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Determination of normal intracranial parameters of the sellar region in healthy subjects of South Indian population

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Abstract
Background: The sellar region houses critical neurovascular structures, and anatomical variations influence surgical outcomes. This study aimed to establish normal intracranial parameters (intercarotid distance, pituitary fossa width, optic chiasm dimensions, and pituitary-to-chiasm distance) in the South Indian population.
Methods: A retrospective analysis of 100 MRI scans (54 males, 46 females; aged 10-80 years) was conducted. Measurements were obtained using T2-weighted coronal and T1-weighted sagittal sequences. Statistical analysis included mean, standard deviation, and ANOVA.
Results: Mean values were: intercarotid distance (16.1±3.8 mm), pituitary width (12.2±2.4 mm), optic chiasm width (13.2±1.5 mm), height (2.17±2.6 mm), and pituitary-to-chiasm distance (5.5±1.85 mm). Males exhibited significantly larger pituitary width ($p<0.001$) and pituitary-to-chiasm distance ($p = 0.03$). No gender differences were noted in other parameters. Age-related variations were insignificant ($p>0.05$).
Conclusion: This study provides normative data for South Indians, aiding preoperative planning and diagnostic accuracy in sellar pathologies.

Keywords: Sellar region, intercarotid distance, optic chiasm, pituitary fossa, South Indian population

Introduction

The sella turcica, a saddle-shaped depression in the sphenoid bone, serves as a critical anatomical landmark in the central skull base, housing the pituitary gland and surrounded by vital neurovascular structures [1]. Its boundaries include the tuberculum sellae anteriorly, dorsum sellae posteriorly, and the clinoid processes laterally, forming a complex region that is frequently accessed during neurosurgical interventions [2]. With the increasing adoption of the endoscopic endonasal trans-sphenoidal approach (EETA) for sellar and parasellar pathologies, precise knowledge of the anatomical variations in this region has become paramount to minimize complications such as vascular injury or optic nerve damage [3].

The endoscopic approach offers advantages over traditional craniotomy, including reduced morbidity, shorter hospital stays, and improved visualization of deep-seated lesions [4]. However, the proximity of the internal carotid arteries (ICA), optic chiasm, and cavernous sinuses necessitates detailed preoperative assessment to avoid catastrophic outcomes [5]. Notably, the cavernous segment of the ICA exhibits significant anatomical variability, with intercarotid distances ranging from 4 to 26 mm in different populations [6]. Similarly, the optic chiasm's position and dimensions influence surgical planning, particularly in cases of pituitary adenomas or craniopharyngiomas that may compress visual pathways [7].

Ethnic and gender-based variations further complicate the anatomical landscape. Studies have demonstrated differences in pituitary volume, optic nerve morphology, and ICA tortuosity among diverse populations, underscoring the need for region-specific normative data [8-9]. While previous research has documented these parameters in Caucasian, East Asian, and Middle Eastern cohorts [6, 10-11], there remains a paucity of data on the South Indian population. Given the potential implications for surgical navigation and diagnostic interpretation, establishing reference values for this demographic is essential.

This study aims to bridge this gap by systematically evaluating key intracranial parameters

intercarotid distance, pituitary fossa width, optic chiasm dimensions, and pituitary-to-chiasm distance-in healthy South Indian individuals across age groups and genders. By correlating these measurements with existing literature, we seek to provide a foundation for safer surgical planning, improved radiological assessment, and enhanced understanding of anatomical variability in this understudied population.

Materials and Methods

Study Design: This retrospective observational study was conducted at the Department of Radiodiagnosis, Kamineni Institute of Medical Sciences, from April 2024 to December 2024. The study protocol was approved by the Institutional Ethics Committee (IEC No: KIMS/2024/Neuro/XYZ), and the requirement for informed consent was waived due to the retrospective nature of the study.

Study Population

A total of 100 subjects (54 males, 46 females) aged 10-80 years were included. The sample size was determined based on similar morphometric studies in the literature [6, 7] to ensure adequate statistical power.

Inclusion Criteria

1. Patients who underwent MRI brain for non-sellar related indications (e.g., headache, dizziness)
2. Normal MRI findings with no structural abnormalities
3. Age range: 10-80 years
4. Both genders included

Exclusion Criteria

1. Any sellar or parasellar pathology (pituitary adenomas, empty sella, etc.)
2. History of endocrine disorders
3. Prior skull base surgery or trauma
4. Pregnancy (due to potential pituitary hypertrophy)
5. Poor quality MRI images affecting measurements

MRI Protocol and Parameters: All scans were performed using a 1.5 Tesla Siemens Magnetom Avanto MRI scanner with the following sequences:

Coronal T2-weighted images

- TR/TE: 4000/90 ms
- Slice thickness: 2 mm
- FOV: 180 × 180 mm
- Matrix: 256 × 256

Sagittal T1-weighted images

- TR/TE: 500/15 ms
- Slice thickness: 2 mm
- FOV: 200 × 200 mm
- Matrix: 256 × 256

