Research article

Radiological study of variations in intersphenoidal septum in a south Indian population- a retrospective cross-sectional study

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ABSTRACT

Introduction and Aim: The anatomical variations in intersphenoidal septum (ISS) will affect the ease of surgery and risk of intraoperative injury to neurovascular structures. It is very important to assess the same in different populations using preoperative imaging. Hence the objective of this study is to determine the prevalence of anatomical variations of intersphenoidal septum and its pattern of attachment among Southern Indian population for better planning of surgery and avoid complications.

Materials and Methods: A retrospective cross-sectional analysis of patients who underwent computed tomography paranasal sinus at a tertiary care hospital was done. Data from 186 cases in total were used in this study. The proportion of cases with intersphenoidal septa was the primary outcome evaluated, and the number, location, development, and point of termination of intersphenoidal septa were the secondary outcomes. Statistical software for social studies was used to analyse the data.

Results: Absence of intersphenoidal septum was noted in 0.5% of cases with predominant sellar type of pneumatization. Also, single intersphenoidal septum (81.6%), right sided deviation of septum (48.1%), complete formation of intersphenoidal septum (92.4%) and protrusion of septum towards optic nerve canal (45.9%) were the common findings noted in this study.

Conclusion: Anatomical variations of the intersphenoidal septum clearly signify that the surgeons should keenly note the variations before planning the surgery.

Keywords: Intersphenoidal septum; anatomical variation; computed tomography; optic nerve canal.

INTRODUCTION

The sphenoid sinus, which is situated in the middle cranial fossa, is completely developed at the age of 14 (1). Due to its various extensions, cavernous sinus, the optic nerve, frontal lobe, internal carotid artery, cranial nerves 3 to 6, pituitary gland, and ventral surface of the brain stem are all in close proximity to it (2, 3).Pneumatization of the sphenoid sinus can occur in different ways and to various degrees. Recesses, prominences, and impressions made by neurovascular structures coursing beneath the bone are a few crucial surgical landmarks that may serve as indications for locating these vital structures, lowering the risk of injury during the procedure (4).

The main sphenoid sinus cavity is formed by pneumatization of the sphenoid from the presphenoidal (front) to the postsphenoidal (back) centres. The greater and lesser wings, as well as the anterior clinoid and pterygoid processes, are pneumatized as a result of aeration of the more peripheral ossification centres. It is believed that the lines of fusion between the different ossification centres represent the zones of relative resilience to pneumatization. The sphenoid sinus's complex internal septation is explained by the fact that the fusion lines' residual bony crests and ridges still exist (5).

Particularly in the case of the bulging variant, intrasinus septa can insert posteriorly onto the internal carotid artery canal, adding the risk of vessel damage with potentially fatal results. The optic nerve and internal carotid artery may bulge and dehisce within the sinus (6, 7). In 75% of instances, well pneumatized sinuses have the optic nerve impression on the lateral sinus wall, which can be seen endoscopically and functions as a guiding landmark to avoid (7). The sphenoid sinus ostium opens in the lower portion of the anterior wall, medial and posterior, as opposed to the superior turbinate tail, which is an essential landmark for its recognition. In proximity to the hypophysis, the sphenoid's upper wall is located. The sphenoid bone's tuberculum sellae and dorsum sellae, two prominences that indicate the upper extension of the clivus, respectively, border the sella turcica (8). The lateral cavernous sinus is traversed by the internal carotid artery, abducens nerve, oculomotor nerve, trochlear nerve, and ocular branch of the trigeminal nerve.

Additionally, it assists in the identification of anatomical variations, which has significant consequences for the clinical decisions made during surgical interventions. A variety of findings connected to typical pneumatization processes within the sinus cavities and surrounding marrow spaces are visible on paranasal sinus CT images (9). Anterior cranial fossa

hemorrhage, CSF leak, meningitis, injury to the internal carotid artery, or injury to the cavernous sinus are among the potential complications that could occur if the sinus surgery is carried out without awareness of individual anatomical variations (6). Surgeons investigated the trans-sphenoid approach for pituitary tumour surgeries in the new era of minimally invasive surgery, which gave the sphenoid sinus clinical importance (10). Therefore, it is crucial for understanding the intersphenoidal septum's (ISS) common and specific anatomical variations across the entire population.

