30	17.27

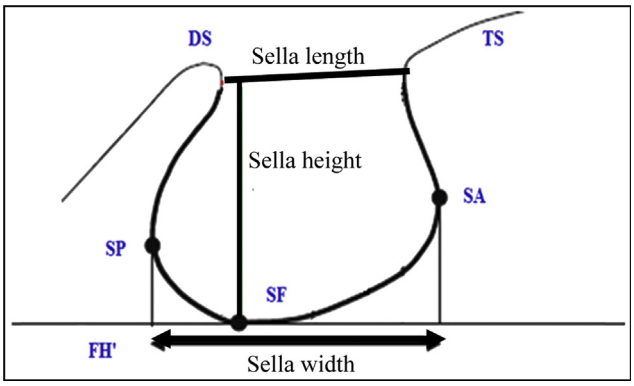


Fig. 1 – Pictorial representation of measurement of Sellar parameters (DS – Dorsum sella, TS – Tuberculum sella, SA – sella anterior, SP – sella posterior, SF – sella floor. FH' – reference line parallel to the Frankfurt horizontal plane).

3.2. *Assessment of shape of sella turcica*

Following width/height (W/H) ratio ranges were used for shape assessment-

- <1.20 for vertically elongated oval shaped sella turcica, (Code-1)
- >1.45 for wide open-flat shaped sella turcica, (Code-2)
- 1.20–1.45 for average shaped sella turcica, (Code-3)

In order to eliminate observer's bias all radiographs were coded. The allocated group was not known to the examiner at the time of evaluating the sellar parameters. 20 randomly selected cephalograms were retraced after 15 days for three consecutive times by the same investigator with 10 years of experience in tracing. The data was analyzed for intra-observer error. The error was below the critical value of 0.5 mm for all the linear measurements.

4. Statistical analyses

The data were analyzed using SPSS version 18 software for windows. The statistical analysis included the following:

- Descriptive statistics, independent-samples t-test, one-way ANOVA and post-hoc Tukey's test, chi square test.

5. Results

- There were no significant differences between males and females regarding the mean values for width, height and W/H ratio. Within each group, there were no significant differences between males and females except for the hypodivergent group in which mean sella turcica length was higher for males as compared to females and the difference was statistically significant with a p value of 0.038. (Table 2)
- The mean value of W/H ratio of sella turcica was maximum for hypodivergent group while it was minimum for hyperdivergent group and this difference was highly significant statistically (p value 0.000). The difference in W/H ratio was not found statistically significant between normodivergent and hypodivergent (p value 0.176); as well as between normodivergent and hyperdivergent groups (p = 0.086). (Table 3 and 4)
- The average shape of the sella turcica is the most common type among all the groups while wide open flat shaped sella turcica and oval shaped sella turcica were the second most common types in hypodivergent and hyperdivergent groups respectively. These results of shape of sella turcica were found to be highly significant statistically, (p = 0.000). (Table 5)

6. Discussion

Cranial base represents the base on which a human face develops and there are studies which show that the dimensions of the middle cranial fossa influence the relation between nasomaxillary complex and the malocclusion.[3] Growth of neural, skeletal and muscular factors is closely interrelated.[4] Thus the impact of dysmorphology in a particular area has secondary ramifications on other craniofacial structures resulting in various types of skeletal malocclusions. An early

Table 2 – Mean values of W/H ratio, width, height and length of the sella in male and female subjects of the three groups.

Group		W/H ratio	Width (mm)	Height (mm)	Length (mm)
Group-A	Female	1.40	10.87	7.82	9.13
(Normodivergent)	Male	1.34	11.06	8.19	9.60
	p-value (T-test)	0.274 (ns)	0.691(ns)	0.287(ns)	0.391(ns)
Group-B	Female	1.45	10.94	7.65	8.79
(Hypodivergent)	Male	1.44	11.81	8.24	9.73
	p-value (T-test)	0.964 (ns)	0.129 (ns)	0.202 (ns)	0.038**
Group-C	Female	1.28	11.19	8.83	8.89
(Hyperdivergent)	Male	1.29	10.68	8.36	9.15
	p-value (T-test)	0.830 (ns)	0.324 (ns)	0.335 (ns)	0.603 (ns)
Total	Female	1.37	11.00	8.10	8.94
	Male	1.36	11.18	8.26	9.49
	p-value (T-test)	0.685 (ns)	0.546 (ns)	0.522 (ns)	0.051 (ns)

** – significant value; ns = non-significant.

Table 3 – Mean and standard deviations in height, width and length of sella with p-value (ANOVA) in different study groups.

