


# A Cephalometric Analysis on Magnitude and Shape of Sella Turcica

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Sella turcica, craniofacial morphology, computed tomography, cephalometry, pituitary fossa, population-based study, age-related changes, U-shaped morphology

## Disclaimers

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## ABSTRACT

**Background:** The sella turcica is a critical craniofacial landmark housing the pituitary gland. Variations in its size and morphology are significant in diagnosing syndromic conditions, pituitary pathologies, and craniofacial anomalies. Establishing normative data is essential for population-specific assessments.

**Objective:** This study aimed to evaluate the size and shape of the sella turcica in the Balochistan population, analyzing its correlation with age and gender.

**Methods:** This cross-sectional study included 142 participants (98 males, 44 females) aged 1–70 years. High-resolution computed tomography (CT) images were analyzed using Mimics software for precise measurement of linear and area dimensions, including anterior, posterior, and median heights, as well as length, diameter, and width. Morphological analysis categorized sella turcica shapes into U-shaped, J-shaped, and shallow. Statistical analysis was conducted using SPSS version 25. Gender differences were assessed using t-tests, and correlations with age were evaluated using Pearson's coefficient.

**Results:** No significant gender differences were observed in sella turcica dimensions ( $p > 0.05$ ). U-shaped morphology was most common (50.7%), followed by J-shaped (32.4%) and shallow (16.9%). Significant positive correlations were identified between age and dimensions, including length ( $r = 0.75$ ,  $p < 0.001$ ) and diameter ( $r = 0.73$ ,  $p < 0.001$ ).

**Conclusion:** The study established normative data for sella turcica dimensions and morphology, emphasizing its utility in orthodontic and craniofacial assessments. Age significantly influenced sella dimensions, while gender differences were negligible.

## INTRODUCTION

The sella turcica, a saddle-shaped depression within the sphenoid bone, serves as a critical anatomical structure housing the pituitary gland. Positioned within the middle cranial fossa, the sella turcica is bordered anteriorly by the tuberculum sellae and posteriorly by the dorsum sellae, with its intracranial surface extending over the pituitary fossa. This complex structure is further supported by the anterior and posterior clinoid processes, which provide structural integrity and form essential reference points for craniofacial analysis. Variations in the morphology of the sella turcica have been extensively studied, as they serve as critical indicators for syndromic conditions affecting the craniofacial region and pituitary pathologies (1, 2). These variations, encompassing differences in size, shape, and orientation, have made the sella turcica an invaluable landmark in cephalometric analyses.

Lateral cephalograms, initially introduced by Hofrath and Broadbent in 1931, have long been used for evaluating craniofacial morphology and treatment planning in orthodontics (9, 10). The sella turcica, being a prominent landmark in these radiographs, provides crucial information for diagnostic purposes and aids in understanding individual growth patterns and the effects of orthodontic

interventions. While traditional two-dimensional (2D) imaging has proven beneficial, its limitations, including geometric distortion and overlapping anatomical structures, have paved the way for more advanced imaging modalities. Cone-beam computed tomography (CBCT) has emerged as a preferred method for maxillofacial diagnosis, offering three-dimensional (3D) imaging with lower radiation exposure compared to conventional multi-slice CT scans. This technology enables precise identification of cephalometric landmarks, thus overcoming the limitations associated with 2D cephalometry and enhancing the accuracy of craniofacial measurements (11-15).

Understanding the normal anatomy and variations of the sella turcica is essential for identifying deviations associated with pathological conditions. Previous studies have reported that the dimensions of a normal sella turcica range between 11 to 16 mm in length and 8 to 12 mm in width, as measured on standard radiographs (7). Additionally, research conducted on cadaveric specimens has revealed the presence of anatomical anomalies such as sella turcica bridging in a subset of individuals, further emphasizing the variability of this structure (8). The morphology of the sella turcica has been categorized into distinct shapes, including U-shaped, J-shaped, and flattened configurations, which are influenced by factors

such as age, gender, and racial background (18, 19). Morphometric evaluations of the sella turcica also provide insights into growth patterns, with studies suggesting that its dimensions exhibit a positive correlation with advancing age, reflecting physiological changes over time (24).

The clinical significance of sella turcica morphology extends beyond orthodontics, as it plays a pivotal role in the assessment of pituitary gland pathologies and syndromic conditions affecting the craniofacial complex. Abnormalities in the size and shape of the sella turcica may serve as early indicators of pituitary tumors, hormone-secreting disorders, and other intracranial pathologies, thus aiding in early diagnosis and intervention. Moreover, establishing normative data for the sella turcica within specific populations is critical for accurate diagnostic and treatment protocols. Such data not only facilitate the identification of pathological deviations but also provide valuable reference standards for diverse demographic groups.

This study focuses on the cephalometric analysis of the sella turcica within the population of Balochistan, aiming to characterize its morphology and dimensions in relation to age and gender. The findings of this research will contribute to the existing body of knowledge by providing population-specific reference data, which can be instrumental in orthodontic diagnosis, craniofacial assessments, and the early detection of pathological conditions associated with the pituitary fossa (6, 22).