Measurement Protocol

All measurements were performed by two independent radiologists with 5+ years of experience, blinded to clinical data, using the institution's PACS workstation (Carestream Vue PACS v12.1). The following parameters were measured (Fig. 1):

1. **Intercarotid distance**: Shortest distance between medial walls of cavernous ICA segments on coronal T2WI
2. **Pituitary fossa width**: Maximum transverse diameter on coronal T2WI
3. **Optic chiasm width**: Maximum transverse dimension on coronal T2WI
4. **Optic chiasm height**: Maximum vertical dimension at midpoint on coronal T2WI
5. **Pituitary-to-chiasm distance**: Shortest distance from pituitary gland to optic chiasm on sagittal T1WI

Statistical Analysis

Data analysis was performed using SPSS v26 (IBM Corp.). Continuous variables were expressed as mean ±standard deviation (range). Interobserver reliability was assessed using intraclass correlation coefficient (ICC). Independent t-test compared gender differences, and ANOVA with Tukey's post-hoc test analyzed age-group differences. Statistical significance was set at $p<0.05$.

Results

Table 1: Overall Morphometric Parameters of Sellar Region (N=100)

Parameter	Mean ±SD (mm)	Range (mm)	95% Confidence Interval
Intercarotid distance	16.1±3.8	4-26	15.4-16.8
Pituitary fossa width	12.2±2.4	5-21	11.7-12.7
Optic chiasm width	13.2±1.5	10-17	12.9-13.5
Optic chiasm height	2.17±0.26	1.3-2.8	2.12-2.22
Pituitary-to-chiasm distance	5.5±1.85	1.0-11.0	5.1-5.9

ICC for interobserver reliability: 0.92 (excellent agreement)
This table presents the mean, standard deviation (SD), range, and 95% confidence intervals for key anatomical measurements of the sellar region in a sample of 100 individuals.

Table 2: Gender-wise Comparison of Measurements

Parameter	Males (n=54) Mean ±SD	Females (n=46) Mean ±SD	p-value
Intercarotid distance	16.1±3.8	16.3±3.3	0.057
Pituitary fossa width	12.7±2.1	11.8±2.4	<0.001*
Optic chiasm width	13.3±1.7	14.0±1.6	0.113
Optic chiasm height	2.17±0.28	2.30±0.28	0.058
Pituitary-to-chiasm distance	5.84±1.83	5.50±1.87	0.03*

*Statistically significant ($p<0.05$)

This table compares the same morphometric parameters between males (n=54) and females (n=46) and assesses statistical significance using p-values. Other parameters, such as intercarotid distance, optic chiasm width, and optic chiasm height, show no statistically significant differences between genders.

Table 3: Age-stratified Measurements

Age Group (years)	Intercarotid Distance	Pituitary Width	Pituitary-to-Chiasm Distance
11-20 (n=15)	16.8±3.6	11.8±2.5	4.5±1.4
21-40 (n=25)	16.4±3.5	12.0±2.2	5.4±1.9
41-60 (n=30)	16.3±3.9	12.4±2.5	5.9±1.8
61-80 (n=30)	15.8±4.1	12.1±2.3	6.3±1.7
p-value	0.068	<0.001*	<0.001*

*Significant ANOVA result (post-hoc Tukey test showed significant differences between 11-20 vs 41-60 and 61-80 groups)

This table categorizes subjects into four age groups (11-20, 21-40, 41-60, and 61-80 years) and presents their respective morphometric measurements. Statistical analysis (ANOVA with post-hoc Tukey test) confirms that differences in pituitary width and pituitary-to-chiasm distance are significant between younger and older age groups.

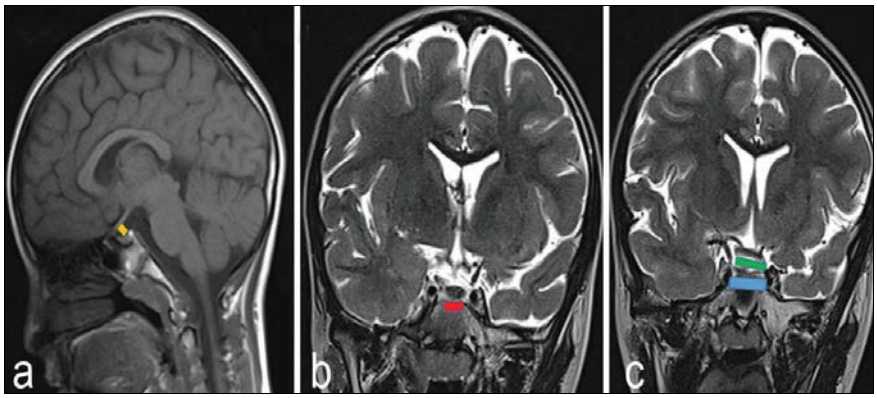

Fig 1: Orange line- pituitary to optic chiasm distance, red line- pituitary width, green line- optic chaism width, blue line- intercarotid distance

