Official Dental Journal of Suez Canal University
DENTAL SCIENCE Updates
Print ISSN 2636-3836
Online ISSN 2636-3844
www.dsujournals.ekb.eg
DSU — Vol. 6, No. 1, March (2025) — PP. 1:8

RELATION BETWEEN LINEAR DIMENSIONS OF SELLA TURCICA AND DIFFERENT VERTICAL GROWTH PATTERNS IN ADULTS USING CBCT

Mohamed Hesham Adel Noureldin[1], Abbadi Adel Elkadi[2], Mohamed Adel Nadim[3]

DOI: 10.21608/dsu.2025.263280.1218
Manuscript ID: DSU-2401-1218

KEYWORDS

Sella Turcica, Vertical growth pattern, CBCT.

• E-mail address: Mohammed.hesham.adel@gmail.com

1. Postgraduate student in the Department of orthodontics, Faculty of Dentistry, Suez Canal University.
2. Professor of Orthodontics, Department of Orthodontics, Faculty of Dentistry, Suez Canal University, Ismailia, 41522, Egypt
3. Professor of Orthodontics, Department of Orthodontics, Faculty of Dentistry, Suez Canal University, Ismailia, 41522, Egypt

ABSTRACT

Introduction: The relationship between shape and morphology of sella turcica and different vertical skeletal classes has been a focus of investigation since the late 19th century. By introducing Cone Beam Computed Tomography (CBCT) to the orthodontic field, studying such a relation became possible and accurate. **Aim:** The aim of this study is to determine the relation between the linear dimensions of the sella turcica and different vertical growth patterns in adults using CBCT. **Patients and Methods:** Cone-beam computed tomographic images of 54 adults were acquired. They were grouped into three groups of 18 each: Vertical growth pattern group, normal growth pattern group and horizontal growth pattern group. The length, depth, and diameter of sella turcica were measured in each group using Dolphin software program. In addition; Mimics Medical Software was used for accurate volumetric analysis of sella turcica. **Results:** Regarding Length (mm), Depth (mm), and Diameter (mm) of sella turcica, there was a statistically non-significant difference between the three groups. As for Diameter (mm); there was a statistically significant positive correlation with SN-MP in the High angle group. Regarding Volume, there was a statistically non-significant positive correlation with SN-MP in all groups. **Conclusion:** The length, depth, diameter and volume of sella turcica showed no difference in all groups. There was a statistically significant positive correlation between SN-MP angle with sella turcica diameter in the High angle individuals.

INTRODUCTION

The relationship between shape and morphology of sella turcica and different anteroposterior skeletal classes has been a focus of investigation since the late 19th century [(1)]. Several studies demonstrated the relation between variations in size of sella turcica and patients with cleft lip and palate. Other studies revealed increased incidence of sella turcica bridge in subjects with dental anomalies [(2)]. The midpoint of sella turcica is a well-established reference point widely used in orthodontics for lateral cephalometric evaluation during treatment planning. Sella turcica morphology and anatomy is critical in certain conditions. Previous investigators observed the relationship between sella turcica shape and disorders of the pituitary gland.

Advanced diagnostic imaging methods as CT, MRI and CBCT have made it possible to perform research that defines the morphology of

the sella turcica. Cone beam computed tomography (CBCT) is the most reliable method for evaluating bony structures [3].

In the current study, CBCT will be used to image the sella turcica. This approach will allow us to evaluate the structures without angular or dimensional distortion or superposition and will involve lower doses of radiation when compared with conventional radiography and CT.

Hence; the aim of the current work will be to assess the morphological shape and morphometric analysis of the sella turcica in different planes of section (coronal and sagittal) and its correlation with the different vertical growth patterns in adults using CBCT.

MATERIALS AND METHODS

In this retrospective study; the CBCT scans were collected from the archive of Radiology Department, Faculty of Dentistry at Suez Canal University. This research project was waived from ethical revision and was approved from the ethical committee to be conducted with an ethical code number approval **(78/2018)**; as there was no intervention or interaction with human subjects. In addition; the radiographed individuals' names were unidentified. All CBCT scans were taken with Soredex SCANORA 3D machine present in the Radiology Department, Suez Canal University. The recommended parameters of the mentioned machine were set to 90 kVp/4-12.5mA with exposure time 2.4-6 seconds for all the patients.

