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CBCT-Based Volumetric and Linear Analysis of Sella Turcica and Its Relationship with Jaw Base in Various Skeletal Malocclusions

ABSTRACT
Background: The sella turcica is an important cephalometric landmark due to its anatomical and embryological association with craniofacial structures. Variations in its morphology and dimensions may reflect differences in craniofacial growth patterns. Three-dimensional volumetric evidence across skeletal malocclusions remains limited. This study aimed to evaluate the relationship between sella dimensions and jaw base measurements.
Methods: This retrospective CBCT study was conducted on 84 individuals, equally distributed among skeletal Class I, II, and III groups. Using Planmeca Romexis software dimensions (length, depth, diameter, and volume) of the sella turcica and the jaw base measurements (maxillary length, mandibular body and ramal length) were evaluated.
Results: Pyramidal morphology was the most prevalent across all groups. Sella bridging was more common in Class III subjects. Reduced sella depth seen in Class II individuals. Ramal length demonstrated a significant positive correlation with sella length, diameter, and volume.
Conclusion: Sella turcica morphology varies among skeletal malocclusion patterns, and reduced depth may indicate a Class II pattern. The positive association between sella dimensions and ramal length suggests a potential relationship with vertical mandibular growth.

INTRODUCTION

In orthodontics, sella turcica (ST) serves as a stable and reliable cranial landmark in cephalometric analysis to assess growth and treatment changes. The term sella turcica is derived from the Turkish word for saddle, reflecting its distinctive saddle-shaped morphology. [1]

Located on the superior surface of the sphenoid bone, this saddle-shaped depression houses the pituitary gland, the central endocrine regulator of growth and development.[2] The anterior limit of the sella turcica is the tuberculum sellae, and its posterior limit is the dorsum sellae.[2]

Since the development of both the ST and the nasomaxillary complex is closely linked to neural crest cell migration, deviations in embryogenesis affecting the pituitary gland, cranial base, or midfacial structures may manifest as alterations in the ST morphology.[3] Alterations in the size, shape, and contour of ST have been linked to skeletal malocclusions, dental anomalies, craniofacial anomalies, and systemic or syndromic conditions.[4,5,6,7]

Mogra et al in his cephalometric study concluded that mandibular dimensions had a nearly constant proportional ratio to sella area. The study concluded that mandibular size shows a stronger and more consistent relationship to sella dimensions than maxillary size, suggesting sella turcica measurements in predicting mandibular growth.[8]

Valizadeh et al. analysed the shape and linear dimensions of ST and reported that Class III individuals exhibited increased sella length along with a higher prevalence of sella turcica bridging.[9]

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The anterior cranial base completes its development by approximately seven years of age, and the posterior cranial base undergoes its major development following the fusion of the spheno-occipital synchondrosis in mid- to late adolescence. [10,11] The sella turcica situated centrally within this early developed structure, serves as a reliable reference for analysing and predicting the growth patterns of the maxillary and mandibular jaw bases.

While previous studies relied predominantly on two-dimensional radiography, limitations such as magnification errors, superimposition, and distortion restrict the reliability of these measurements.[12] Cone-beam computed tomography (CBCT) overcomes these drawbacks by offering accurate three-dimensional visualization of craniofacial structures, enabling precise assessment of ST morphology and dimensions.

Despite many evidence linking sella turcica dimensions and the skeletal malocclusion, the literature remains limited regarding the three-dimensional volumetric assessment of the sella and its correlation with jaw base dimensions in different skeletal malocclusions. Understanding the relationship between sella turcica dimensions, volumetric analysis and jaw base dimensions may provide valuable insights into craniofacial growth patterns and early detection of skeletal discrepancies.

This study focuses on comparing and correlating the morphology, linear dimensions, and volume of the sella turcica with the jaw base sizes in individuals with Class I, II, and III skeletal malocclusions using CBCT. This study aims to determine whether the sella turcica, given its central role in craniofacial development, can serve as a reliable indicator of skeletal patterns and aid in early detection of developing malocclusions.

II. MATERIALS AND METHODS

This retrospective CBCT-based study was conducted in 84 subjects (24 subjects in each group of Class I, Class II and Class III) in the age group of 20-30 years. Subjects were grouped into Class I, II and III based on the Wits appraisal and β-angle. Skeletal Class I with β angle between 27°-35°; Class II group with β-angle < 27° and ClassIII β-angle > 35°.Subjects with a history of facial trauma, craniofacial anomalies, facial asymmetry and were excluded. All CBCT scans were obtained using a Planmeca 3D CBCT unit with participants seated in an upright position under standardized imaging conditions.

