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Anatomical variations of Sphenoid sinus among the population of the Eastern province of Saudi Arabia

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Abstract

Objective The sphenoid sinus is a key anatomical structure in skull base surgery due to its close relationship with the neighboring neurovascular structures. This study focuses on investigating the variability of the intersinus septum in the Eastern Province of Saudi Arabia through high-resolution CT imaging. By exploring these anatomical features, the research aims to enhance surgical techniques, improve patient safety, and contribute to the development of region-specific guidelines and educational resources for skull base surgeries. Design and Methods A retrospective cross-sectional study conducted on 100 patients who underwent CT scan of paranasal sinuses from January 2023 to December 2023. Various parameters from axial, sagittal, and coronal views were used to calculate the dimensions and variations of the sphenoid sinuses. Results The study revealed that the most common pneumatization type was sellar (53%), followed by postsellar (30%) and presellar (17%), with the conchal type being extremely rare (1%). The mean presellar width and depth were nearly identical at 1.47 cm and 1.46 cm, respectively. Suprasellar depth variability was slightly higher than other dimensions. The most frequent intersinus septa configurations were single (81%), with midline septa being the predominant posterior termination (52.9%). Pneumatization of the anterior clinoid process was observed in 22%, and the pterygoid process was pneumatized in 50% of cases. The rate of Onodi cells was 36%, and optic nerve protrusion was found in 26% of cases. Statistical analyses revealed significant associations between postsellar pneumatization and both pterygoid process pneumatization ($p<0.001$) and the presence of Onodi cells ($p=0.045$). Conclusion The study highlighted significant anatomical variations of the sphenoid sinus in the Eastern Province of Saudi Arabia, which have important implications for surgical planning and risk management in skull base surgeries. A detailed preoperative CT scan is essential for navigating these variations to ensure safer and more effective surgical interventions. These findings contribute valuable insights into the regional anatomical features of the sphenoid sinus and support the development of targeted surgical guidelines and educational resources.

Keywords: *Sphenoid sinus, Skull base surgery, Pneumatization, Intersinus septum, High-resolution CT, Onodi cells, Optic nerve protrusion, Internal carotid artery, Saudi Arabia*

Introduction

The sphenoid sinus is a key anatomical structure in skull base surgery due to its close proximity to the optic nerve (ON) and internal carotid artery (ICA). Its anatomical complexity, including diverse patterns of pneumatization and internal septation, affects surgical approaches for various skull base conditions. A thorough understanding of these variations is crucial for minimizing risks and guiding successful surgical outcomes.

This study focuses on investigating the variability of the intersinus septum in the Eastern Province of Saudi Arabia through high-resolution CT imaging. By exploring these anatomical features, the research aims to enhance surgical techniques, improve patient safety, and contribute to the development of region-specific guidelines and educational resources for skull base surgeries.

Materials and methods

A retrospective cross-sectional study conducted at

King Fahd University Hospital in Al-Khobar, on 100 patients who underwent CT scan of paranasal sinuses from January 2023 to December 2023. Patients who are younger than 18 years of age, had a previous sinus surgery prior to the CT scan, had a history of basal skull fracture as a consequence of head trauma, or are known cases of chronic rhinosinusitis were excluded. Additionally, images with a slice thickness > 3 mm, low resolution quality, and those with metallic artifacts that impair sinus visualization were also excluded. Out of the intitial 172 CT scans, 72 patients were excluded for not meeting the inclusion criteria due to having chronic rhinosinusitis (57 cases), prior sinus surgery (5 cases), younger than 18 years old (5 cases), basal skull fracture (3 cases), and due to low resolution quality (2 cases). In regards to the parameters that we measured, we have referred to a paper published by Wiebracht, N. D., & Zimmer, L. A. (2014), as well as various parameters from axial, sagittal, and coronal views were used to calculate the dimensions and variations of the sphenoid sinuses.

Ethical considerations

The study protocol was reviewed and approved from the Institutional Research Board and the Ethics Committee of Imam Abdulrahman bin Faisal University in Dammam (Approval Code: IRB-PGS-2023-01-082) ensuring that the study meets ethical standards for research. Given that the study involves no actual patient contact, the risk to participants is minimal. Ensuring the privacy of the participants was paramount; thus, The medical record numbers and personal information remained anonymized throughout the conduction of this research. All collected data were stored in SPSS format with no links to individual respondents, ensuring complete anonymity.