Sample size calculation:

A total number of "54" unidentified CBCT radiographs were obtained from CBCT archive of Faculty of Dentistry in Suez Canal University. This sample size was determined according to the equation:

$$n = \frac{(Z\frac{\alpha}{2})^2 * (S)^2}{(d)^2}$$

Where "n" represented the minimum available number of radiographs for each group in the study, "S" represented the standard deviation which normally doesn't increase than 10% as followed in previous similar studies and "d" represented the effect size (d=5%).

The Z (alpha/2) was related to confidence levels, and by having a confidence level of 95% in this study, the Z (alpha/2) was obtained from the Z –table and its value was 1.96. This equation was determined according to Herbert Arkin's book published in December 1981 for sample size calculations and called " Sampling methods for the auditor: An advanced treatment ". The symbol "n" represented the minimum available number of radiographs for each group in this study and was given a value equal to

$$n = \frac{(Z\frac{\alpha}{2})^2 * (S)^2}{(d)^2} = \frac{(1.96)^2 * (8)^2}{(5)^2} = 9.834 = 10.$$

An additional 8 radiographs were added to this number to exceed the minimum available number of radiographs and to increase the accuracy of this study; so that each group contained 18 radiographs.

Sampling:

The CBCT radiographs used in this study had been selected according to the following inclusion criteria:

1. Post pubertal age group older than 16 years as no considerable change in sella occurs after this age.
2. High quality image CBCT radiographs with clear reproduction of the sella turcica area and no motion artifacts.

3. Radiographs selected should be of individuals who have no history of previous orthodontic treatment or maxillofacial surgeries or showing signs of trauma or cleft palate.

Step 1: Identifying the vertical growth pattern:

All data were imported in DICOM (Digital Imaging and Communications in Medicine) format and handled by Dolphin Imaging Software*. The lateral cephalometric radiographs were extracted from the lateral right views of the CBCT scans; then orthodontic landmark points were identified. Finally; digitized cephalometric images were obtained. Steiner cephalometric analysis was used to measure the required vertical measurements to identify the sample's vertical growth pattern as in (Figure 1).

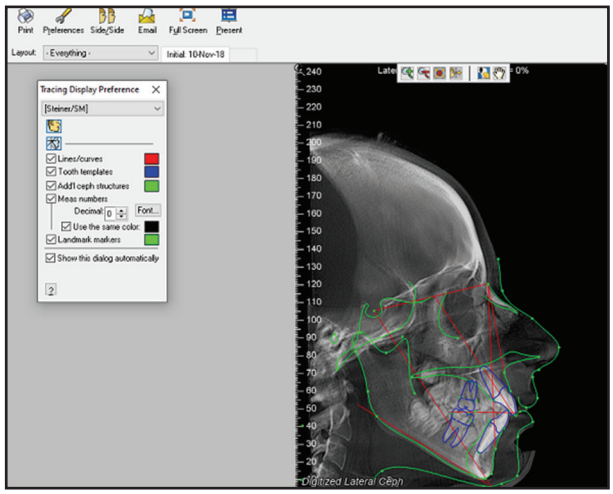

Fig. (1) Digitized lateral cephalogram with digitized reference planes and angles traced according to Steiner cephalometric analysis

Step 2: Grouping of the collected cephalometric radiographs:

The collected cephalometric radiographs were distributed into 3 groups according to the different vertical growth patterns based on the SN-mandibular angle [4]:

Group I: High angle individuals:

SN-mandibular plane angle > 37°

Group II: Normal individuals:

SN-mandibular plane angle: 27° < 32° < 37°

Group III: Low angle individuals:

SN-mandibular plane angle < 27°

Step 3: Standardization of the reference planes of the CBCT scans:

To ensure standardization of the CBCT scans; the head 3D reconstructions of each subject were reoriented according to three reference planes which were the sagittal plane, coronal plane, and axial plane. [3,5]

Step 4: Measuring the linear dimensions of sella turcica from CBCT scans:

The sella turcica linear dimensions including length, depth, and diameter were measured from the collected CBCT scans. The midsagittal plane was selected for measuring of length, depth, diameter with a standardized coronal plane tangential to the anterior limit of sella turcica. The linear dimensions of sella turcica are illustrated respectively in (Figures 2a, 2b, 2c) [6,7,8].