Using Planmeca Proman 3D Romexis 5.2.0.R software the measurements of sella length, depth, diameter, volume and jaw base dimensions were made. Linear measurements ST was made according to Silverman et al.[13] [Figure 1]. Volume of ST was done using the manual segmentation tool in the software [Figure 2].

Figure 1: Linear dimensions of sella tucica measured using Silverman method.
TS: tuberculum sella; DS: dorsum sella
Red line: length of sella connecting TS and DS; Yellow line: depth of sella which is measured by a perpendicular drawn through the above defined line towards the floor of Sella; Green line: Diameter of sella drawn from TS to the point which is furthest located on the posterior inner wall of sella.

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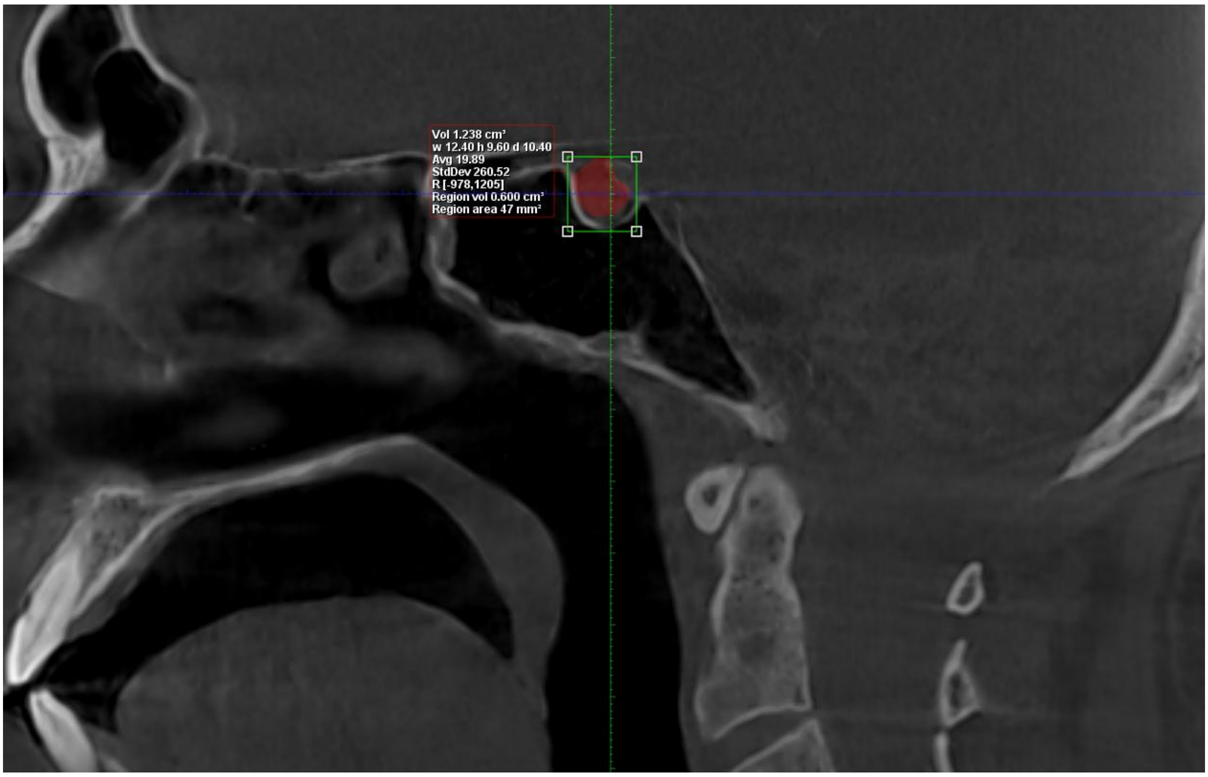

