ORIGINAL RESEARCH ARTICLE

EVALUATION OF ANATOMICAL VARIATIONS OF SPHENOID SINUS USING COMPUTED TOMOGRAPHY IN A TERTIARY CARE CENTRE

[1]Dr. Chandrashekar H.M., [2]Dr. T.D. Thimmappa, [3]Dr. Anusha S., [4]Dr. Vidya Nagendra Kagadagar.

[1]Associate Professor, Department of Radio-Diagnosis, Shimoga Institute of Medical Sciences, Shivamogga, Karnataka, India.

[2]Associate Professor, Department of Otorhinolaryngology, Shimoga Institute of Medical Sciences, Shivamogga, Karnataka, India.

[3]Post Graduate, Department of Radio-Diagnosis, Shimoga Institute of Medical Sciences, Shivamogga, Karnataka, India.

[4]Post Graduate, Department of Radio-Diagnosis, Shimoga Institute of Medical Sciences, Shivamogga, Karnataka, India.

Corresponding Author

Dr. Vidya Nagendra Kagadagar, Post Graduate, Department of Radio-Diagnosis, Shimoga Institute of Medical Sciences, Shivamogga, Karnataka, India.

Received: 31-03-2024 / Revised: 06-04-2024 / Accepted: 13-05-2024

ABSTRACT

OBJECTIVES

To delineate the anatomic variations of the sphenoid sinus that pose surgical risk and the many relationships that exist between the sinus and associated neurovascular systems.

METHODS

In total 380 computed tomography scans were evaluated in axial, coronal and sagittal planes with 1mm slices to study the type of sphenoid sinus pneumatization, protrusion and dehiscence of the ICA and ONC, presence of septations.

RESULTS

The most common SSP was sellar type (60%). Pneumatization of PP, ACP, GWS were seen in 16%, 18.4%, 21.05%, patients respectively Protrusion of ICA, ON, MN and VN were noticed in 27.1%, 31.5%, 18.1%, 20.5% of the patients respectively. Dehiscence of ICA, ON, MN and VN were noticed in 2.6%, 2.1%, 8.1% and 13.4% of patients respectively.

CONCLUSION

The sphenoid sinus's anatomical variations frequently result in complex symptoms and sometimes dangerous side effects. It is crucial to evaluate the anatomic variances using a CT scan in order to lower the risk of harm and complications during endoscopic sinus surgery.

KEY WORDS
Sphenoid Sinus, Anatomical Variations, Septation, Pneumatization.

INTRODUCTION

At the centre of the base of the skull is a complicated structure called the sphenoid bone, it is surrounded by the temporal bone laterally, the occipital bone posteriorly, and the frontal and ethmoidal bones anteriorly. It represents a transition between the intracranial and extracranial components of the skull [1] Because of its deep position inside the skull, the sphenoid sinus is the most difficult paranasal sinus to access.[2]

Assessing the sphenoid sinus clinically is more difficult than other paranasal sinuses (PNS).[1] The last sinus to be pneumatized is the sphenoid sinus, which is completed at the age of 12 after starting at birth.[1]

The sphenoid sinus is highly variable in terms of pneumatization, septations, and its relationship with nearby surgical risk elements like nerves, ICA, and pituitary gland.[3] Its pneumatization ranges from absent to extensive, which subsequently makes the bone that covers the carotid arteries, the optic nerves, and the vidian nerves to be thin or even missing. Therefore, the mentioned structures become vulnerable to iatrogenic injury.[2]

The trans-sphenoid route is regarded as the conventional method for pituitary adenomas surgery. The different routes to the sella: transethmoid, transnasal, trans-septal, whether microscopic or endoscopic, ultimately pass through the sphenoid sinus to reach the sella.[4]

Without knowledge of sphenoid sinus pneumatization, using a transsphenoidal technique can lead to serious consequences, including damage to crucial cranial arteries and nerves.[1]

CT is the most accurate method to visualize paranasal sinuses, providing detailed bone and soft tissue images. Coronal views are most useful for anatomical landmarks, especially for endoscopic clearance. Compared to axial scans, coronal CT reveals deeper structures encountered during surgery.[5-6]

The study aims to show the clinical significance and interrelationship of sphenoid sinus and related structures by using coronal CT scans to identify variations.