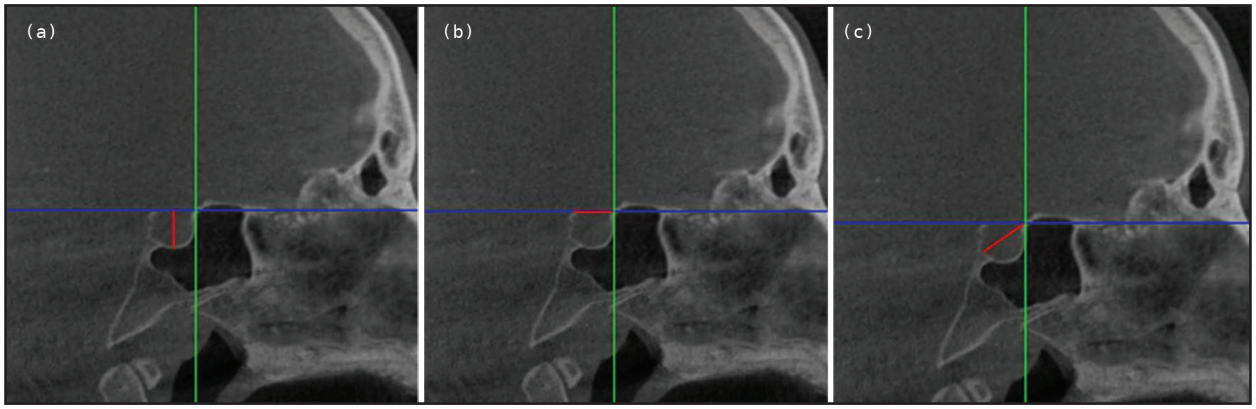

Fig. (2) Digitized lateral cephalogram extracted from lateral right view of a CBCT scan with digitized reference planes and angles.

Fig. (2a) Red line representing the length of sella turcica extending from the tip of dorsum sella to the tuberculum sella.

Fig. (2b) Red line representing the depth of sella turcica which is a perpendicular line extending from the length of sella turcica to deepest point of the sellar floor.

Fig. (2c) Red line representing the diameter of sella turcica extending from the tuberculum sella to the furthest point on the posteroinferior aspect of the pituitary fossa.

Step 5: Measuring the volume of sella turcica:

In order to measure the volume of sella turcica, segmentation of the sella turcica was acquired at the corrected sagittal, coronal and axial plans to obtain a 3D rendered image that allow obtaining an accurate evaluation of the volume of each sella turcica. Dolphin Imaging Software didn't have these advanced volumetric segmentation options. Thus; Mimics Medical Software* was used by the assistance of a qualified radiologist for accurate volumetric analysis of sella turcica. Each CBCT scan was assessed separately by inserting their DICOM files (Digital Imaging and Communications in Medicine) into the software program to assess accurately the volume of sella turcica. Volume was acquired using volumetric segmentation of sella turcica at corrected coronal, axial and sagittal plans as shown in (Figure 3).