In order to improve the surgical outcome, the objective of this study is to identify the anatomical variations of the intersphenoidal septum which are most common in the Southern Indian population.

METHODS

A retrospective cross-sectional study was conducted among the cases those who underwent computed tomography (CT) paranasal sinus referred by the department of Otorhinolaryngology to the department of Radiodiagnosis at Chettinad Hospital and Research Institute, Kelambakkam during the months of October 2020 to October 2021. Cases with CT paranasal sinus showing existing sphenoidal diseases, cases aged less than 18 years and CT suggestive of post-operative features of functional endoscopic sinus surgery were excluded from the study. During the study period a total of 241 CT paranasal sinus was done in the hospital and after excluding the cases based on exclusion criteria a total data of 186 cases were included in this study.

All the CT paranasal sinus data were assessed for the patient's age, gender, pneumatization pattern, presence or absence of ISS, its location either in midline, deviated to left side or right side, complete or incomplete in terms of development and the pattern of termination of ISS. The primary outcome assessed was the proportion of cases with ISS and the secondary outcomes were the assessment of number, location, development and point of termination of ISS. All the data were noted in a proforma and the same was entered in MS excel sheet by the researchers and these data were submitted to statisticians for analysis.

Statistical analysis

The SPSS version 20 was utilized for the analysis after the data from the MS Excel spreadsheet was converted. Calculated descriptive data included mean, standard deviation, and proportion.

RESULTS

In this study from the data collected from the computed tomography-paranasal sinuses, there were 23.7% (44) of the participants between the age group of 18-30 years, 30.6% (57) of the participants were in the age group of 31-40 years, 26.3% (49) of the participants are in the age range of 41-50 years, in the age group of 51-60 years there were 19.4% (36) participants. Mean age of the study participants was found to be 44.7±13.9 years. In this study 52.2% (97) and 47.8% (89) of females and males, respectively, were included (Fig. 1).

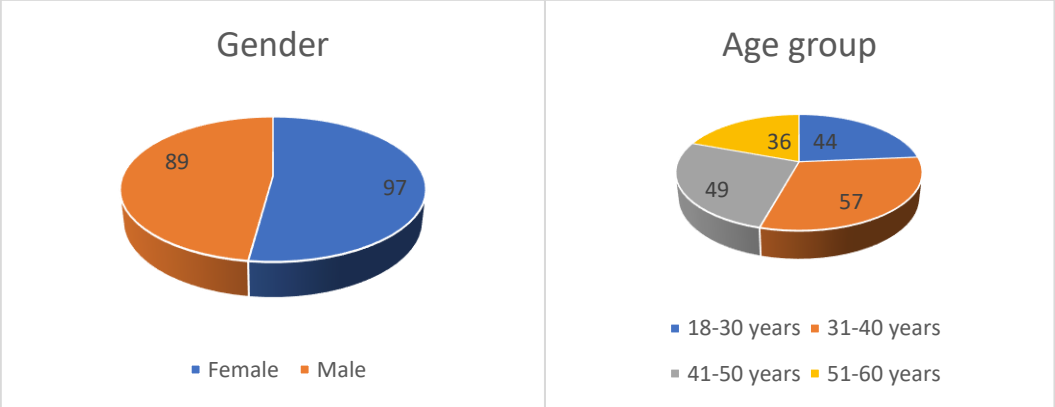

Fig.1: Demographic characteristics of the study participants

The most common type of pneumatization found was sellar type among 91.9% (171) of the participants followed by pre sellar type which was found among 7% (13) of the participants and Conchal type of pneumatization was seen among 1.1% (2) of the study participants. Among all the study participants 99.5% (185) of them had ISS while 0.5% (1) of the participants had no ISS (Fig. 2).