## MATERIAL AND METHODS

This cross-sectional study was conducted on 142 participants, including 98 males and 44 females, aged between 1 and 70 years, at Bolan Medical College and Hospital, Quetta, from October 22, 2021, to April 22, 2022. Ethical approval was obtained from the Ethical Committee of Bolan Medical College, ensuring compliance with the ethical principles outlined in the Declaration of Helsinki. All participants provided written informed consent prior to inclusion in the study. The study sample was selected based on computed tomography (CT) images that clearly depicted the sella turcica and fulfilled the inclusion and exclusion criteria. Participants with craniofacial anomalies, congenital syndromes, facial asymmetries, trauma-related injuries, or a history of hormonal or corticosteroid therapy were excluded from the study. Only individuals with no observable pathologies in the maxillofacial region and a well-preserved sella turcica structure were included.

The CT images were acquired using a General Electric (GE) Light Speed Plus CT Scanner System, employing high-resolution helical scans with a slice thickness of 1.25 mm and spacing of 1.25 mm. The scans were stored in the Radiology Department database at Bolan Medical College Hospital. Image segmentation was performed using Mimics

software, enabling precise identification of seven landmarks and the measurement of seven sella turcica parameters. Linear and area measurements were obtained for the anterior, posterior, and median heights, as well as the length, diameter, and width of the sella turcica, with all measurements aligned to the Frankfort Horizontal (FH) plane for consistency. Each measurement was performed by a single operator to minimize inter-examiner variability and was repeated three times to reduce intra-examiner variability. To eliminate bias, the operator was blinded to the previous results during the subsequent measurements. The average value of the three readings for each parameter was utilized in the final analysis.

The study population was divided into two age groups for analysis: pre-pubertal (under 15 years) and post-pubertal (15 years and older). This stratification was based on the understanding that sella turcica morphology typically stabilizes after the age of 12, with females generally completing pubertal development by 15 years of age. Data collection focused on identifying variations in the size and morphology of the sella turcica, including its classification into three distinct shapes: U-shaped, J-shaped, and shallow.

Descriptive statistics, including mean and standard deviation, were calculated for all parameters. Normality of the data was assessed using skewness and kurtosis. Independent samples t-tests were employed to compare the linear and area dimensions of the sella turcica between male and female participants, while Pearson's correlation coefficient was used to evaluate the relationship between age and sella turcica dimensions. Statistical significance was set at  $p < 0.05$ . Data analysis was performed using SPSS software version 25 (IBM), ensuring a robust and standardized approach to statistical evaluation.

This methodological framework ensured that the study adhered to the highest standards of medical research, providing reliable and reproducible results that contribute valuable insights into the morphometric characteristics of the sella turcica within the population of Balochistan.

## RESULTS

The study analyzed 142 participants, comprising 98 males and 44 females, with ages ranging from 1 to 70 years. No significant gender differences were observed in the linear or area dimensions of the sella turcica. Detailed descriptive and inferential statistics for each parameter are presented in Table 1. Across all measurements, the mean dimensions of the sella turcica were comparable between males and females, with p-values indicating non-significant differences. Furthermore, Pearson's correlation analysis revealed a positive relationship between age and sella turcica dimensions, as shown in Table 2.

**Table 1: Comparisons of Sella Turcica Dimensions Between Male and Female Participants**

Variable	Mean (SD) Male (mm)	Mean (SD) Female (mm)	p-value
Tuberculum Sella Height	8.46 (1.61)	8.42 (2.32)	0.93
Sella Anterior Height	8.21 (1.60)	8.21 (1.73)	0.98

Variable	Mean (SD) Male (mm)	Mean (SD) Female (mm)	p-value
Dorsum Sellae Height	10.79 (2.28)	10.47 (2.01)	0.58
Sella Floor Depth	7.41 (1.80)	6.81 (1.05)	0.15
Posterior Clinoid Length	7.40 (1.43)	7.03 (1.49)	0.32
Sella Medium Width	7.44 (1.34)	7.07 (1.22)	0.27
Tuberculum-Anterior-Floor Composite Width	65.29 (21.81)	60.33 (21.44)	0.37

The sella turcica morphology demonstrated three distinct shapes: U-shaped, J-shaped, and shallow. The U-shaped morphology was the most prevalent, observed in 50.7% of

participants, followed by J-shaped in 32.4%, and shallow in 16.9%. These findings are summarized in Table 2.

**Table 2: Distribution of Sella Turcica Shapes**

Shape Type	Frequency	Percentage (%)
U-shaped	72	50.7
J-shaped	46	32.4
Shallow	24	16.9

The correlation between sella turcica dimensions and age is detailed in Table 3. Significant positive correlations were identified between age and multiple parameters, including the tuberculum sella to dorsum sellae length ( $r = 0.75$ ,  $p <$

$0.001$ ) and sella anterior to sella posterior length ( $r = 0.73$ ,  $p < 0.001$ ). These results highlight that sella turcica dimensions tend to increase with age.

