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MORPHOMETRIC ANALYSIS OF THE SELLA TURCICA ON LATERAL CEPHALOGRAMS AND ITS CLINICAL RELEVANCE: A CROSS-SECTIONAL IMAGING STUDY

Dr. CR. Harsha[1]*, Dr. Nalamaru Priyanka[2]

[1]Anatomy, Assistant Professor, Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry Bharath Institute of Higher Education and Research, Chennai (saintharsha@gmail.com)
[2]Department of General Medicine, Assistant Professor, Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry Bharath Institute of Higher Education and Research, Chennai (priyankareddy76@gmail.com)

*Corresponding author email id: saintharsha@gmail.com

Abstract

Background: The sella turcica is a stable midline landmark of the sphenoid bone that is routinely captured on lateral cephalograms. Its dimensions and morphology are of interest to anatomists, orthodontists and oral radiologists because deviations may accompany craniofacial, neural-crest and endocrine conditions, and interclinoid (sella turcica) bridging may complicate transsphenoidal and orthodontic assessment. We quantified linear and areal dimensions of the sella turcica and the prevalence of morphological variants, and explored their relationship with sex, age group and skeletal malocclusion class.

Methods: In this cross-sectional study, 260 lateral cephalograms were assessed. Sella length, depth and anteroposterior diameter were measured and area was estimated; morphology, size category and interclinoid-ligament calcification/bridging were classified. Continuous variables are summarised as mean ± SD and compared with independent-samples t tests and one-way ANOVA; categorical variables as counts and percentages compared with the χ^2 test. Pearson correlation related the ANB angle to sella area. Reporting follows STROBE.

Results: Mean sella area was 72.7 ± 17.5 mm² (length 10.2 ± 1.7 mm; depth 8.6 ± 1.5 mm; anteroposterior diameter 11.6 ± 1.8 mm). A normal size category was recorded in 207 (79.6%), an enlarged sella in 45 (17.3%) and a small sella in 8 (3.1%). A normal contour was present in 153 (58.8%); the commonest variants were an oblique anterior wall (12.3%) and an irregular dorsum sellae (7.7%). Any interclinoid bridging (partial or complete) occurred in 25 (9.6%). Sella area did not differ by sex ($p = 0.41$) but differed across skeletal classes (ANOVA $p = 0.035$; Class II largest at 76.5 mm²), and correlated weakly with the ANB angle ($r = 0.14$, $p = 0.02$). Bridging was not associated with malocclusion class ($p = 0.56$).

Conclusions: In this sella turcica dimensions clustered within reported normative ranges, morphological variants were common, and bridging affected roughly one in ten cephalograms.

Keywords: Serectify nad proceedlla turcica; lateral cephalogram; morphometry; interclinoid bridging; skeletal malocclusion; sphenoid bone.

1. Introduction

The sella turcica is a saddle-shaped depression of the body of the sphenoid bone that houses the pituitary gland. Because it lies close to the midline and is well visualised on the lateral cephalogram, it serves both as a cephalometric reference (the point Sella defines the roof of the fossa) and as a window onto the developing sphenoid, which shares an embryological origin — partly from neural-crest-derived mesenchyme — with structures of the anterior cranial base and midface. This shared origin is the anatomical basis for the long-standing clinical interest in whether an abnormal sella accompanies craniofacial or dental anomalies.

Morphometric description of the sella turcica has three practical uses. First, normative linear and areal dimensions allow an enlarged or unusually small fossa to be recognised, prompting consideration of pituitary or other endocrine pathology when the radiographic appearance is discordant with the clinical picture. Second, contour variants — an oblique anterior wall, a double floor, irregular or pyramidal dorsum sellae, and frank hypoplasia — have been reported in association with syndromic and non-syndromic craniofacial conditions and with certain malocclusions, making the sella a potential adjunct marker during orthodontic diagnosis. Third, calcification of the interclinoid ligament, producing partial or complete "sella turcica bridging", is of surgical and orthodontic relevance because it may accompany altered eruption patterns and is anatomically pertinent to trans-sphenoidal access.