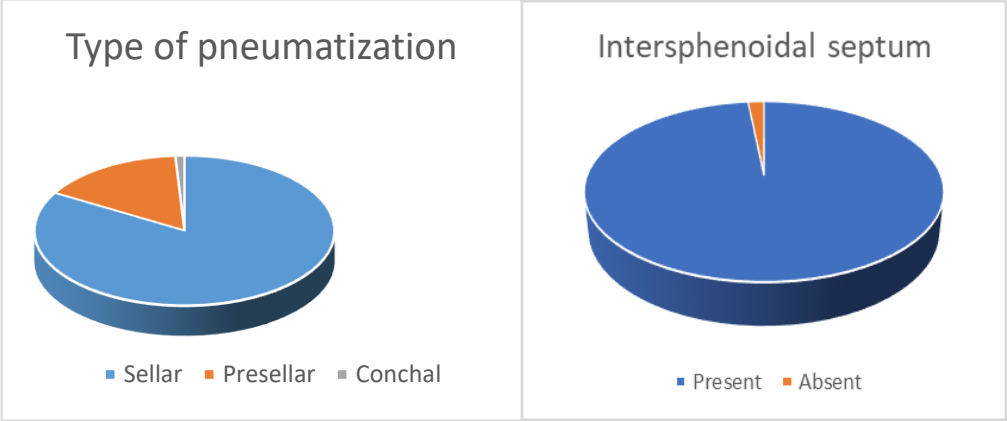

Fig. 2: Proportion of participants based on type of pneumatisation

Based on the number of ISS, 81.6% of the patients had a single of ISS whereas 18.4% of the patients had double of ISS. For 48.1% of the patients of ISS was deviated to the right side (Fig. 3) while for 35.1% of the patients of ISS was deviated to the left side. However, for 16.8% of the participants of the ISS was located in the midline (Fig. 4). Complete development of the ISS was noted in 92.4% of the participants. Regarding pattern of termination of ISS, for 45.9% of the participants it was in the optic nerve canal for 30.8% of the participants it was in ICA canal (Fig. 5, 6) and for 23.2% of the participants the termination of ISS was in the bony lateral wall (Fig. 7). The various characteristics of the ISS were mentioned in the table. 1.

Table 1: Certain characteristics of ISS

Variables	Frequency	Percentage
No. of ISS		
Single	151	81.6
Double	34	18.4
Location of ISS		
Midline	31	16.8
Right side deviation	89	48.1
Left side deviation	65	35.1
Complete development of ISS		
Yes	171	92.4
No	14	7.6
Pattern of termination of ISS		
Optic nerve canal	79	45.9
ICA canal	52	30.8
Bony lateral wall	40	23.2