Group	Height (mm) Mean ± SD	Width (mm) Mean ± SD	Length (mm) Mean ± SD	W/H ratio
Group-A (Normodivergent)	8.01 ± 0.94	10.96 ± 1.29	9.37 ± 1.46	1.37 ± 0.13
Group-B (Hypodivergent)	7.94 ± 1.26	11.37 ± 1.55	9.26 ± 1.26	1.44 ± 0.18
Group-C (Hyperdivergent)	8.60 ± 1.32	10.94 ± 1.40	9.02 ± 1.37	1.28 ± 0.16
p-Value (ANOVA)	0.068	0.413	0.605	0.001**

p-value ≤ 0.05 is significant; ** – significant value.

Table 4 – Level of significance of W/H ratio of the sella among different groups (post hoc Tukey's test).

Group	Compared to	Significance
Group-A (Normodivergent)	Group-B (Hypodivergent)	0.176
Group-A (Normodivergent)	Group-C (Hyperdivergent)	0.086
Group-B (Hypodivergent)	Group-C (Hyperdivergent)	0.000**

** – significant value (p < 0.05).

diagnosis plays a major role as the skeletal malocclusions are best treated at an earlier age.[5]

During embryonic development sella turcica area is a key point for migration of neural crest cells to the frontonasal and maxillary developmental fields, hence developmentally nasomaxillary complex, anterior cranial base, base-occipital base, jaws including condylar cartilage develop from the branchial arches by migration of neural crest cells linking them embryologically.[6] Moreover, as the area anterior to the sella turcica in the early embryonic period develops predominantly from neural crest cells, any structural deviations in the anterior wall are believed to be related to specific deviations in the facial skeleton.[7] Thus the study of variation in sellar morphology due to its early fixation allows us to investigate its correlation with growth of the face and jaws such as growth pattern in the present study.

The present study was undertaken firstly to determine the average dimensions of the sella turcica in skeletal class II subjects and secondly to determine if any correlation can be drawn between the sellar morphology and growth pattern. The sella turcica is known to vary greatly among individuals, both in normal and pathological conditions as reported by Axelsson[8] and Kjaer.[7] Reports by Becktor,[9] Marcotty et al[10] and Leonardi et al[11] had shown an association of morphological variations in sella turcica with various dental and skeletal malocclusions.

Linear measurements of sella turcica have been assumed to reflect the size and perhaps the activity of its contained gland and therefore may be of some clinical value to the orthodontist.[12] Kjaer[13] in a review described morphology of sella in various anomalies such as holoprosencephaly, trisomy 21, myelomeningocele, hydrocephalus etc. Sellar size is quite variable and various authors have given different normal dimensions of the sella turcica and comparison of these dimensions with other facial dimensions had been carried out in various studies.[2,14,15] In the present study, there were no significant differences between males and females regarding the mean values for width, height, length and W/H ratio. Within each group, there were no significant differences between males and females regarding the mean values for width, height and the W/H ratio of sella turcica except for the hypodivergent group in which mean sella turcica length was 8.79 mm for females and 9.73 mm for males and the difference was statistically significant. A significant difference was found in diameter (width) size between subjects of class II and class III malocclusion in study by Alkofide.[14] In another study by Filipvoic, it was found that subjects with class II malocclusion had lowest and subjects with class III malocclusion had the highest values for the depth (height) of the sella.[3] Since comparisons of only linear dimensions were carried out in almost all the previous studies; errors due to varying magnification, even after careful standardization might have given

Table 5 – Percentage wise distribution of shape of sella in different study groups.

Shape of sella		W/H ratio <1.20 Oval shape (Code-1)	W/H ratio >1.20 to 1.45 Wide flat shape (Code-2)	W/H ratio 1.20 to 1.45 Average shape (Code-3)
Group-A (Normodivergent)	N	0	26	4
	%	0.00%	86.67%	13.33%
Group-B (Hypodivergent)	N	2	15	13
	%	6.67%	50.00%	43.33%
Group-C (Hyperdivergent)	N	11	15	4
	%	36.67%	50.00%	13.33%

Chi Square vale = 27.882; df = 4; p value = 0.000.

altered results. In order to minimize such errors, the width by height ratio of the sella turcica was used in the present study.

In a longitudinal study by Axelsson it was observed that sella turcica enlarged in depth (superoinferior dimension) and diameter (greatest anterioposterior dimension) from 6 to 21 years of age but only small changes occur in length.[16] From the data of this longitudinal study it can be shown that as a gradual increase in depth and diameter occurred from 6 to 21 years, the ratio of the diameter by depth, remained almost constant with a trend of a slight increase with age. Hence it can serve as a better determinant of sellar morphology that can be correlated with other facial dimensions. A ratio of width (greatest anterioposterior dimension) by height (superoinferior dimension) of the sella turcica was used in the present study to compare different growth patterns of skeletal class II malocclusion. There was a significant difference in W/H ratio among all the three groups when analyzed by analysis of variance, however, the post-hoc analysis revealed the significant difference between hypodivergent and hyperdivergent groups (Table 3 and 4).