Statistical analysis

The quantitative data was captured by an Excel spreadsheet, cleaned, and exported to SPSS version 26 (Armonk, NY: IBM Corp., USA.) for analysis. Descriptive statistics were described as numbers and percentages for all categorical variables, while means and standard deviations were used to present all continuous variables. The relationship between the pneumatization type in sphenoid sinus among the demographic and clinical characteristics of the patients has been conducted using the Fischer Exact test. A p-value of less than 0.05 was considered statistically significant.

Results

This study has analyzed 100 patients. As seen in Table 1, the mean age of the patients was 36.9 (SD 12.6) years, with more than half (51%) categorized as younger age group (≤ 35 years). Also, the proportion of males (50%) and females (50%) were equal.

Table 1:

Study variables	N (%)
Age in years	36.9 ± 12.6
• ≤35 years	51 (51.0%)
• >35 years	49 (49.0%)
Gender	
• Male	50 (50.0%)
• Female	50 (50.0%)

Regarding the characteristics of the sphenoid sinus, the mean values of presellar width, height, and depth were 1.47, 2.29, and 1.46 centimeters, respectively. The suprasellar depth and intrasellar depth mean values were 2.29 and 2.58 centimeters, respectively, while the maximum width has a mean of 3.63 centimeters. Intersinus septa mainly were single (81%) and double (15%). No absent septum was observed in our study population. Of the single/diverging (N=85), the majority were midline (58.8%), with sellar being the most common posterior termination (52.9%). Of the double intersinus septa (N=15), the most common posterior termination was right carotid + left carotid (33.3%). Regarding the pneumatization type, the most prominent type was sellar (53%). The presence of pneumatization in anterior clinoid processes, pterygoid processes, and onodi cells were found in 22%, 50%, and 36% of the cases. Left protrusion in the internal carotid artery was 18%, while Vidal canal left protrusion was 10%. In addition, Foramen Rotundum left protrusion was 5% (Table 2).

Measuring the relationship between pneumatization type among the demographic and clinical characteristics of the sphenoid sinus group found that post-sellar type of pneumatization was more associated with the pneumatization of pterygoid process as well ($p<0.001$) and the presence of Onodi cells ($p=0.045$). No significant relationships were observed between pneumatization type in terms of gender or age. (Table 3)

Table 2:

Dimensions	**Mean ± SD**
Presellar width (cm)	1.47 ± 0.38
Maximum width (cm)	3.63 ± 3.46
Presellar height (cm)	2.29 ± 0.34
Suprasellar depth (cm)	1.25 ± 0.39
Presellar depth (cm)	1.46 ± 0.38
Intrasellar depth (cm)	2.58 ± 0.66
Intersinus septa	**N (%)**
Number	
• Single	80 (81.0%)
• Double	15 (15.0%)
• Diverging	04 (04.0%)
• Position (n=85)	
• Right	16 (18.8%)
• Left	19 (22.4%)
• Midline	50 (58.8%)
Single Posterior termination (n=85)	
• Sellar	45 (52.9%)
• Left Sellar	14 (16.5%)
• Right Sellar	09 (10.6%)
• Left Carotid	06 (07.1%)
• Right Carotid	05 (05.9%)
• Right Lateral	04 (04.7%)
• Left Lateral	02 (02.4%)
Double posterior termination (n=15)	
• Right Carotid + Left Carotid	05 (33.3%)
• Right Carotid + Left Sellar	01 (06.7%)
• Right Carotid + Left Lateral	01 (06.7%)
• Right Sellar + Left Sellar	02 (13.3%)
• Right Sellar + Left Carotid	02 (13.3%)
• Right Sellar + Left Lateral	01 (06.7%)
• Left Sellar + Left Carotid	02 (13.3%)
• Left lateral + Left lateral	01 (06.7%)
Pneumatization	
Type	
• Sellar	53 (53.0%)
• Pre Sellar	16 (16.0%)
• Post Sellar	30 (30.0%)
• Conchal	01 (01.0%)
Anterior clinoid process	
• No	78 (78.0%)
• Yes	22 (22.0%)
Pterygoid process	
• No	50 (50.0%)
• Yes	50 (50.0%)
Onodi cells	
• No	64 (64.0%)
• Yes	36 (36.0%)