Objectives and Aim

To assess the different types of anatomical variations of sphenoid sinuses among the cases.

METHODOLOGY

This study was approved by the research ethics committee of the institution. A Cross sectional retrospective study has been performed in 380 paranasal CT scans collected between august - 2023- to February 2024 for a duration of 6 months at McGann Teaching Hospital, Shimoga Institute of Medical sciences**.**

Sample size was calculated based on study conducted by Gian Luca Fadda et al, who observed that the most common sphenoid sinus pneumatization was sellar type with a prevalence of 58.7%. Taking these values as reference, the minimum required sample size with 5% absolute precision and 95% confidence interval is 373 patients rounded off to 380 patients.

Inclusion criteria were tomography scans of individuals older than 18 years of age, with rhinosinusal symptoms and request from physician ordering tomography assessment of the nose and paranasal sinus. Exclusion criteria were tomography scans identifying individuals with facial bone fractures, rhinosinusal neoplasms, or rhinosinusitis of the posterior paranasal sinus, with a history of prior sinus or sphenoid surgery and massive polyposis.

ISSN:0975 -3583,0976-2833 VOL 15, ISSUE 06, 2024

CT scan images were acquired from patients with informed consent. Data will beanonymous to maintain patient confidentiality. Images with a slice thickness > 3 mm, low resolution quality, and those with metallic artifacts that impair sinus visualization are excluded from the study. A Philips 128 slice MDCT scanner, is used to acquire images. Images are taken inthe axial planes and then 0.65 mm and 1mm slices are reconfigured into coronal and sagittal planes. Patients will be placed in the supine position with their chin hyperextended and scan planeangled perpendicular to the hard palate. Axial scans are performed from the maxillary sinus floor to the level of the frontal sinus roof, in a plane parallel with the hardpalate. Images are reviewed on the console with varying window levels and widths. The sphenoid sinuses are counted (single, double, and absent) and compared in both planes. The data reviewed in both axial and coronal planes, and the total number of septa are Based on the CT images, the following variables were assessed :, type of septum,type of SSP, extension of pneumatization into great wing of sphenoid, anterior clinoid process, pterygoid process, protrusion and dehiscence of the ICA, ONC, MN, ONC.

RESULTS

A total of 380 patients fulfilled the study entry criteria. All patients with ages ranging from 16 to 82 years. There were equal number of men and women. Anatomic variations of sphenoid sinuses were determined in coronal screening, sagittal views. In this study, 380 patients participated, out of which 190 (50%) were females, 190 (41.5%) were males. The participants' age ranged from 18to 70, with a mean of (±SD) 45 (±14.5) years. The mean age of males was 56, while for females was 38.

Our findings showed that anatomographic variants of sphenoid sinus were 229 (60%) seller, 82(22%) presellar, 46(12%) postsellar, and 23 (6%) were conchal types of pneumatization (Figures 1, 2, 3 and 4; Table 1). We also found that pneumatization of the anterior clinoid process (ACP) was 70 (18.4%), pterygoid plates (PP) was 61 (16%), and the greater wing of sphenoid was(GWS) 80 (21.05%) (Figure 8,9,10 and 11; Table 3).

Septal bone septation of the sphenoid sinus in the population was single272 (71.5%).That is, 272 (71.5%) complete and 57 (15%) incomplete, 44 (11.5%) accessory septa (all are complete), and (2.5%) 7 of cases no septation was seen. (Figures 5, 6 and 7; Table 2).