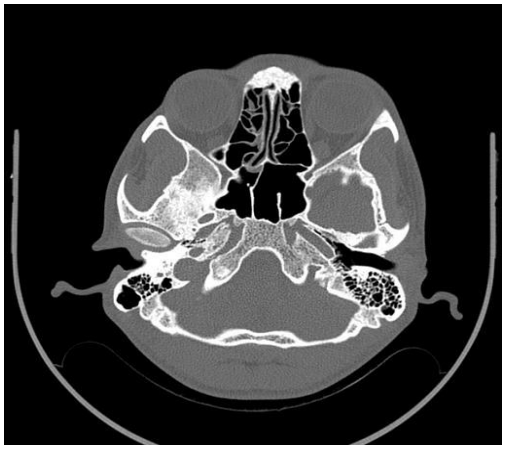

Fig. 3: Right deviation of ISS with accessory septum

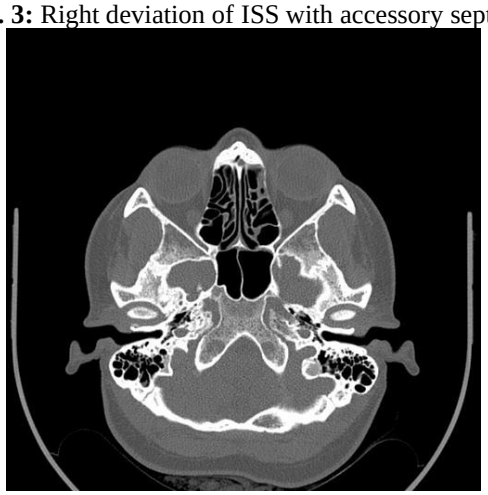

Fig. 4: ISS in midline

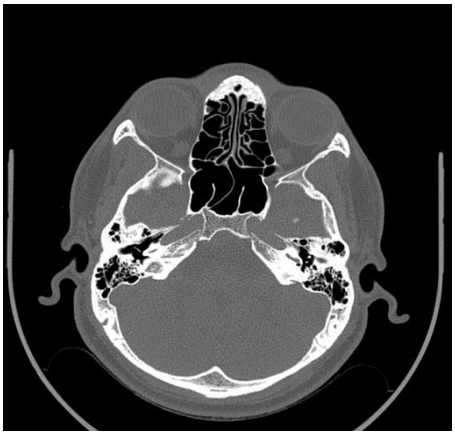

Fig. 5: Right deviation of ISS with ICA termination

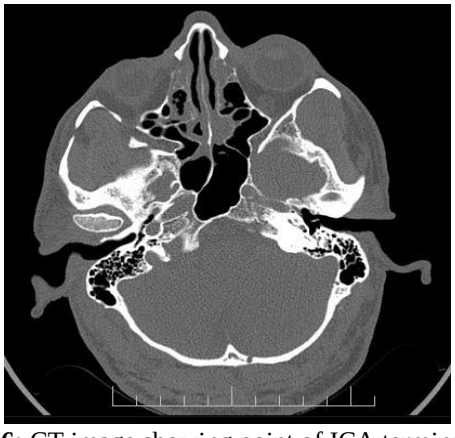

Fig. 6: CT image showing point of ICA termination

Fig. 7: Lateral bony wall termination

DISCUSSION

In the present study, absence of ISS was noted in 0.5% of cases with predominant sellar type of pneumatization. Also, single ISS (81.6%), right sided deviation of septum (48.1%), complete formation of ISS (92.4%) and protrusion of septum towards optic nerve canal (45.9%) were the common findings noted in this study. It is very important to evaluate the anatomically critical structures like orbital contents, optic nerve, cribriform plate and sphenoid sinus. The common complications are haemorrhage, especially retrobulbar area may cause blindness. Other complications include optic nerve damage, loss of ocular motility, CSF leak, injury to internal carotid artery and cavernous sinus or injury to anterior cranial fossa (7).

Raseman *et al.,* (11) conducted a retrospective study in the United States and reported that the common sphenoid pneumatization patterns were sellar and postsellar types. In their study they reported that optic nerve protrusion and dehiscence was noted among 17% and 6% of cases, respectively however internal carotid artery protrusion and dehiscence was noted among 30% and 5% of cases, respectively. In the present study most common types are sellar, optic nerve protrusion is 45.9% and ICA canal is 30.8%.

Kapoor *et al.,* (12) conducted a study among the population in West Bengal and reported that the mean age of patients was 33.5 years and 37.4 years for male and female participants, respectively. This mean age was slightly lesser than the mean age reported in this study. Single complete septum with sellar pneumatization was the most commonly reported pattern of ISS. Lateral recess (48.6%), Carotico-optic recess (24.3%) and onodi cell (5%) were also reported in their study. The present study reported the frequency of single complete septum was 81.6%. Kumar *et al.,* (13) performed a study in Uttar Pradesh during 2019 and reported that single, double and multiple ISS was noted in 75%, 11.5% and 5.8% of cases, respectively and absence of ISS was reported among 7.7% of cases. This current study reported the absence of septum was comparatively less (0.5%).

Degaga *et al.,* (14) conducted a study in Ethiopia, in their study reported that the pneumatization pattern was conchal (2%), presellar (25.5%), sellar (50%) and postsellar (22.5%). Also, they reported 77.5% of cases with single complete septa, 11.5% of cases with single incomplete septa, 10% of cases with double septa and 1% of cases without septa.