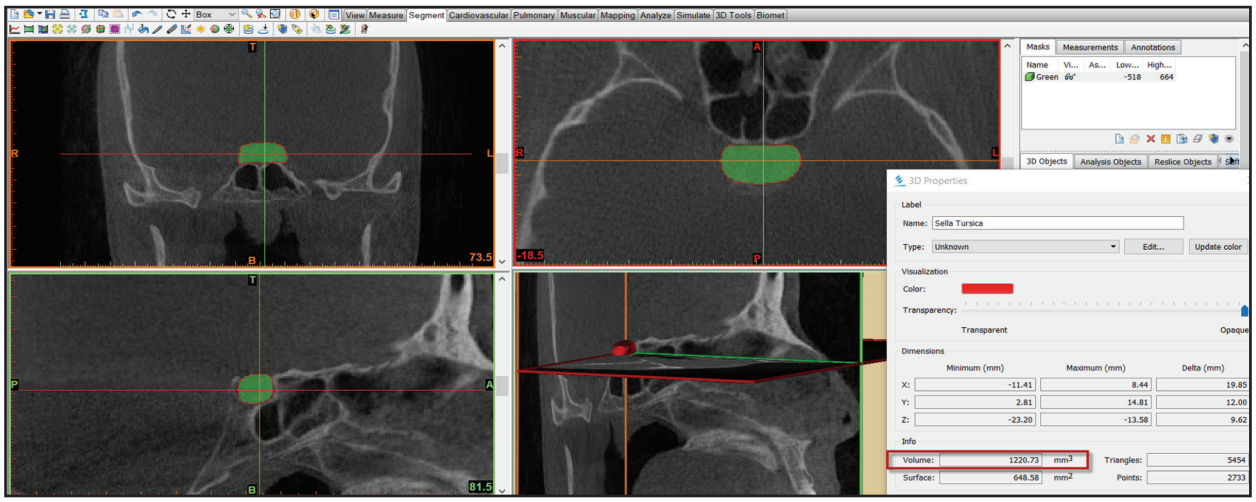

Fig. (3) MPR screen (Multi planar reformatted screen) showing corrected coronal, axial and sagittal cuts with segmented sella turcica. In this case; 3D calculation of sella turcica volume was 1220 mm3 *(*Version 19.0.0.347; Mimics Medical Materialise, Leuven, Belgium)*

Statistical Analysis:

IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) was used to analyze the data**.** Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution and the quantitative data were described using range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR). Significance of the obtained results was judged at the 5% level. Chi-square test was used for categorical variables, to compare between different groups. While F-test (ANOVA) was used to compare between more than two groups, for normally distributed quantitative variables.

RESULTS

Regarding Length (mm), Depth (mm), and Diameter (mm) of sella measurements, there was a statistically non-significant difference between the three groups (p=0.443, 0.669, and 0.772 respectively). The Length (mm), Depth (mm), and Diameter (mm) of sella measurements showed no difference in all groups. Regarding Volume of sella, there was a statistically non-significant difference between the three groups (p=0.836). A comparison between the three studied groups according to sella measurements and volume was represented in Table (1) and plotted in (Figure 4 and Figure 5) respectively.

Table (1) *Comparison between the three studied groups according to sella measurements and volume*

Sella Measurements	Group I (n = 18)	Group II (n = 18)	Group III (n = 18)	F	p
Length (mm)					
Min. – Max.	8.70 – 12.50	8.70 – 14.30	9.30 – 13.70		
Mean ± SD.	11.03 ± 1.0	11.35 ± 1.38	10.84 ± 1.18	0.826	0.443
Median	11.05	11.05	10.70		
Depth (mm)					
Min. – Max.	7.0 – 11.10	7.10 – 10.60	7.40 – 10.90		
Mean ± SD.	9.05 ± 1.10	8.77 ± 0.91	8.97 ± 0.90	0.406	0.669
Median	9.05	8.85	8.90		
Diameter (mm)					
Min. – Max.	11.40 – 14.80	11.20 – 15.50	10.60 – 15.90		
Mean ± SD.	12.98 ± 1.06	12.89 ± 1.26	12.68 ± 1.44	0.261	0.772
Median	13.0	12.75	12.35		
Volume					
Min. – Max.	845.9 1856.3 –	848.3 1922.3 –	830.3 2092.1 –		
Mean ± SD.	1306.6 ± 290.3	1300.9 ± 331.4	1249.7 ± 319.1	0.179	0.836
Median	1256.0	1249.5	1230.4		

F: F for ANOVA test p: p value for comparing between the studied groups
Group I: High Angle Group II: Average Angle Group III: Low Angle

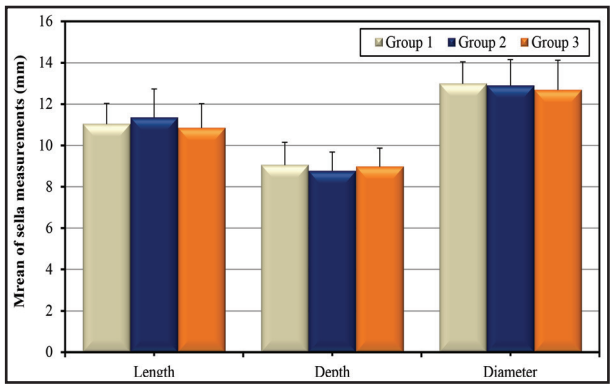

Fig. (4) Comparison between the three studied groups according to sella measurements