We also investigated the dehiscence and protrusion of sphenoid sinus in relation to internal carotid artery, optic nerve canal, maxillary nerve and vidian nerve (Table 4). Protrusion of the internal carotid artery into the sphenoid sinus was identified on the CT images of 103 (27.1%) patients: the right side alone was involved in 35 (9.2%) patients; the left alone in 51(13.4%) patients, and bilateral involvement was involved in 17(4.4%) patients. The dehiscence of the bonysphenoidal wall of the internal carotid artery occurred in 10 (2.6%) patients; the right side alone was involved in 6(1.8%) patients, left side alone in 4 (1.05%) patients, and bilateral involvement was observed in 1(0.26%) patients. 120(31.5%) cases had the optic nerve protrusion into the sphenoid sinus: right sided in 35(9.2%) case, left side in 73(19.2%) cases, and bilateral involvement in 12(3.15%) cases. However, dehiscence occurred in 8(2.1%) patients; right sided in6(1.57%) cases, left side in 1 (0.26%) cases, and bilateral involvement in 1 (0.26%) cases. We also identified the presence of onodi cells only in two (2.5%) cases (Figure 6).

Protrusion of maxillary canal was encountered in 69(18.1%) patients of whom were bilateral, 29 were on the right side, and36 were on the left side. Dehiscence of the bony wall of maxillary canal was seen in 31(8.1%) patients, of whom 7 were bilateral, 9were right sided, and 15 were left sided.

Sphenoid Pneumatisation	Men	Women	Total
Sellar	135	94	229
Presellar	45	37	82
Postsellar	31	15	46
Conchal	14	9	23

Table 1: Prevalence of anatomic variants of sphenoid sinus based on pneumatization

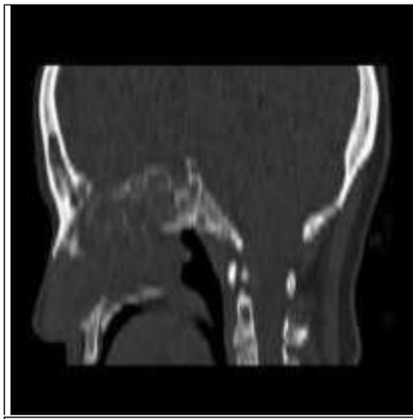
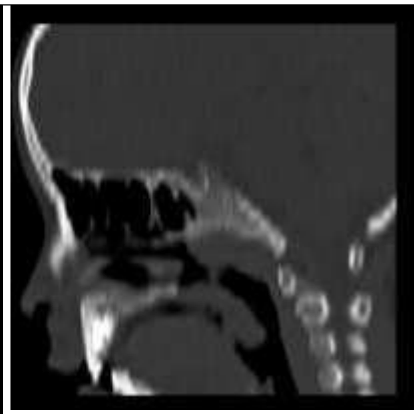
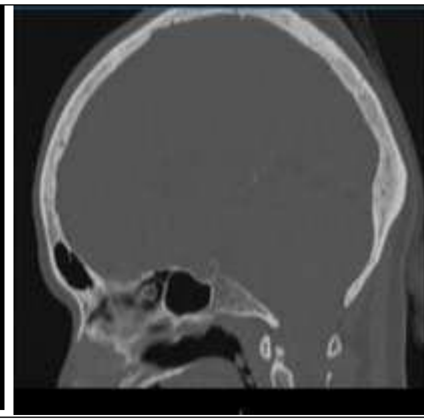

Figure 1: Conchal type Figure 2- presellar Figure 3- sellar

Figure 4- post sellar

Intersphenoid Septae	Men n (%)	Women n (%)	Total (*n* = 380), n (%)b
Midline	56	35	91
Deviated to right.	73	45	118
Deviated to left.	38	25	63
Accessory septae.	15	29	44
Absent septae	5	2	7