Figure 2: Volumetric analysis of sella turcica using manual segmentation tool

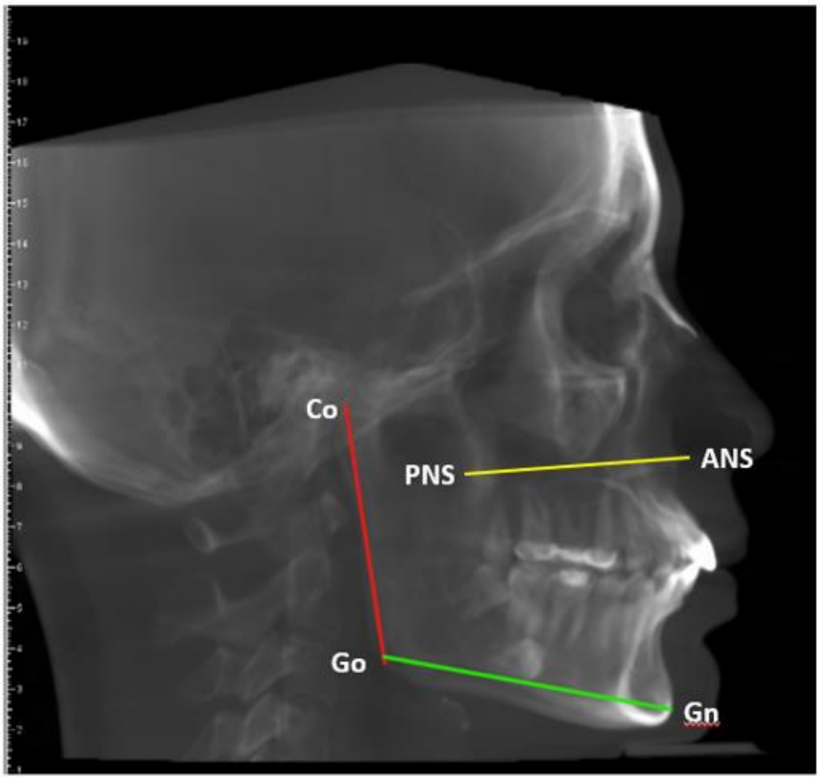

Fig 3. Jaw base dimensions

Yellow line: Measurement of maxillary length (ANS-PNS) Red line: Measurement of mandibular ramal length (Co-Go)
Green line: Measurement of mandibular body length (Go-Gn)
ANS: Anterior nasal spine; PNS: Posterior nasal spine; Co: Condylion; Go: Gonion; Gn: Gnathion

Jaw base dimensions included the maxillary length (ANS-PNS), mandibular body length (Go-Gn) and ramal length (Co-Go) [Figure 3]. The morphology of ST was analysed based on the classification by Axelsson et al [14] which is named as double contour of the floor of Sella, oblique anterior wall, pyramidal shape of dorsum Sella, irregularity in the posterior part of the dorsum Sella and the Sella bridging.

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RESULTS

1. Association between ST morphology and skeletal malocclusion groups

Normal sella morphology was seen in 42.9% of Class I subjects, 39.3% of Class II subjects, and 28.6% of Class III subjects. Pyramidal shape was the most common morphology across all groups, observed in 50.0% of Class I, 35.7% of Class II, and 46.4% of Class III subjects. Sella bridging demonstrated marked variation among the groups, being present in 7.1% of Class I subjects and 25.0% of Class III subjects. Double contour morphology was exclusively noted in Class II subjects, accounting for 25.0% of that group, while it was not observed in either Class I or III subjects.

The mean ST length was 10.269 ± 1.58 mm in Class I, 9.799 ± 1.69 mm in Class II, and 10.249 ± 1.42 mm in Class III subjects. ST length and diameter did not show a statistically significant difference among the groups. The mean sella diameter was 11.57 ± 1.72 mm in Class I, 10.94 ± 1.56 mm in Class II, and 11.455 ± 1.39 mm in Class III subjects. In contrast, sella turcica depth showed a statistically significant difference among the skeletal malocclusion groups. The mean sella depth was 7.70 ± 0.90 mm in Class I, 6.847 ± 1.09 mm in Class II, and 7.296 ± 0.92 mm in Class III subjects. Class I subjects had significantly greater depth compared to Class II subjects.