Internal Carotid Artery	N (%)
Protrusion	
• None	68 (68.0%)
• Right	03 (03.0%)
• Left	18 (18.0%)
• Bilateral	11 (11.0%)
Vidan Canal	
Protrusion	
• None	75 (75.0%)
• Right	05 (05.0%)
• Left	10 (10.0%)
• Bilateral	10 (10.0%)
Foramen Rotundum	
Protrusion	
• None	94 (94.0%)
• Right	01 (01.0%)
• Left	05 (05.0%)
• Bilateral	0

Table 3:

Factor	Pneumatization type			P-value §
	Sellar N (%) (n=53)	Pre-sellar N (%) (n=16)	Post-sellar N (%) (n=30)	
Age in years				
• ≤35 years	29 (54.7%)	04 (25.0%)	18 (60.0%)	0.065
• >35 years	24 (45.3%)	12 (75.0%)	12 (40.0%)	
Gender				
• Male	24 (45.3%)	07 (43.8%)	19 (63.3%)	0.256
• Female	29 (54.7%)	09 (56.3%)	11 (36.7%)	
Anterior clinoid process				
• No	39 (73.6%)	15 (93.8%)	23 (76.7%)	0.244
• Yes	14 (26.4%)	01 (06.3%)	07 (23.3%)	
Pterygoid process				
• No	27 (50.9%)	14 (87.5%)	08 (26.7%)	**<0.001 ****
• Yes	26 (49.1%)	02 (12.5%)	22 (73.3%)	
Onodi cells				
• No	39 (73.6%)	11 (68.8%)	14 (46.7%)	**0.045 ****
• Yes	14 (26.4%)	05 (31.3%)	16 (53.3%)	

Discussion

The anatomy of the sphenoid sinus is characterized by significant variability, including differences in sinus dimensions, the posterior termination of the intersinus septum, the number of septa, and the extent of pneumatization of the sphenoid bone. This anatomical variability has a direct impact on surgical planning for endoscopic skull base surgeries, as it can influence both the complexity of the surgery and the potential for complications.

Based on the highly known classification of Hammer and Radberg [2], the pneumatization pattern of the sphenoid sinus can be categorized into four main types in relation to the sella turcica. Sellar type which was the most prevalent pattern in our study, observed in 53% of the cases. Is when the posterior wall of the sinus lies anterior to the posterior wall of sella turcica.

Postsellar type of pneumatization was the second most common in our study accounting for 30% of the cases. This type is characterized by extensive pneumatization with the posterior wall of the sinus extending even beyond the posterior wall of the sella

turcica.

Presellar type was seen in 17% of our study population, aligning with the 10-38% incidence range found in existing literature. [3]

Lastly, the conchal type which is also referred as the non-pneumatized sphenoid sinus. An extremely rare type. It was observed in only one patient in our study, which is consistent with the 2% incidence reported in the literature. [4]

In our study, the mean presellar width of 1.47 cm was almost the same as the mean presellar depth of 1.46 cm. The variability in the suprasellar depth, as indicated by the standard deviation, was slightly greater than the variability observed in the presellar width and depth, with standard deviations of 0.39 cm compared to 0.38 cm for both the presellar width and depth. Additionally, the maximum width of the sphenoid sinus was consistently found to be located just below the plane of the sella turcica's floor.