Table 2: Prevalence of anatomic variants of sphenoid sinus based on septations

ISSN:0975 -3583,0976-2833 VOL 15, ISSUE 06, 2024

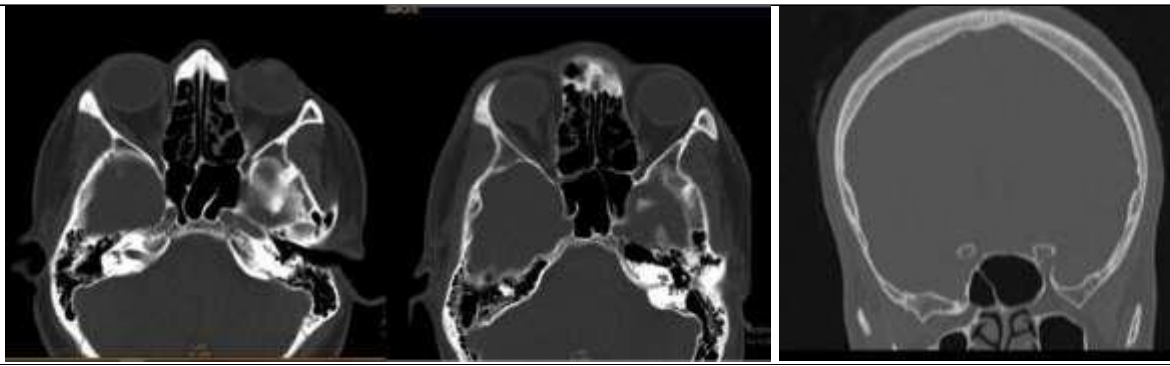

Figure 5- Accessory sphenoid septa, Figure 6 – Septa attached to bilateral internal carotid artery. Figure 7- Intersphenoid septum deviated to right side

Pneumatization	Bilateral	Right Side	Left Side	Total
ACP	13	23	34	70
GWS	22	15	43	80
PP	10	28	23	61

Table 3: Prevalence of anatomic variants of sphenoid sinus based on pneumatization of Anterior clinoid process, greater wing of sphenoid and pterygoid process

Figure 8: Pneumatization of great wing of sphenoid, Figure 9&10: Pneumatization of anterior clinoid process and greater wing of sphenoid

	Bilateral	Right Side	Left Side	Total
Protrusion				
ICA canal	17	35	51	103
ON canal	12	35	73	120
Foramen rotundum	4	29	36	69(18.1%
Vidian canal	9	43	26	78

Table 4 Prevalence of anatomic variants of sphenoid sinus based on protrusion of internal carotid artery canal,optic nerve canal,maxillary nerve canal (foramen rotundum), vidian canal

ISSN:0975 -3583,0976-2833 VOL 15, ISSUE 06, 2024

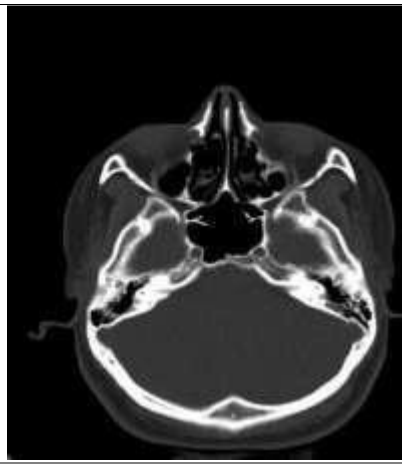
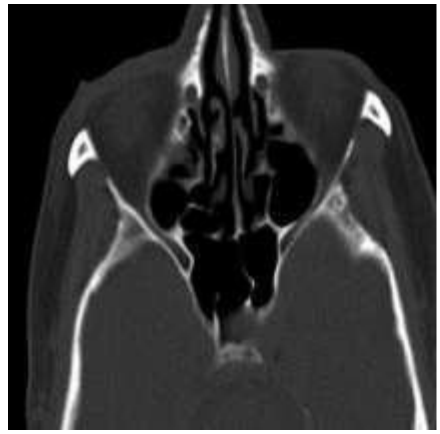
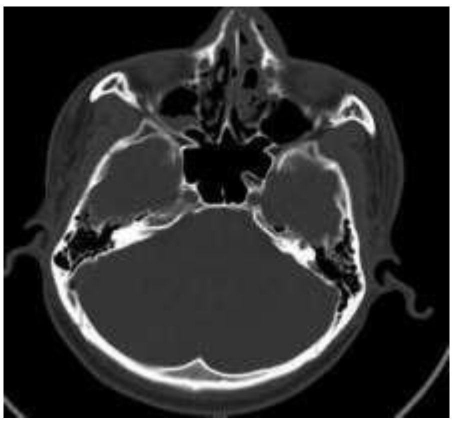
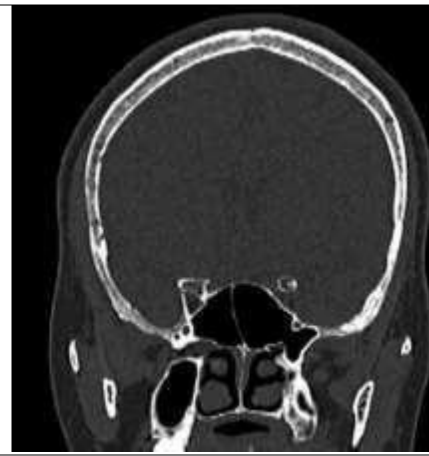