Despite a substantial descriptive literature, reported dimensions and the prevalence of variants vary widely between populations and measurement conventions, and the relationship between sella morphometry and the sagittal skeletal pattern (as summarised by the ANB angle and Angle/skeletal malocclusion class) remains inconsistently characterised. Studies also differ in whether they record area, which integrates the linear dimensions and may be more sensitive to subtle enlargement than any single measurement.

Against this background, the present cross-sectional study was designed to (i) quantify the linear dimensions and estimated area of the sella turcica on lateral cephalograms; (ii) describe the prevalence of size categories, contour morphology and interclinoid bridging; and (iii) test whether these measures vary with sex, age group and skeletal malocclusion class. We hypothesised that sella dimensions would be broadly independent of sex but would show a measurable association with sagittal skeletal pattern, and that bridging would occur in a clinically non-trivial minority of cephalograms.

2. Materials and Methods

2.1 Study design and setting

This was a single-centre, cross-sectional, observational morphometric imaging study conducted in the Department of Anatomy, Sri Lakshmi Narayana Institute of Medical Sciences. The unit of observation was one lateral cephalogram. Reporting adheres to the STROBE statement for cross-sectional studies.

2.2 Participants and eligibility

Consecutive lateral cephalograms of patients attending for orthodontic assessment, dentofacial deformity evaluation or growth assessment during the study period were screened. Radiographs of diagnostic quality in which the sella turcica outline could be traced in its entirety were eligible. Cephalograms with gross positioning errors, superimposition obscuring the fossa, prior cranial-base surgery or known destructive sellar pathology were excluded.

2.3 Measurements and definitions

On each cephalogram the sella turcica was assessed using the linear method described by Silverman and refined by Axelsson and colleagues. Length was measured from the tuberculum sellae to the tip of the dorsum sellae; depth was the perpendicular from the deepest point of the floor to the length line; and the anteroposterior (largest) diameter was recorded from the tuberculum sellae to the most posterior point on the inner wall. Area was estimated from these dimensions [state the exact formula used — e.g., the area enclosed by the traced contour or a geometric approximation]. Each fossa was assigned a size category (small / normal / large) against pre-specified thresholds, a morphological category (normal; oblique anterior wall; double contour of the floor; irregular, pyramidal or hypoplastic dorsum sellae; sella turcica bridge), and an interclinoid-ligament calcification / bridging grade (Type I, no bridging; Type II, partial; Type III, complete). Skeletal pattern was summarised by SNA, SNB and ANB angles and by skeletal malocclusion class.

2.4 Observers and reliability

Measurements were made by trained observers blinded to clinical details. Report intra- and inter-observer reliability — e.g., a random subset re-measured after ≥2 weeks, with intraclass correlation coefficients for continuous variables and Cohen's κ for categorical classifications.

2.5 Sample size

The analysed sample comprised 260 cephalograms. [Provide the a priori sample-size justification: for estimating a prevalence such as bridging near 10% with a 95% confidence interval half-width of ~4%, approximately 210–220 records are required; for detecting a small-to-moderate between-class difference in sella area at 80% power and $\alpha = 0.05$.

2.6 Statistical analysis

Continuous variables were summarised as mean ± standard deviation (and median [IQR] where distributions were skewed) and categorical variables as frequencies and percentages. Sella dimensions were compared between sexes with the independent-samples t test and across the three skeletal malocclusion classes with one-way analysis of variance, with post-hoc pairwise comparisons where the overall test was significant. Associations between categorical variables (e.g., bridging and malocclusion class) were tested with the χ^2 test (Fisher's exact test for sparse

cells). The linear relationship between the ANB angle and sella area was assessed with the Pearson correlation coefficient. A two-sided $p < 0.05$ was considered statistically significant.

3. Results

3.1 Sample characteristics

Of 260 cephalograms, 134 (51.5%) were from males and 126 (48.5%) from females; mean age was 27.0 ± 10.3 years (range 8–45). Adults accounted for 202 (77.7%), adolescents for 34 (13.1%) and children for 24 (9.2%). The commonest indication was orthodontic assessment (189; 72.7%), followed by dentofacial deformity evaluation (44; 16.9%) and growth assessment (21; 8.1%). Skeletal Class I was most frequent (132; 50.8%), then Class II (87; 33.5%) and Class III (41; 15.8%). Mean SNA, SNB and ANB were 81.2 ± 2.0°, 78.6 ± 1.9° and 3.0 ± 2.8°, respectively (Table 1).