The mean ST volume was 1.757 ± 0.42 mm³ in Class I, 1.563± 0.36 mm³ in Class II, and 1.759 ± 0.51 mm³ in Class III subjects. The difference in volume among the three skeletal malocclusion groups was not statistically significant. (Figure 4)

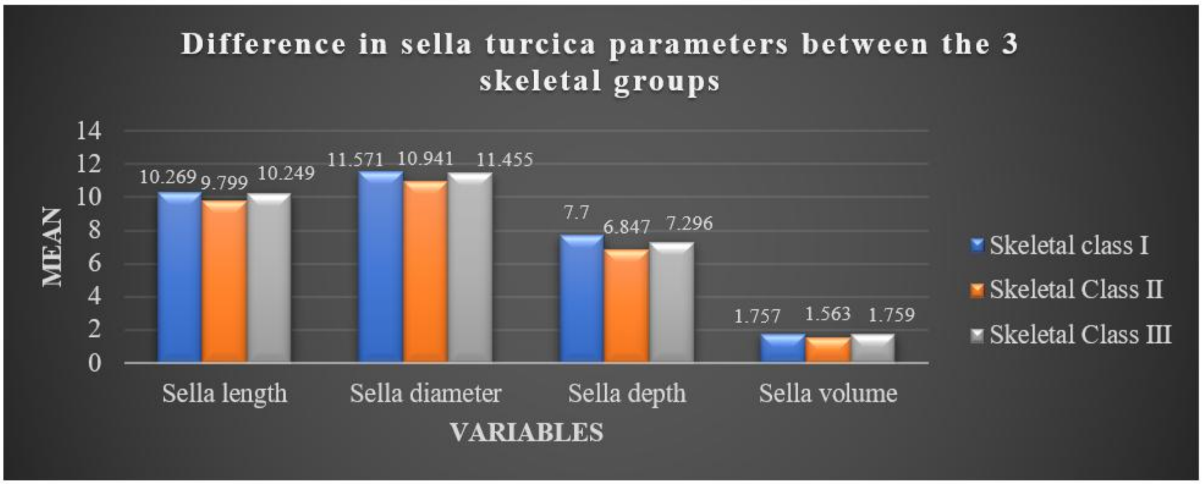

Figure 4: Difference in sella turcica parameters between the three skeletal groups

Measurement	r Depth	p	r Length	p	r Diameter	p	r Volume	p	N
Maxillary length	.032	.772	.121	.274	.198	.071	.176	.108	84
Mandibular body length	.096	.384	.053	.633	.096	.385	.139	.207	84
Mandibular ramal length	.214	.055	.228*	.037*	.247*	.024*	.262*	.016*	84

Table 1: Pearson Correlation Analysis

r: Pearson correlation coefficient

* p < 0.05 indicates statistically significant correlation.

Maxillary length and mandibular body length showed a weak positive correlation with sella depth, length, diameter and volume. These correlations were not statistically significant.

Mandibular ramal length showed statistically significant positive correlations with multiple ST dimensions. A weak positive correlation was observed between ramal length and sella length, and volume. The correlation between ramal length and sella depth was not significant. These findings indicate that greater mandibular ramal length is associated with increased sella length, diameter, and volume. [Table 1]

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DISCUSSION

The sella turcica holds significant importance in orthodontics as a stable cranial base landmark essential for cephalometric analysis. The sella turcica's anterior and posterior walls have a separate embryological origin: Neural crest cells give rise to the anterior wall, while the posterior wall develops from the paraxial mesoderm under the influence of the notochord.[15] Craniofacial malformations have been linked to ST abnormalities due to their shared neural crest cell origin.[15] Roomaney et al. highlighted that individuals with various craniofacial syndromes exhibit altered sella turcica morphology.[6] Additionally, variations in the shape and linear dimensions of ST across different ethnic populations have been studied.

Morphology of sella turcica

Pyramidal dorsum sella was the most common morphology across all skeletal patterns, with higher prevalence in Class I and III than Class II. Normal morphology occurred in all groups but was less frequent in Class III. Sella turcica bridging varied among patterns, showing higher occurrence in Class III and absence in Class II subjects.