Figure 11: protrusion of bilateral internal carotid artery and optic nerve canal, Figure 12&13: protrusion of bilateral optic nerve canal. Figure 14: Protrusion of foramen rotundum and vidian canal

	Bilateral	Right Side	Left Side	Total
Dehiscence				
ICA canal	1	6	4	11
ON canal	1	6	1	8
Foramen rotundum	7	9	15	31
Vidian canal	5	17	29	51

Table 5: Prevalence of Anatomical variations based on dehiscence of carotid canal wall, optic nerve canal, foramen rotundum, vidian canal.

ISSN:0975 -3583,0976-2833 VOL 15, ISSUE 06, 2024

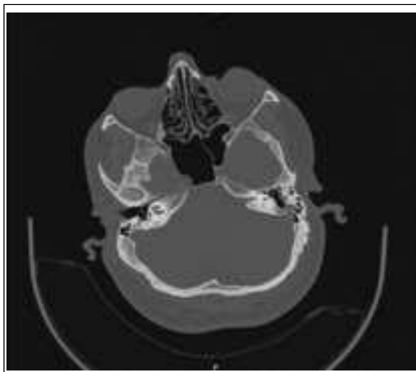
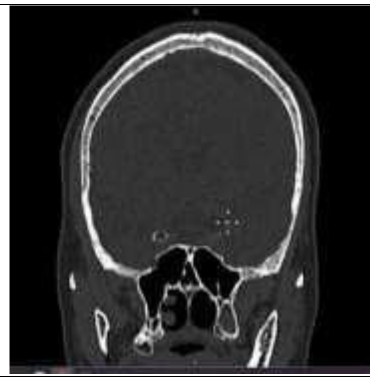


Figure 15: Dehiscence of internal carotid artery on right side, Figure 16: Dehiscence of the wall of foramen rotundum, Figure 17: Dehiscence of the wall of vidian canal

DISCUSSION

The etiology of paranasal sinus lesions, which vary from inflammation to malignancy, is quite diverse and affects a large population.[7,8,9]

Increased frequency of anatomical changes in the sphenoid sinus can raise the risk of damage to significant neurovascular and glandular structures.[10] An optic nerve damage may result from extensive hyperpneumatization of the sphenoid sinus followed by pneumatization of the ethmoid sinus.[11] During endoscopic surgeries, variations in the locations, numbers, and insertions within the sinus septum may injure the internal carotid artery when it protrudes into the sinus lumen.[12]·Hammer and Radberg identified three types of sphenoid sinuses: conchal, presellar, and sellar. The most prevalent pattern was the sellar variant, accounting for 85% of cases. The presellar and conchal variants comprised 11% and 2.5% of instances, respectively.

Moreover, the post-sellar variation is a new subgroup that Hamid et al. introduced to the sphenoid sinus.[13] Hiremath provided the term "complete sellar variant" increases the likelihood of CSF rhinorrhea, emphasizing the importance of reporting its existence to prevent post-surgical CSF rhinorrhea.[5] There is a considerable variation in the sphenoid sinus pneumatization patterns, according to literature reports.[13-15]

Consistent with other authors,[16-20] the sellar type accounted for 60 percent of the patterns in our sample, with the presellar type accounting for 22 percent. The sellar type is recorded at extremely high percentages in earlier literature,[17-20] ranging from 78.5 to 93%. In our investigation, the conchal type was discovered in 6% of cases, which is more than reported in the literature (1-2%).[18-20] The presellar type was detected in 22% of cases, in line with previous studies ranging in between (10–38%).[3] No conchal type was detected by Wang et al.[21] Dal Secchi et al,[16] or Anusha et al.[22] A transsphenoidal approach to the sella always seems to be contraindicated in cases of conchal non-pneumatized sphenoid.[5,23]