In the literature several methods were used to measure sella turcica dimensions out of which Silverman's method[12] was most commonly employed.[3,14,16,17] In those studies where antero-posterior diameter of sella turcica was measured from tuberculum sella to the most distant point on the opposite side of the outline (as per Silverman's method), there could have been a problem because the orientation of the measurement depends on the shape being measured and which is not directionally consistent between subjects.[2,3,14,16,17] According to Andredaki et al an external reference plane should be used, so that antero-posterior and vertical measurements of sella turcica would be related to that external reference system which is independent on sella turcica shape. Hence the FH plane was used as an external reference plane by Andredaki et al to overcome the shortcomings of Sliverman's method.[2] In the present study a method similar to Andredaki et al was used. Present study was compared with other studies with caution due to differences in the method of measurement.

The variation of sella turcica dimensions among genders has been concluded differently by different researchers. Alkofide[14] and Marcotty[10] found no significant difference in sella turcica linear dimensions between genders. Silverman[18] observed a larger sella turcica in males during puberty, while Andredaki et al[2] observed a larger sella turcica in females. Andredaki et al also found no significant difference between males and females regarding the mean values for width and length, however mean anterior sella turcica height was the only variable found to be significantly different, being larger in females than males by 0.5 mm^2. This could be explained by the mean age of his sample (11.8 years), which is the pubertal age for females, leading to a larger pituitary fossa size in them.

The results of the present study are in accordance with Axelsson who found no significant difference between males and females regarding the mean values for width and height but found significant difference regarding mean sella turcica length.[16]

The present study found difference between sellar parameters in hyperdivergent group which is contrary to the findings of Preston who found no correlation between sellar size and vertical facial types. This may be because W/H ratio may differ while the area obtained with width and height may remain same. Moreover Preston used only one angle between occlusal plane and mandibular plane, to categorize vertical facial types, which alone is not sufficient.

Based on the observational values of W/H ratio, we divided the whole sample into equal thirds for different sellar shapes: average, vertically elongated or oval and wide open flat shapes. The average shape of the sella turcica was found to be most common among all the three growth patterns. Majority of the subjects (86.67%) in normodivergent group had average shaped sella turcica, while half of the subjects in hypodivergent and hyperdivergent groups had average shaped sella turcica. Wide flat shaped sella turcica was found to be second most common among hypodivergent (43.33%). The hyperdivergent group showed oval shaped sella turcica as second most common type of shape (36.67%).

The shape of the sella turcica is exceedingly variable having as described in the literature such as circular, oval, flat, wide, J-shaped etc; however, three basic shapes have been described by Camp.[19] These are flat, oval and round. The oval type was most frequent and the flat type was the least frequent. However he did not give any description about gender, age, and method used. Andredaki et al constituted quantitative reference data that could be used for objective evaluation of sella turcica shape.[2] He described three basic shapes of sella turcica based on the height to width ratio. In addition, some atypical forms of sella turcica have been described by Axelsson which includes oblique anterior wall, double contour of floor, sella turcica bridge, notching in the posterior part of the dorsum sella and pyramidal shape of dorsum selle.[16] The results of the shape of the sella turcica obtained in the present study do not bear resemblance with any other study. However, this study may be considered a valid starting point for finding a correlation between the sellar morphology and growth pattern as it consists of a well designed sample in which all three growth patterns were compared.

7. Conclusions

Following conclusions can be drawn from the study-

1. No significant difference in mean sella turcica length, width and height was found between the groups.
2. For width by height ratio of sella turcica there was statistically significant difference between skeletal class II hypodivergent and skeletal class II hyperdivergent group, thus width/height ratio of the sella turcica was significantly related to growth pattern.
3. The average shape of the sella turcica is the most common type among all the groups while wide open flat shaped sella turcica and oval shaped sella turcica were the second most common types in hypodivergent and hyperdivergent groups respectively. These results of shape of sella turcica were found to be highly significant statistically. Thus sellar shape was significantly related to growth pattern.

As morphology of the sella turcica is established early in life, the phenotype of sella turcica should follow in the facial phenotype, which could have some clinical importance. Further longitudinal research needs to be done using 3D imaging and with a larger sample to elaborate more on the relationship between the sella turcica morphology and growth pattern. If these studies derive similar results, sellar morphology could be used as an indicative tool for predicting growth pattern at an early age.

Conflicts of interest

The authors have none to declare.

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