Studies by Marsan G et al, Marcotty et al and Sathyanarayana et al also reported a higher prevalence of ST bridging seen in Class III subjects.[16,17,18] Whereas Öktem et al found higher prevalence of bridging in Class II individuals.[19]An interesting finding of this study was the exclusive presence of double contour morphology in Class II subjects. A study by Gökçe G et al found that 14% in Class II div 1 and 20 % in Class II div 2 subjects had double contour morphology.[20] Whereas the study by Kucia et al. reported double contoured ST in 66.6% of class I subjects and 11.1% in class II subjects.[21]

Linear and volumetric analysis of sella turcica

In this study, linear dimensions of ST such as length and diameter, did not exhibit statistically significant differences among Class I, Class II, and Class III skeletal groups. In contrast, sella turcica depth demonstrated a statistically significant variation among the skeletal malocclusion groups, with Class II subjects exhibiting decreased sella depth than Class I subjects. A study by Grover et al also found that Class II subjects had minimum depth.[22] Studies by Mortezai et al and Nadim et al showed that there was no statistically significant difference in length, depth, and diameter of ST in Class I, II, and III skeletal pattern.[23,24] In contrast to this study, Valizadeh et al. found increased length in III individuals compared I and II individuals.[9] A study by AlKofide found larger diameter in Class III individuals and smaller dimensions in Class II individuals.[25]

ST volume did not show a statistically significant difference among the three skeletal patterns. The CBCT studies by Tunca et al and Silveira et al also showed no significant difference in the volume of ST in different malocclusions.[26,27]

Correlation Between Sella Dimensions and Jaw Base Measurements

Maxillary length or mandibular body length did not show any correlation with the sella turcica dimensions. These findings indicate that maxillary growth and mandibular body length may be relatively independent of sella size.

However, ramal height demonstrated a statistically significant positive correlation with sella length, diameter, and volume. This suggests that increased vertical growth of the mandibular ramus is associated with larger sella dimensions. Whereas the study by Mogra et al found that mandibular body and ramus had a significant correlation to the sella dimensions.[8]

The results of the present study indicate that sella turcica dimensions exhibit a stronger association with ramal length than with other jaw measurements, which may be explained by the influence of growth hormone secreted by the pituitary gland housed within the sella turcica.

Growth hormone (GH), secreted by the anterior pituitary gland directly stimulates chondrocyte proliferation at cartilaginous growth sites and indirectly mediates skeletal growth via insulin-like growth factor-1 (IGF-1), which enhances osteoblast proliferation, differentiation, and bone remodelling.[28]

GH deficiency (GHD) in children results in characteristic alterations in craniofacial morphology. Children with GHD consistently exhibited reduced cranial base length, diminished ramus height, shortened mandibular body, decreased posterior facial height, and a retrognathic maxilla and mandible. These skeletal discrepancies often lead to increased facial convexity and clockwise rotation of the mandible.[29,30,31]

Several studies have reported that growth hormone replacement therapy leads to significant improvement in posterior facial height, cranial base length, and mandibular growth. The facial convexity of these patients reduced. The ramus and condylar region was more responsive to GH therapy than the maxilla.[30,31,32]

In contrast, Oliveira-Neto et al. reported that maxillary length was the most affected parameter in GHD subjects, followed by posterior cranial base length, posterior facial height, anterior facial height, and mandibular body length.[33]

The ramus exhibits a stronger response to GH compared to the mandibular body because ramal growth occurs via endochondral ossification of the condylar cartilage, a secondary cartilage known to be highly sensitive to GH and IGF-1. In contrast, the mandibular body grows mainly through intramembranous ossification and remodelling, rendering it less responsive to systemic GH levels.[32,34,35]

Similarly, the maxilla, which develops primarily through intramembranous ossification and sutural growth, demonstrates limited responsiveness to GH deficiency and replacement therapy.[34,36] Additionally, the maxilla and anterior cranial base mature earlier in development, whereas the mandible continues to grow actively into adolescence, further explaining the greater GH-mediated changes observed in mandibular dimensions.[32]

The findings of this CBCT-based study highlight the clinical importance of evaluating sella turcica (ST) morphology and linear dimensions in the diagnosis of sagittal skeletal malocclusion. A significant association

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was observed between ST morphology and skeletal malocclusion, with a higher prevalence of bridging in Class III subjects and reduced sella depth in Class II individuals. Although ST dimensions did not correlate with maxillary or mandibular body length, their relationship with ramal height suggests a link with vertical mandibular growth. Therefore, ST linear parameters may aid in early identification of skeletal growth patterns and improve diagnostic accuracy and treatment planning.