Before surgery, computed tomography scans can be used to detect the protrusion of the ICA and ONC into the SS as well as their dehiscence, which can assist prevent injury during surgery.[21] Similar to the findings of Dal Secchi et al. (26%)[16] and Sirikci et al.(26.1%),[10] ICA protrusion into the SS was observed in 27.1% of patients in our assessment. A total of 10 instances (2.6%) had dehiscence of the ICA detected. According to published research, the range of ICA protrusion in the literature is often large, ranging from 5.2 to 67.0%,[17] whereas the range of its dehiscence is 1.5–5%[24,16,17] to 1.5\%.[5,8,9,22]

While the rate of dehiscence was 2.1%, it was relatable to the literature (range 0.7–30.6%).[24-26,17,22] The rate of ONC protrusion was 31.5%, in line with the literature (range 2.3–35.6%).[25,26,17,22]

Protrusion of maxillary canal was encountered in 69(18.1%)patients in our study which is superior to that found by Elwany et al. and Heskova et al, but much lower compared to the findings of Araujo Filho et al. Dehiscence of the bony wall of maxillary canal was seen in 31(8.1%) patients, lower compared to.[4]

Protrusion of vidian canal into the sinus cavity was present in 78(20.52%) patients in our study which is superior to that found by Elwany et al. and Lupascu, but much lower compared to the findings of Araujo Filho et al.

Dehiscence of the bony wall of the vidian canal was identified in 51(13.4%) patients, but much lower compared to. .[4]

ONC injury by protrusion or dehiscence can occur as a major complication when the IS is attached to it and has to be removed. Defects in the visual field, visual acuity or blindness[11] are the risks of injury to optic nerve canal.[5]

In the presence of Onodi cells, the ONC is more vulnerable to damage.[23] We discovered that the ON projecting into Onodi cells was present in 3.6% of our patients. There is a strong correlation between high SSP and dehiscence and/or protrusion of neurovascular structures. Sphenoid sinus septal bone variations are also considered the potential anatomographical variations illustrated in this region.[27,28] Intersphenoidal septa may also have attachment sites on the bone walls of the ICA and ONC; this is an anatomical risk factor during ESS, particularly in the event of a severe fracture.[5]

Serious intraoperative bleeding or blindness may result from an inadvertent fracture of the intersphenoidal septum, which connects to the ICA or ONC bone wall, during endoscopic sinus surgery. Verifying the anatomical characteristics of the SS is crucial to reducing the likelihood of accidental damage to these vital tissues during ESS.·

According to our research, 2.5% of the population included in the study had no septationat all, while around 71.5% of participants had a single septum. Of the cases with a single septum, 23.9% were midline, 31.05% were on the right side, and 16.5% were on the left; in contrast, 15% of the cases had a single incomplete septum and 11.5% had a double septum.[7]

While it was 2.7% in Nigerians[29,30] and 2.2% in other studies[31-33] only 2.5% of the individuals in our study had no septa. Considering that their sample sizes differ, their results are nearly identical. Our findings are supported by the fact that less than 2% of the various populations under study exhibit the uncommon occurrence of a sphenoid sinus without septation.[7]

Sphenoid sinus septal bone variations are also considered the potential anatomographical variations illustrated in this region.[27,28] Intersphenoidal septa may also have attachment sites on the bone walls of the ICA and ONC; this is an anatomical risk factor during ESS, particularly in the event of a severe fracture.[5]

Serious intraoperative bleeding or blindness may result from an inadvertent fracture of the intersphenoidal septum, which connects to the ICA or ONC bone wall, during endoscopic sinus surgery. Verifying the anatomical characteristics of the SS is crucial to reducing the likelihood of accidental damage to these vital tissues during ESS.[5]