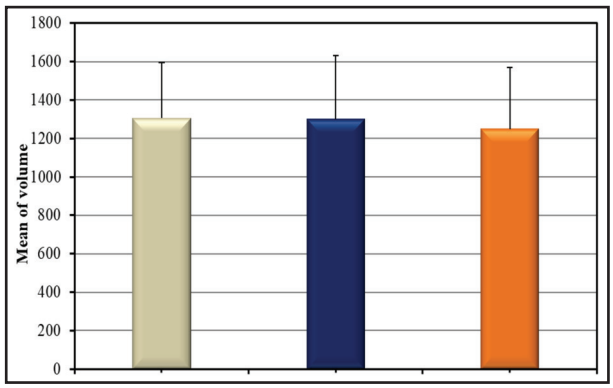

Fig. (5) Comparison between the three studied groups according to sella volume

DISCUSSION

The relationship between sella turcica and orthodontics has been the focus of investigation since the late 19th century. **Sathyanarayana et al.** [9] focused on the importance of sella turcica in orthodontics and confirmed that being familiar with the normal embryological and anatomical development of sella turcica is a must for every orthodontist. The current study coincides with this concept as any deviation from the normal radiological anatomy or morphological sellar shape may reflect a pathological disorder that affects the pituitary gland or a craniofacial syndrome. [10] These deviations may act as an early alarm for the pathological changes that should be detected and treated as early as possible before they progress and become clinically apparent.

Lateral cephalometric analysis was used by many authors as **Axelsson et al.** [6] and **Andredaki et al.** [11] for the assessment of the linear dimensions of sella turcica including length, depth and diameter. Many authors as **Taner et al.** [12] and **Yasa et al.** [3] recommended the cone beam computed tomography (CBCT) for morphometric analysis and three-dimensional examination of the sella turcica in their studies. CBCT has potential advantages over conventional CT including the high dimensional accuracy of the craniofacial region and better landmark identification with shorter scanning time, reduced radiation exposure dose, and lower hardware costs. [3,7,13] In addition; CBCT allowed for standardization of the collected CBCT scans and their reorientation according to the three reference planes which were the sagittal plane, coronal plane, and axial plane. Therefore; CBCT was used for measuring the linear dimensions of sella turcica in the current study.

In the current study; it was found that there was a statistically non-significant difference between the high angle, normal angle and low angle growth pattern subjects regarding the linear dimensions of sella turcica including the length, depth, and diameter. In addition; there was a statistically significant positive correlation between SN-MP angular value in group I (high angle individuals) and the sellar diameter. As the SN-MP angular value increases; the diameter of sella turcica increases.

Konwar et al. [14] stated opposite findings to the findings of the current study regarding sellar linear dimensions where they found that the sellar length was larger in the low angle subjects compared to the high angle ones. **Ahmad et al.** [15] found other different findings where they stated that

the sellar length and diameter were greater in the normodivergent group compared to hyperdivergent and hypodivergent ones, while the sellar depth was greater in the hyperdivergent group than the other two groups. These differences in findings may be due to the different methods of measurement and assessment as the previous studies depended on 2D lateral cephalometric radiographs for measuring and evaluating a 3D sellar structure.

The results of the current study concerning sellar diameter correlations coincide with the findings of **Yasa et al.** [4] who stated that the sellar diameter was larger in both the high and low angle individuals compared to the average angle individuals. Besides, they found that the sellar depth was larger in the high angle individuals compared to both the average angle and low angle ones. The probable reasons for these similarities in findings may be attributed to the ethnicity and the similar methods of assessment using cone beam computed tomography (CBCT).

Regarding the sellar volume; the results in the current study showed that there was a statistically non-significant difference between the high angle, normal angle and low angle growth pattern subjects. In addition; there was a statistically non-significant positive correlation with SN-MP in all groups. **Silveria et al.** [16] compared the sellar volume in relation to the anteroposterior growth pattern. They stated that there were no statistically significant differences found between class II and class III subjects in all the sellar measurement including volume, but the volume of sella had higher values in female subjects when both genders were compared.