CONCLUSION

- Pyramidal morphology was the most prevalent form across all skeletal classes, while sella turcica bridging was observed predominantly in skeletal Class III individuals. Double contour morphology was exclusively identified in skeletal Class II subjects.
- Among the linear parameters, ST length and diameter did not differ significantly between skeletal classes. However, ST depth was significantly reduced in skeletal Class II subjects compared to Class I.
- ST dimensions (sella length, diameter and volume) showed a significant correlation with the mandibular ramus length. Maxillary length and mandibular body length did not have any correlation to the sella dimensions.

REFERENCES

1. Andredaki M, Koumantanou A, Dorotheou D, Halazonetis DJ. A cephalometric morphometric study of the sella turcica. The European Journal of Orthodontics. 2007 Oct 1;29(5):449-56.
2. Tekiner H, Acer N, Kelestimur F. Sella turcica: an anatomical, endocrinological, and historical perspective. Pituitary. 2015 Aug;18(4):575-8.
3. Cordero DR, Brugmann S, Chu Y, Bajpai R, Jame M, Helms JA. Cranial neural crest cells on the move: their roles in craniofacial development. American journal of medical genetics Part A. 2011 Feb;155(2):270-9.
4. Alkofide EA. Sella turcica morphology and dimensions in cleft subjects. The Cleft palate-craniofacial journal. 2008 Nov;45(6):647-53.
5. Sinha S, Shetty A, Nayak K. The morphology of Sella Turcica in individuals with different skeletal malocclusions–A cephalometric study. Translational Research in Anatomy. 2020 Mar 1;18:100054.
6. Roomaney IA, Chetty M. Sella turcica morphology in patients with genetic syndromes: A systematic review. Orthodontics & Craniofacial Research. 2021 May;24(2):194-205.
7. Ugurlu M, Bayrakdar IS, Kahraman F, Oksayan R, Dagsuyu IM. Evaluation of the relationship between impacted canines and three-dimensional sella morphology. Surgical and Radiologic Anatomy. 2020 Jan;42(1):23-9.
8. Mogra S, Shetty VS, Shetty S. Sella size and jaw bases-Is there a correlation???. Contemporary Clinical Dentistry. 2016 Jan 1;7(1):61-6.
9. Valizadeh S, Shahbeig S, Mohseni S, Azimi F, Bakhshandeh H. Correlation of shape and size of sella turcica with the type of facial skeletal class in an Iranian group. Iranian Journal of Radiology. 2015 Jul 22;12(3):e16059.
10. Afrand M, Ling CP, Khosrotehrani S, Flores-Mir C, Lagravère-Vich MO. Anterior cranial-base time-related changes: a systematic review. American Journal of Orthodontics and Dentofacial Orthopedics. 2014 Jul 1;146(1):21-32.
11. Vu GH, Xu W, Go BC, Humphries LS, Kalmar CL, Taylor JA, Bartlett SP, Vossough A, Nah-Cederquist HD, Swanson JW. Physiologic timeline of cranial-base suture and synchondrosis closure. Plastic and Reconstructive Surgery. 2021 Dec 1;148(6):973e-82e.
12. Nanjannawar LG, Agrawal JM, Agrawal MS, Parushetti AD. CBCT in orthodontics: the wave of future. The journal of contemporary dental practice. 2013 Jun 1;14(1):153
13. Silverman FN. Roentgen standards for size of the pituitary fossa from infancy through adolescence. Am J Roentgenol. 1957; 78 (3): 451-460
14. 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. The European Journal of Orthodontics. 2004 Dec 1;26(6):597-604.
15. Becktor JP, Einersen S, Kjær I. A sella turcica bridge in subjects with severe craniofacial deviations. The European Journal of Orthodontics. 2000 Feb 1;22(1):69-74.
16. Marşan G, Öztaş E. Incidence of bridging and dimensions of sella turcica in Class I and III Turkish adult female patients. World journal of orthodontics. 2009 Jun 1;10(2).
17. Meyer-Marcotty P, Reuther T, Stellzig-Eisenhauer A. Bridging of the sella turcica in skeletal Class III subjects. The European Journal of Orthodontics. 2010 Apr 1;32(2):148-53.
18. Sathyanarayana HP, Kailasam V, Chitharanjan AB. Sella turcica-Its importance in orthodontics and craniofacial morphology. Dental research journal. 2013 Sep;10(5):571.
19. Öktem H, Tuncer Nİ, Sencelikel T, Bagci Zİ, Cesaretli S, Arslan A, Gürsel İT, Degirmenci B. Sella turcica variations in lateral cephalometric radiographs and their association with malocclusions. Anatomy. 2018 Apr;12(1):13-9
20. Gökçe G, Yavan MA. Morphometric Assessment of the Sella Turcica in different morphologic types of class II malocclusion: a retrospective study. Acıbadem Univ Sağlık Bilim Derg. 2022 Jan 1;13(1):112-8.
21. Kucia A, Jankowski T, Siewniak M, Janiszewska-Olszowska J, Grocholewicz K, Szych Z, Wilk G. Sella turcica anomalies on lateral cephalometric radiographs of Polish children. Dentomaxillofacial Radiology. 2014 Dec 1;43(8):20140165.
22. Grover N, Khan DU, Bhagchandani J, Saha S, Dhinsa K, Navit S. A Cephalometric Study of Sella Turcica: Correlation of Its Size with Different