According to our research, 2.5% of the population included in the study had no septationat all, while around 71.5% of participants had a single septum. Of the cases with a single septum, 23.9% were midline, 31.05% were on the right side, and 16.5% were on the left; in contrast, 15% of the cases had a single incomplete septum and 11.5% had a double septum.[7]

While it was 2.7% in Nigerians.[29,30] and 2.2% in other studies,[31-33] only 2.5% of the individuals in our study had no septa. Considering that their sample sizes differ, their results are nearly identical. Our findings are supported by the fact that less than 2% of the various populations under study exhibit the uncommon occurrence of a sphenoid sinus without septation.[7]

REFERENCES

[1] Keerthi BHP, Savagave SG, Sakalecha AK, Reddy V, L YU, Keerthi BP, et al. The Evaluation of Variations in Patterns of Sphenoid Sinus Pneumatization Using Computed Tomography in a South Indian Population. Cureus [Internet]. 2022;14(3). Available from: https://www.cureus.com/articles/87559-the-evaluation-of-variations-in-patterns-of-sphenoid-sinus-pneumatization-using-computed-tomography-in-a-south-indian-population

[2] Rahmati A, Ghafari R, Anjom Shoa M. Normal Variations of Sphenoid Sinus and the Adjacent Structures Detected in Cone Beam Computed Tomography. J Dent (Shiraz) 2016;17(1):32-7.

[3] Lupascu M, Comsa G, Zainea V. Anatomical variations of the sphenoid sinus - a study of 200 cases -. ARS Medica Tomitana 2014;20.

[4] Hewaidi G, Omami G. Anatomic variation of sphenoid sinus and related structures in Libyan population: CT scan study. Libyan J Med 2008;3(3):128-33.

[5] Fadda GL, Petrelli A, Urbanelli A, Castelnuovo P, Bignami M, Crosetti E, et al. Risky anatomical variations of sphenoid sinus and surrounding structures in endoscopic sinus surgery. Head & Face Medicine 2022;18(1):29.

[6] Secchi MMD, Dolci RLL, Teixeira R, Lazarini PR. An analysis of anatomic variations of the sphenoid sinus and its relationship to the internal carotid artery. Int Arch Otorhinolaryngol. 2018;22(02):161–6.

[7] Degaga TK, Zenebe AM, Wirtu AT, Woldehawariat TD, Dellie ST, Gemechu JM. Anatomographic variants of sphenoid sinus in ethiopian population. Diagnostics 2020;10(11):970.

[8] Tomovic S, Esmaeili A, Chan NJ, Shukla PA, Choudhry OJ, Liu JK, Eloy JA. High- resolution computed tomography analysis of variations of the sphenoid sinus. J Neurol Surg Part B Skull Base 2013;74:82–90.

[9] Hamid O, El Fiky L, Hassan O, Kotb A, El Fiky S. Anatomic variations of the sphenoid sinus and their impact on trans-sphenoid pituitary surgery. Skull Base 2008;18:9-15.

[10] Kantarci M, Karasen RM, Alper F, Onbas O, Okur A, Karaman A. Remarkable anatomic variations in paranasal sinus region and their clinical importance. Eur J Radiol 2004;50:296-302.

[11] Heskova G, Mellova Y, Holomanova A, Vybohova D, Kunertova L, Marcekova M, Mello M. Assessment of the relation of the optic nerve to the posterior ethmoid and sphenoid sinuses by computed tomography. Biomed. Pap. Med. Fac. Univ. Palacky Olomouc. Czech. Repub 2009;153:149-52.

[12] Jaworek-Troc´ J, Zarzecki M, Bonczar, A, Kaythampillai LN, Rutowicz B, Mazur M, et al. Sphenoid bone and its sinus-anatomo-clinical review of the literature including application to FESS. Folia Med. Cracov 2019, 59:45-59.

[13] Hamid O, El Fiky L, Hassan O, Kotb A, El Fiky S: Anatomic variations of the sphenoid sinus and their impact on trans-sphenoid pituitary surgery. Skull Base 2008;18:9-15.