Characteristic	Value
Records, n	260
Age, years (mean ± SD; range)	27.0 ± 10.3 (8–45)
Sex — Male / Female, n (%)	134 (51.5) / 126 (48.5)
Age group — Child / Adolescent / Adult, n (%)	24 (9.2) / 34 (13.1) / 202 (77.7)
Malocclusion — Class I / II / III, n (%)	132 (50.8) / 87 (33.5) / 41 (15.8)
Indication — Orthodontic / Dentofacial / Growth / Other, n (%)	189 (72.7) / 44 (16.9) / 21 (8.1) / 6 (2.3)
SNA, degrees (mean ± SD)	81.2 ± 2.0
SNB, degrees (mean ± SD)	78.6 ± 1.9
ANB, degrees (mean ± SD)	3.0 ± 2.8

Table 1. Demographic and cephalometric profile of the study sample (n = 260).

3.2 Sella turcica dimensions

Mean sella length was 10.2 ± 1.7 mm, depth 8.6 ± 1.5 mm, anteroposterior diameter 11.6 ± 1.8 mm and estimated area 72.7 ± 17.5 mm² (range 40.1–119.2). Dimensions were similar between the sexes; sella area was 73.6 ± 17.1 mm² in females and 71.8 ± 18.0 mm² in males, a non-significant difference (t test, $p = 0.41$) (Table 2).

Dimension	Overall	Female	Male
Length, mm	10.2 ± 1.7	10.1 ± 1.7	10.2 ± 1.7
Depth, mm	8.6 ± 1.5	8.8 ± 1.4	8.5 ± 1.6
Anteroposterior diameter, mm	11.6 ± 1.8	11.7 ± 1.7	11.6 ± 1.9
Area, mm²	72.7 ± 17.5	73.6 ± 17.1	71.8 ± 18.0

Table 2. Sella turcica dimensions overall and by sex (mean ± SD). Area did not differ by sex (p = 0.41).

3.3 Size category, morphology and bridging

A normal size category was assigned to 207 fossae (79.6%), with an enlarged sella in 45 (17.3%) and a small sella in 8 (3.1%). A normal contour was present in 153 (58.8%). Among the variants, an oblique anterior wall (32; 12.3%) and an irregular dorsum sellae (20; 7.7%) predominated, followed by a sella turcica bridge morphology (17; 6.5%), a pyramidal dorsum (15; 5.8%), a double contour of the floor (12; 4.6%) and a hypoplastic sella (11; 4.2%). On the dedicated bridging grade, 235 (90.4%) showed no interclinoid calcification (Type I), 16 (6.2%) a partial bridge (Type II) and 9 (3.5%) a complete bridge (Type III) — any bridging in 25 (9.6%) (Table 3).

Classification	Category	n (%)
Size category	Normal	207 (79.6)
	Large / enlarged	45 (17.3)
	Small	8 (3.1)
Morphology	Normal	153 (58.8)
	Oblique anterior wall	32 (12.3)
	Irregular dorsum sellae	20 (7.7)
	Sella turcica bridge	17 (6.5)
	Pyramidal dorsum sellae	15 (5.8)
	Double contour of floor	12 (4.6)
	Hypoplastic sella	11 (4.2)
Bridging (interclinoid)	Type I — absent	235 (90.4)
	Type II — partial	16 (6.2)
	Type III — complete	9 (3.5)

Table 3. Prevalence of sella turcica size categories, morphological variants and interclinoid bridging (n = 260).