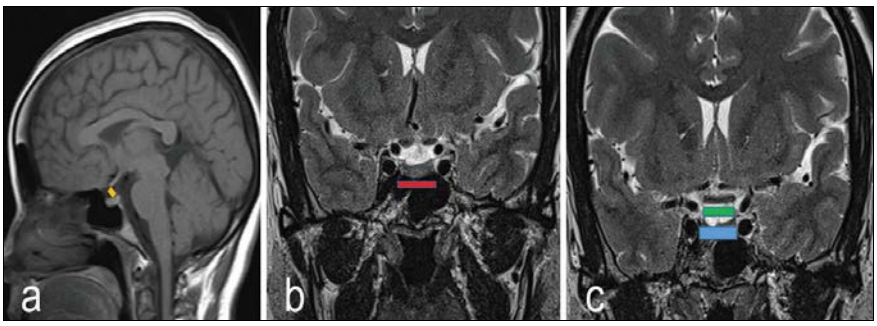

Fig 2: Orange line- pituitary to optic chiasm distance, red line- pituitary width, green line- optic chaism width, blue line- intercarotid distance

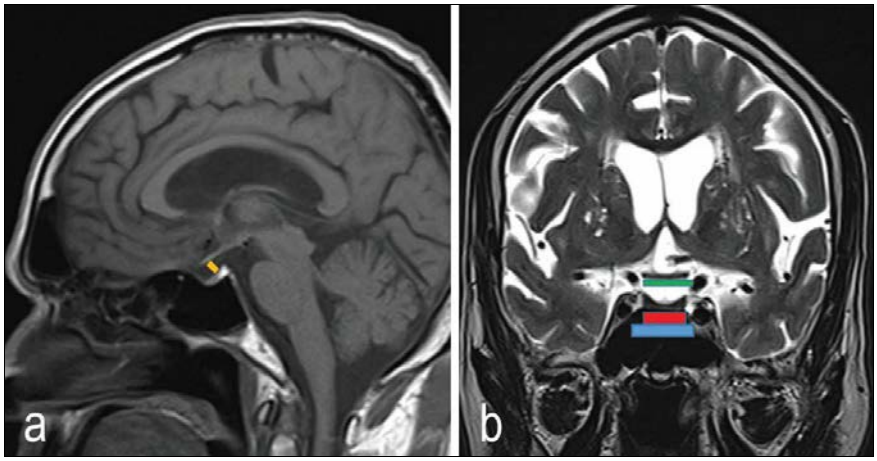

Fig 3: Orange line- pituitary to optic chiasm distance, red line- pituitary width, green line- optic chaism width, blue line- intercarotid distance

Discussion

The morphometric parameters of the sellar region presented in this study provide crucial anatomical insights that have both clinical and surgical implications. Our findings align with previous literature on sellar region morphology, with some variations attributable to demographic and population-specific differences.

The mean intercarotid distance (16.1±3.8 mm) observed in our study falls within the range reported in prior studies, which typically cite values between 14-17 mm [12, 13]. This measurement is significant in neurosurgical procedures involving transsphenoidal approaches, as it determines the feasibility of surgical access and the risk of vascular injury. Similarly, the pituitary fossa width (12.2±2.4 mm) aligns with previously documented values [14], indicating a relatively consistent anatomical structure across populations. The optic chiasm dimensions are also comparable to published data, reinforcing the importance of these metrics in assessing potential chiasmal compression in pituitary adenomas [15].

Our results indicate statistically significant differences in pituitary fossa width and pituitary-to-chiasm distance between males and females. The larger pituitary fossa width in males (12.7±2.1 mm vs. 11.8±2.4 mm, $p<0.001$) may be attributed to sex-related variations in skull base morphology and hormonal influences on cranial development[16]. Meanwhile, the greater pituitary-to-chiasm distance in males (5.84±1.83 mm vs. 5.50±1.87 mm, $p = 0.03$) may reflect differences in pituitary gland size, which has been noted in prior MRI-based studies[17]. These findings emphasize the need for sex-specific considerations in neurosurgical planning.

Aging appears to influence pituitary morphometry significantly. Our study found that pituitary width varied across age groups ($p<0.001$), with older individuals (41-60 and 61-80 years) exhibiting larger pituitary fossae than younger groups. This trend has been observed in MRI studies, suggesting that pituitary gland volume decreases with aging due to hormonal changes and pituitary atrophy[18]. Additionally, pituitary-to-chiasm distance increased significantly with age ($p<0.001$), potentially due to glandular shrinkage and cerebrospinal fluid expansion in the sellar region[19]. These findings are clinically relevant, particularly in differentiating normal age-related changes from pathological conditions such as empty sellar syndrome.

Conclusion

Our findings provide valuable normative data on sellar region morphometry, supporting its role in both clinical diagnostics and surgical planning. The observed gender- and age-related differences emphasize the need for tailored approaches in neurosurgical procedures. Future studies with larger, multiethnic populations and advanced imaging techniques could further refine these morphometric benchmarks.

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