[14] Anusha B, Baharudin A, Philip R, Harvinder S, Shaffie BM, Ramiza RR. Anatomical variants of surgically important landmarks in the sphenoid sinus: a radiologic study in Southeast Asian patients. Surg Radiol Anat 2015, 37:1183-90.

[15] Hewaidi G, Omami G: Anatomic variation of sphenoid sinus and related structures in Libyan population: CT scan study. Libyan J Med 2008;3:128-33.

ISSN:0975 -3583,0976-2833 VOL 15, ISSUE 06, 2024

[16] Dal Secchi MM, Dolci RLL, Teixeira R, et al. An analysis of anatomic vari- ations of the sphenoid sinus and its relationship to the internal carotid artery. Int Arch Otorhinolaryngol 2018;22:161-6.
[17] Anusha B, Baharudin A, Philip R, et al. Anatomical variants of surgically important landmarks in the sphenoid sinus: a radiologic study in south- east Asian patients. Surg Radiol Anat 2015;37(10):1183-90.
[18] Akgül MH, Muluk NB, Burulday V, et al. Is there a relationship between sphenoid sinus types, septation and symmetry, and septal deviation? Eur Arch Otorhinolaryngol 2016;273:4321-8.
[19] Orhan I, Ormeci T, Nagihan B, et al. Morphometric analysis of sphe- noid sinus in patients with nasal septum deviation. J Craniofac Surg 2019;30(5):1605-8.
[20] El Kammash TH, Enaba MM, Awadall AM. Variability in sphenoid sinus pneumatization and its impact upon reduction of complications following sellar region surgeries. Egypt J Radiol Nucl Med 2014;45:705-14.
[21] Wang J, Bidari S, Inoue K, et al. Extensions of the sphenoid sinus: a new classification. Neurosurgery 2010;66(04):797–816.
[22] Anusha B, Baharudin A, Philip R. Anatomical variations of the sphe- noid sinus and its adjacent structures: a review of existing litera- ture. Surg Radiol Anat 2014;36(5):419-27.
[23] Fatemi N, Dusick JR, de Paiva Neto MA. The endonasal microscopic approach for pituitary adenomas and other parasellar tumors: a 10-year- experience. Neurosurgery 2008;63(4 Suppl 2):244-56.
[24] Unal B, Bademci G, Bilgili YK, et al. Risky anatomic variations of sphenoid sinus for surgery. Surg Radiol Anat 2006;28(2):195-201.
[25] Asal N, Muluk N, Inal M, et al. Carotid canal and optic canal at sphenoid sinus. Neurosurg Rev 2019;42(2):519–29.
[26] Hewaidi G, Omami G. Anatomic variation of sphenoid sinus and related structures in Libyan population: CT scan study. Libyan J Med 2008;3(03):128–33.
[27] Sirikci A, Bayazit YA, Bayram M, et al. Variations of sphenoid and related structures. Eur Radiol 2000;10(5):844–8.
[28] Poirier J, Duggai N, Lee D, et al. Sphenoid sinus septations: unpredictable anatomic landmarks in endoscopic pituitary surgery. J Otolaryngol Head Neck Surg 2011;40:489–92.
[29] Fasunla, AJ, Ameye SA, Adebola OS, Ogbole G, Adeleye AO, Adekanmi AJ. Anatomical variations of the sphenoid sinus and nearby neurovascular structures seen on computed tomography of black Africans.
[30] Akanni D, Souza C, Savi de Tove KM, Nzi K, Yèkpè P. Biaou O, Boco V. Sphenoid sinuses pneumatization and association with the protrusion of surrounding neurovascular structures amongst beninese. Open J. Radiol 2018;8:209-16.
[31] Riza D, Erkan K, Fatih S, Mehmet A, Ahmet K, Engin S, et al. Radiological evaluation of septal bone variations in the sphenoid sinus. J Med Updates 2014;4:6–10.
[32] Hengerer AS. Surgical anatomy of the paranasal sinuses. Ear Nose Throat J 1984:63;137-43.
[33] Bedawi K, Madani GA, Seddeg Y. The radiological study of onodi cells among adult sudanese subjects. OSR-JDMS 2017;16:106-9.