Battal *et al.,* (15) performed a study in Turkey and reported the proportion of cases with different patterns of pneumatization as presellar (18.2%), sellar (12.7%), postsellar (68.2%) and conchal (1%). They also reported that there was a significant difference in the mean distances between the deviated sphenoid septum and the internal carotid arteries deviation to the opposite sides. Dunder *et al.,* (16) in Turkey during 2014, they reported that 60.5% of cases had single complete septum, 30.2% of cases had single incomplete septum, 2.7% of cases had double incomplete septum, 4.1% of cases had two complete septa and 2.2% of cases with no ISS. Also, they stated that 64% of cases had septum in the midline and protrusions of optic nerve and internal carotid artery were noted among 17.8% and 27.9% of cases, respectively.

Priya *et al.,* (17) conducted a study in Tamil Nadu, India and reported that in their study a single inter sphenoid sinus septum was noted in 83.3% of cases with midline, right and left side deviation of septum were noted in 11.4%, 33.9% and 21.9% of cases, respectively. However there was no ISS noted in 0.8% of cases. Termination of intersphenoidal septum to internal carotid canal and optic canal were reported in 27.3% and 48% of cases, respectively. Ngubane *et al .,* (18) in South Africa, in their study reported that absence of ISS was noted in 7.5 % of cases, single septum was noted in 65 % of cases and double septa was noted in 22.5 % of cases. Also left sided deviation of ISS was more commonly noted in their study.

Anusha *et al.,* (19) conducted a study among South East Asian population and reported that the rates of optic nerve dehiscence, internal carotid artery dehiscence and internal carotid artery protrusion were reported as 7%, 3% and 10 %, respectively with optic nerve protrusion which was noted in 2.3 % of cases. Abdulghani *et al.,* (20) performed a study in Sudan during 2021 and reported that in their study multiple septa were noted in 30% of cases, with 2 septa and three septa were noted among 20% and 10% of cases, respectively.

Thakur *et al.,* (21) conducted a study in Uttarakhand, India and reported that their study includes 60.5% of male participants with 89.5% of cases with sellar type of pneumatization and single intersinus septum was noted among 68% of cases. These findings are consistent with the findings of the present study. Vidian canal and Foramen rotundum were found to be

dehiscent among 40.5% and 6.38% of cases, respectively.

CONCLUSION

Due to these wide ranges of anatomical variations of the ISS in different populations, it is important for the surgeons to keenly note the variations in the computed tomography of paranasal sinuses before planning the surgery. Also it is recommended to consider each case with its unique features with respect to the anatomical variations of the ISS. The main purpose of computed tomography of paranasal sinus is to evaluate the anatomical variation thereby improving the surgical outcome and to avoid complications.

CONFLICT OF INTEREST

Authors declare no conflicts of interest.