**Table 3: Correlation Between Age and Sella Turcica Dimensions**

Variable	Correlation Coefficient (r)	p-value
Tuberculum Sella - Posterior Clinoid	0.58	0.02
Sella Anterior - Sella Posterior	0.73	<0.001
Tuberculum Sella - Dorsum Sellae	0.75	<0.001
Tuberculum Sella - Sella Floor	0.50	0.06
Posterior Clinoid - Sella Floor	0.69	0.03
Sella Medium - Sella Floor	0.57	<0.001
Tuberculum Sella - Sella Anterior-Floor	0.55	<0.001

The findings indicate that the linear and area dimensions of the sella turcica increase progressively with age, with no significant differences observed between male and female participants. The distribution of morphological shapes suggests a predominance of U-shaped sellae, which may serve as a reference for craniofacial assessments within the studied population. The robust statistical evaluation underscores the significance of age as a factor influencing sella turcica dimensions, while gender appears to play a minimal role in these variations.

## DISCUSSION

The findings of this study provide valuable insights into the morphometry and shape of the sella turcica in a population from Balochistan, highlighting its utility as a diagnostic and reference point in craniofacial and pituitary assessments. The study demonstrated that the sella turcica exhibits no significant gender-based differences in linear or area dimensions. These results align with previous studies, which have similarly reported that sella turcica dimensions are generally comparable between males and females, with variations predominantly influenced by age (18, 24). While some earlier research has noted slight gender-based differences, particularly in younger age groups due to earlier pubertal growth in females, this was not evident in the

present study, likely due to the broader age range of participants (23).

The morphological analysis revealed that the U-shaped sella turcica was the most prevalent, followed by the J-shaped and shallow variants. These findings corroborate previous research, which also identified the U-shape as the dominant morphological form in diverse populations (19, 22). Such consistency in morphological patterns across studies reinforces the reliability of using sella turcica shape as a reference in orthodontic and craniofacial evaluations. The identification of distinct sella turcica shapes is particularly relevant in detecting developmental anomalies and pathological changes, as deviations from these standard patterns may indicate underlying conditions affecting the craniofacial or pituitary regions (6).

The positive correlation observed between age and sella turcica dimensions supports the notion that the sella turcica undergoes continuous growth throughout life. This aligns with findings from prior studies, which have noted that sella turcica dimensions increase with age, reflecting normal physiological development (24). These observations are significant, as they establish normative growth patterns that can aid in the differentiation of pathological enlargement from normal age-related changes. However, it was also noted that the growth rate stabilizes in adulthood, particularly after pubertal development, which further

emphasizes the importance of age-specific reference standards in clinical assessments (7).

The study's strengths lie in its use of high-resolution CT imaging, which allowed for precise and reproducible measurements of the sella turcica. The implementation of 3D segmentation software reduced the risk of measurement errors, and the blinding of the observer ensured objectivity in data collection. The inclusion of a diverse age range and the use of advanced statistical methods further enhanced the robustness of the analysis. However, the study was not without limitations. The sample size, while adequate for initial analysis, was relatively small and limited to a specific geographical population, which may affect the generalizability of the findings. Additionally, the cross-sectional design of the study precluded the ability to assess longitudinal changes in sella turcica dimensions. Future studies with larger, more diverse populations and longitudinal follow-ups would provide a more comprehensive understanding of the factors influencing sella turcica morphology.

Another notable limitation was the exclusion of individuals with hormonal disorders or craniofacial anomalies, which, while necessary to establish normative data, limited the scope of the findings in identifying variations associated with these conditions. Furthermore, while the study employed a rigorous methodology, it relied on a single operator for all measurements, which, despite efforts to minimize bias, may still introduce an element of subjectivity. Future research incorporating multiple observers and inter-examiner reliability assessments would further strengthen the validity of the results.

The findings of this study have important clinical implications. The establishment of normative data for the sella turcica dimensions and morphology in the Balochistan population provides a reference for identifying abnormalities associated with syndromic conditions, pituitary pathologies, and craniofacial anomalies. It also underscores the need for population-specific reference standards, as variations in sella turcica morphology have been shown to differ across ethnic and geographical groups (16, 21). Clinicians should consider these variations when evaluating patients to ensure accurate diagnosis and treatment planning.

In conclusion, the study contributed valuable data to the understanding of sella turcica morphology and dimensions, providing a foundation for future research and clinical applications. While the findings are consistent with previous studies, the limitations identified highlight the need for further research to address these gaps and expand upon the current knowledge base. Collaborative efforts incorporating advanced imaging technologies, larger sample sizes, and diverse populations will be instrumental in enhancing the utility of sella turcica analysis in clinical practice.

## CONCLUSION

This study established normative data for the dimensions and morphology of the sella turcica in the Balochistan population, revealing no significant gender-based differences but a positive correlation with age. The

predominant U-shaped morphology, along with other identified shapes, provides a reference for evaluating craniofacial development and detecting pathological changes in the pituitary region. These findings have significant implications for human healthcare, offering a reliable baseline for diagnosing syndromic conditions, pituitary disorders, and craniofacial anomalies. The results underscore the importance of population-specific standards in clinical and orthodontic practice, enhancing diagnostic accuracy and treatment planning.

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