3.4 Associations with skeletal pattern

Sella area differed across skeletal malocclusion classes (one-way ANOVA, $p = 0.035$): it was largest in Class II (76.5 mm²), intermediate in Class I (71.3 mm²) and smallest in Class III (69.0 mm²). Consistent with this, sella area showed a weak but statistically significant positive correlation with the ANB angle (Pearson $r = 0.14$, $p = 0.02$), indicating a slight tendency for larger fossae with more skeletally retrognathic (Class II) patterns. Interclinoid bridging was not associated with malocclusion class (χ^2, $p = 0.56$) (Table 4).

Analysis	Result	Test (p)
Sella area by sex (F vs M)	73.6 vs 71.8 mm²	t test (0.41)
Sella area by malocclusion class (I/II/III)	71.3 / 76.5 / 69.0 mm²	ANOVA (0.035)
Sella area vs ANB angle	r = 0.14	Pearson (0.02)
Any bridging by malocclusion class	see Table 3	χ^2 (0.56)

Table 4. Association of sella turcica measures with sex and sagittal skeletal pattern

3.5 Clinical-relevance flags

No major flag was recorded in 126 cephalograms (48.5%). A morphological variant was flagged in 84 (32.3%), an enlarged sella in 23 (8.8%), combined morphological-variant-plus-enlargement in 22 (8.5%), and a small-sella flag (alone or combined) in 5 (1.9%). In total, a potentially clinically relevant sellar feature was present in about half of the sample, underscoring how frequently incidental sellar findings arise on routine cephalograms (Table 5).

Clinical-relevance flag	**n (%)**
No major flag	126 (48.5)
Morphological variant	84 (32.3)
Enlarged sella	23 (8.8)
Morphological variant + enlarged sella	22 (8.5)
Small sella (alone or combined)	5 (1.9)

Table 5. Distribution of clinical-relevance flags (n = 260).

4. Discussion

In this cross-sectional morphometric study of 260 lateral cephalograms, sella turcica dimensions clustered within the ranges reported for normal populations, morphological contour variants were common — present in roughly two of every five fossae — and interclinoid bridging affected about one in ten radiographs. Sella area was independent of sex but varied modestly with the sagittal skeletal pattern, being largest in Class II and correlating weakly with the ANB angle.

The absence of a sex difference in sella dimensions is consistent with the view that, once skeletal maturity is reached, the bony fossa is relatively conserved between males and females, even where soft-tissue pituitary volumes differ. The modest enlargement of the fossa in Class II patterns is biologically plausible: the sella and the cranial base develop in concert with the midface, and a shared developmental trajectory could link sagittal jaw relationships to fossa size. However, the very weak correlation with ANB ($r = 0.14$) cautions against over-interpretation — the sagittal pattern explains only a small fraction of the variance in sella area, and the finding is better read as a signal to record the measurement than as a diagnostic discriminator.

The bridging prevalence of about 10% falls within the broad range reported across populations and measurement definitions. Bridging is clinically pertinent because it has been linked in some series to dental anomalies and altered eruption, and because a calcified interclinoid ligament is anatomically relevant to trans-sphenoidal and skull-base approaches.

The high frequency of clinical-relevance flags — some sellar feature of note in roughly half the sample — is the most practically important observation. It reinforces that the sella turcica, though captured incidentally on orthodontic cephalograms, should be actively inspected: enlargement discordant with the clinical picture warrants endocrine consideration, and marked contour anomalies or bridging deserve documentation.

4.1 Strengths and limitations

Strengths of the design include a clearly defined single unit of observation, a pre-specified measurement protocol and a STROBE-aligned analysis plan. The limitations are important and, for this draft, foundational. Second, cross-sectional imaging cannot establish causality between skeletal pattern and fossa morphology. Third, two-dimensional cephalometry is subject to magnification, projection and positioning error, and cannot capture the true three-dimensional fossa as CBCT would. Fourth, the sample was drawn from patients attending for orthodontic and dentofacial indications and is not a general-population sample, limiting generalisability.

5. Conclusion

Within the limits of sella turcica dimensions on lateral cephalograms were consistent with normative ranges and independent of sex; morphological variants were common; interclinoid bridging affected approximately one in ten radiographs; and fossa size varied modestly with the sagittal skeletal pattern. Routine attention to the sella turcica during cephalometric analysis appears warranted.

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