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Skeletal Malocclusions. International Journal of Clinical Pediatric Dentistry. 2023 Nov;16(Suppl 3):229.

23. Mortezai O, Rahimi H, Tofangchiha M, Radfar S, Ranjbaran M, Pagnoni F, Reda R, Testarelli L. Relationship of the morphology and size of Sella Turcica with Dental anomalies and Skeletal Malocclusions. Diagnostics. 2023 Sep 29;13(19):3088.
24. Nadim MA. Correlation of linear dimensions of sella turcica with anteroposterior skeletal jaw relationship of Egyptian subjects using CBCT. Egyptian Dental Journal. 2019 Jan 1;65(1-January (Orthodontics, Pediatric & Preventive Dentistry)):63-8.
25. Alkofide EA. The shape and size of the sella turcica in skeletal Class I, Class II, and Class III Saudi subjects. The European Journal of Orthodontics. 2007 Oct 1;29(5):457-63.
26. Tunca M, Kaya S. Evaluation of Sella Turcica Bridging, Ponticulus Posticus Calcification and Sella Turcica Volume in Individuals with Different Malocclusions. Necmettin Erbakan Üniversitesi Diş Hekimliği Dergisi. 2024;6(2):142-50.
27. Silveira BT, Fernandes KS, Trivino T, Dos Santos LY, 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. Surgical and Radiologic Anatomy. 2020 May;42(5):577-82.
28. Wójcik D, Beń-Skowronek I. Craniofacial morphology in children with growth hormone deficiency and Turner syndrome. Diagnostics. 2020 Feb 7;10(2):88.
29. Giustina A, Veldhuis JD. Pathophysiology of the neuroregulation of growth hormone secretion in experimental animals and the human. Endocrine reviews. 1998 Dec 1;19(6):717-97.
30. Pirinen S, Majurin A, Lenko HL, Koski K. Craniofacial features in patients with deficient and excessive growth hormone. Journal of Craniofacial Genetics and Developmental Biology. 1994 Jul 1;14(3):144-52.
31. Cantu G, Buschang PH, Gonzalez JL. Differential growth and maturation in idiopathic growth-hormone-deficient children. European Journal of Orthodontics. 1997 Apr 1;19(2):131-9.
32. Choi SH, Fan D, Hwang MS, Lee HK, Hwang CJ. Effect of growth hormone treatment on craniofacial growth in children: Idiopathic short stature versus growth hormone deficiency. Journal of the Formosan Medical Association. 2017 Apr 1;116(4):313-21.
33. Funatsu M, Sato K, Mitani H. Effects of growth hormone on craniofacial growth. The Angle Orthodontist. 2006 Nov 1;76(6):970-7.
34. Oliveira-Neto LA, Melo MF, Franco AA, Oliveira AH, Souza AH, Valença EH, Britto IM, Salvatori R, Aguiar-Oliveira MH. Cephalometric features in isolated growth hormone deficiency. The Angle Orthodontist. 2011 Jul 1;81(4):578-83.
35. Kjellberg H, Beiring M, Wikland KA. Craniofacial morphology, dental occlusion, tooth eruption, and dental maturity in boys of short stature with or without growth hormone deficiency. European Journal of Oral Sciences. 2000 Oct;108(5):359-67.
36. Kjellberg H, Wikland KA. A longitudinal study of craniofacial growth in idiopathic short stature and growth hormone-deficient boys treated with growth hormone. The European Journal of Orthodontics. 2007 Jun 1;29(3):243-50.

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