Regarding the sellar morphology; the results in the current study showed that sella turcica was oval in the majority of the high angle subjects, round in the average angle subjects, and oval in the low angle subjects. There was a statistically non-significant difference between the three groups. These results coincide with what **Konwar et al.** [14] and **Yasa et al.** [4] stated in their studies that sellar morphology appeared normally round in the majority of subjects and very minor morphological variations were found between the high angle, average angle and the low angle compared groups.

CONCLUSIONS

Based on the results of the current study, the following conclusions were conducted:

1. The length, depth, diameter and volume of sella turcica showed no difference in all groups.
2. Regarding sellar morphology; sella turcica was oval in the majority of subjects in group I, round in group II, and oval in group III.
3. There was a statistically significant positive correlation between SN-MP angle with sellar diameter in group I (High angle individuals). As the SN-MP angle increases; the diameter (mm) of sella increases.
4. There was a statistically non-significant positive correlation between SN-MP angle with sellar volume in all groups.

REFERENCES

1. Tekiner H, Acer N & Kelestimur F. Sella turcica: an anatomical, endocrinological and historical perspective; 2014.
2. Becktor JP , Einersen S & Kjaer I . A sella turcica bridge in subjects with severe craniofacial deviations. Eur J Orthod 2000;22:69-74.
3. Yasa Y, Ocak A, Bayrakdar IS, Duman SB & Gumussoy I. Morphometric analysis of sella turcica using cone beam computed tomography. J Craniofac Surg 2017;28:70-74.
4. Yasa Y, Büyük SK, Benkli YA, Arslan A & Topbaş NM. The size and shape of the sella turcica in adolescent orthodontic patients with different vertical growth patterns. Clin Dent Res 2017;41:3-9.

5. Yasa Y, Bayrakdar IS, Ocak A, Duman SB & Dedeoglu N. Evaluation of sella turcica shape and dimensions in cleft subjects using Cone-Beam computed tomography. Med Princ Pract 2017;26:280-285.

6. Axelsson S, Storhaug K & Kjær I. Post-natal size and morphology of the sella turcica. Longitudinal cephalometric standards for Norwegians between 6 and 21 years of age. Eur J Orthod 2004;26:597-604.

7. Chauhan P, Kalra S, Mongia SM, Ali S & Anurag A. Morphometric analysis of sella turcica in North Indian population: a radiological study 2017;2:521-527.

8. Motwani MB, Rohit B, Apeksha D, Anuraag BC & Apurva M. A study to evaluate the shape and size of sella turcica and its correlation with the type of malocclusion on lateral cephalometric radiographs. IOSR-JDMS 2017;16: 126-132.

9. Sathyanarayana HP, Kailasam V & Hitharanjan AB. Sella turcica-Its importance in orthodontics and craniofacial morphology. Dent Res J 2013;10:571-575.

10. Korayem M & Alkofide E. Size and shape of the sella turcica in subjects with Down syndrome. Orthod Craniofac Res 2015;18:43-50.

11. Andredaki M, Koumantanou A, Dorotheou D, & Halazonetis DJ. A cephalometric morphometric study of the sella turcica. Eur J Orthod 2007;29: 449-456.

12. Taner L, Deniz UF, Demirel O, & Güngor K. Volumetric and three-dimensional examination of sella turcica by cone-beam computed tomography: reference data for guidance to pathologic pituitary morphology. Folia Morphol Warsz 2019;78:517-523.

13. Tassoker M & Ozcan S. Clinical and radiological significance of sella turcica: A literature review 2016.

14. KONWAR SK, SINGHLA A, & BAYAN R. Morphological (length, depth, and diameter) study of sella turcica in different mandibular growth patterns in indians. IDJMS 2016;3:4-9.

15. AHMAD N, SHAH W, & SHAHEED S. The frequency of sella turcica bridging in orthodontic patients and its association with sagittal and vertical malocclusion groups. PODJ 2018;37:257-261.

16. SILVEIRA BT, FERNANDES KS, TRIVINO T, DOS SANTOS LYF & DE FREITAS CF. Assessment of the relationship between size, shape and volume of the sella turcica in class II and III patients prior to orthognathic surgery. Surg Radiol Anat 2020;42:577-582.