Our study has found that approximately 81% had single septation, while the remaining individuals exhibited either double septation (15%) or diverging septation (4%). Among those with single septation, 58.8% had a midline septum, 22.4% had a left-positioned septum, and 18.8% had a right- positioned septum. Comparable findings were evident in the literature. For instance, two studies conducted in Ethiopia, and the other in Egypt reported that the majority of the population exhibited a single intersphenoid septum [4,5], with a significant proportion of Ethiopian population (38%) had the septum in midline position [5]. The attachment of the intersphenoid sinus is crucial for surgical planning because of its close relationship with neurovascular structures. Our findings regarding the posterior termination in case of single or double septation are summarized in (Table 2). We found that for the single intersinus septum cases, a posterior termination at the sellar side accounted for the majority of cases, comprising 52.9%. On the other hand, cases that had double septation, 33% had the insertion of the septa into the walls of the right and left ICA. Likewise in the Egyptian study, where around 8% of the multiple intersphenoid septums were attached to the ICA [4]

The rate of anterior clinoid process pneumatization in our study was 22%, which is within the reported range in the literature of 6% to 29.3% [4,6]. Our findings also show a high rate of pterygoid process pneumatization at 50%, which is greater than what has been reported in other studies. Regarding ICA protrusion, our observed rate of 22% again lies within the international range from 5.2% [7] to 67.0% [8].

Onodi cells, the posterior-most posterior ethmoid air cells that are found in superio-lateral aspect of sphenoid sinus, making it in close proximity to both optic nerve and internal carotid artery and their incidence ranges widely in literature from 3.4% to 60%. [9] The rate of Onodi cells in our study was 36%,

Optic nerve protrusion is often linked to the extent of pneumatization of the anterior clinoid process. In our study, 26% of cases showed varying degrees of optic nerve protrusion, a rate consistent with what has been reported in the literature. [6]

Conclusion

The degree of pneumatization of the sphenoid sinus and its anatomical variations play a critical role in affecting surrounding vital structures and can lead to surgical complications. A preoperative CT scan is essential for effective surgical planning, helping to navigate these variations and reduce risks during sphenoid sinus surgeries. This study presents significant variations in the anatomy of the sphenoid sinus in the Eastern Province of Saudi Arabia and their implications for surgical practice.

References

1. Wiebracht, N. D., & Zimmer, L. A. (2014). Complex anatomy of the sphenoid sinus: a radiographic study and literature review. Journal of Neurological Surgery Part B: Skull Base, 75 (06), 378-382.
2. Hammer, G., & Rådberg, C. (1961). The sphenoidal sinus: an anatomical and roentgenologic study with reference to transsphenoid hypophysectomy. Acta radiologica, (6), 401-422.
3. Hamid, O., El Fiky, L., Hassan, O., Kotb, A., & El Fiky, S. (2008). Anatomic variations of the sphenoid sinus and their impact on trans-sphenoid pituitary surgery. Skull base, 18(01), 009-015.
4. Tawfik, A., Abd El-fattah, A. M., Nour, A. I., & Tawfik, A. M. (2018). Neurovascular surgical keys related to sphenoid window: radiologic study of egyptian's sphenoid. World Neurosurgery, 116 e840-e849.
5. Degaga, T. K., Zenebe, A. M., Wirtu, A. T., Woldehawariat, T. D., Dellie, S. T., & Gemechu, J. M. (2020). Anatomographic variants of sphenoid sinus in Ethiopian population. Diagnostics, 10(11), 970.
6. Anusha, B., Baharudin, A., Philip, R., Harvinder, S., Shaffie, B. M., & Ramiza, R. R. (2015). Anatomical variants of surgically important

landmarks in the sphenoid sinus: a radiologic study in Southeast Asian patients. Surgical and Radiologic Anatomy, 37, 1183-1190.

7. Kazkayasi, M., Karadeniz, Y., & Arikan, O. K. (2005). Anatomic variations of the sphenoid sinus on computed tomography. Rhinology, 43(2), 109-114.
8. Meloni, F., Mini, R., Rovasio, S., Stomeo, F., & Teatini, G. P. (1992). Anatomic variations of surgical importance in ethmoid labyrinth and sphenoid sinus. A study of radiological anatomy. Surgical and Radiologic Anatomy: SRA, 14(1), 65-70.
9. Cellina, M., Gibelli, D., Floridi, C., Toluian, T., Valenti Pittino, C., Martinenghi, C., & Oliva, G. (2020). Sphenoid sinuses: pneumatisation and anatomical variants—what the radiologist needs to know and report to avoid intraoperative complications. Surgical and Radiologic Anatomy, 42, 1013-1024.