REFERENCES

1. Scuderi, A.J., Harnsberger, H.R., Boyer, R.S. Pneumatization of the paranasal sinuses: normal features of importance to the accurate interpretation of CT scans and MR images. AJR. American Journal of Roentgenology. 1993;160(5): 1101-1104.
2. Carter, L.C., Pfaffenbach, A., Donley, M. Hyperaeration of the sphenoid sinus: cause for concern? Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 1999 Oct 1;88(4):506-510.
3. Terra, E.R., Guedes, F.R., Manzi, F.R., Bóscolo, F.N. Pneumatization of the sphenoid sinus. Dentomaxillofacial Radiology. 2006;35(1):47-49.
4. Edem, I.J., Banton, B., Bernstein, M., Lwu, S., Vescan, A., Gentilli, F., *et al.,* A prospective qualitative study on patients' perceptions of endoscopic endonasal transsphenoidal surgery. Journal of Neurological Surgery Part B: Skull Base. 2012 Feb;73(S 01):A249.
5. Fujioka, M., Young, L.W. The sphenoidal sinuses: radiographic patterns of normal development and abnormal findings in infants and children. Radiology. 1978 Oct;129(1):133-136.
6. Maniglia, A.J. Fatal and major complications secondary to nasal and sinus surgery. The Laryngoscope. 1989 Mar;99(3):276-283.
7. Maniglia, A.J., Ryan Chandler, J., Jarrard Goodwin, Jr, W., Flynn, J. Rare complications following ethmoidectomies: a report of eleven cases. The laryngoscope. 1981 Aug;91(8):1234-1244.
8. Stankiewicz, J.A. Complications of endoscopic intranasal ethmoidectomy. The Laryngoscope. 1987 Nov;97(11):1270-1273.
9. Fasunla, A.J., Ameye, S.A., Adebola, O.S., Ogbole, G., Adeleye, A.O., Adekanmi, A.J. Anatomical variations of the sphenoid sinus and nearby neurovascular structures seen on computed tomography of black Africans. East and Central African journal of surgery. 2012;17(1):57-64.
10. Awadalla, A.M., Hussein, Y., ELKammash, T.H. Anatomical and radiological parameters of the sphenoid sinus among Egyptians and its impact on sellar region surgery. Egyptian Journal of Neurosurgery. 2015 Jul 11;30(1):1-2.
11. Raseman, J., Guryildirim, M., Beer-Furlan, A., Jhaveri, M., Tajudeen, B.A., Byrne, R.W., *et al.,* Preoperative computed tomography imaging of the sphenoid sinus: striving towards safe transsphenoidal surgery. Journal of Neurological Surgery Part B: Skull Base. 2020 Jun;81(03):251-262.
12. Kapoor, K., Yadav, A., Poonia, M. Normal anatomical variations of sphenoid sinus–a retrospective radiological analysis by cross sectional imaging. J Med Sci Clin Res. 2017;5(9):28402- 28407.
13. Kumar, K., Gautam, P., Mishra, A.P., Babu, C.R. Computed tomographic study of sphenoid sinus and its septations. Ind J Clinical Anatomy and Physiology. 2019;6(3):325-330.
14. Degaga, T.K., Zenebe, A.M., Wirtu, A.T., Woldehawariat, T.D., Dellie, S.T., Gemechu, J.M. Anatomographic variants of sphenoid sinus in Ethiopian population. Diagnostics. 2020 Nov 19;10(11):970.
15. Battal, B., Sinan, A.K., Karaman, B., Hamcan, S., Akgün, V., Sebahattin, S.A., *et al.,* The relationship between the variations of sphenoid sinus and nasal septum. Gülhane Tip Dergisi. 2014 Dec 1;56(4):223.
16. Dündar, R. Radiological evaluation of septal bone variations in the sphenoid sinus. Journal of Medical Updates. 2014;4(1):6-10.
17. Priya, T.S., Kumar, N.V., Guru, A.T., Kumari, S.D. An anatomo-imagistic study of intersphenoidal sinus septum. International Journal of Anatomy and Research. 2016;4(1):2015-2020.
18. Ngubane, N.P., Lazarus, L., Rennie, C.O., Satyapal, K.S. The Septation of the Sphenoidal Air Sinus. A Cadaveric Study. International Journal of Morphology. 2018 Dec 1;36(4):1413-1422.
19. Anusha, B., Baharudin, A., Philip, R., Harvinder, S., Shaffie, B.M., Ramiza, R.R. Anatomical variants of surgically important landmarks in the sphenoid sinus: a radiologic study in Southeast Asian patients. Surgical and Radiologic Anatomy. 2015 Dec;37:1183-1190.
20. Abdulghani, Y.S., Salih, K.A. Sphenoidal Air Sinuses Septum Anatomical Variations among Sudanese-A Radiological Study. Journal of Medical and Dental Science Research. 2021;8(4):39-42.
21. Thakur, P., Potluri, P., Kumar, A., Tyagi, A.K., Kumar, A., Varshney, S., *et al.,* Sphenoid Sinus and Related Neurovascular Structures-Anatomical Relations and Variations on Radiology-A Retrospective Study. Indian Journal of Otolaryngology and Head & Neck Surgery. 2021 Dec; 73(4): 431-436.