Journal of Pharmaceutical Research International

26(3): 1-7, 2019; Article no.JPRI.40188
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759)

Variations in the Anatomy of Sphenoid Sinus: A Computed Tomography Investigation

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2019/v26i330137
Editor(s):
(1) Dr. Rafik Karaman, Professor, Bioorganic Chemistry, College of Pharmacy, Al-Quds University, Jerusalem, Palestine.
Reviewers:
(1) K. S. Gangadhara Somayaji, Department of ENT and Head and Neck Surgery, Yenepoya Medical College, Yenepoya Deemed to be University, India.
(2) Dr. Ukamaka Dorothy Itanyi, Department of Radiology, University of Abuja, Nigeria.
(3) Dr. Jbali Souheil, Department of ENT and head and neck surgery, Salah Azaiez Institute, Tunisia.
Complete Peer review History: http://www.sdiarticle3.com/review-history/40188

Original Research Article

Received 04 January 2018
Accepted 20 March 2018
Published 29 March 2019

ABSTRACT

Aims: The sphenoid sinus is surrounded by many neurovascular structures which are very vulnerable to intrasphenoid sinus surgeries. The purpose of this study is to investigate the variation of sphenoid sinus structure by CT scan imaging.
Methodology: This is a retrospective study of 3D images of a paranasal sinus in 129 cases. In this study, three-way metering of the sphenoid sinus, additional septum, pneumatization of the period process (PP), anterior clinoid process (ACP) and greater wing of sphenoid and protrusion and dehiscence of adjacent structures will be assessed.
Results: Protrusion of internal carotid artery (ICA), a vidian nerve, maxillary nerve (V2) and optical canal were seen respectively 50.4%, 57.36%, 62.5% and 54.3% but dehiscence of this structure

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was seen 8.5%, 7%, 3.9% and 6.2%. penumtazition of PP, ACP and greater wing of sphenoid were seen 96.87%, 43.9% and 41.1%. Additional septum also is seen in 76% of the population.
Conclusion: This study demonstrates numerous variations in sphenoid sinus structure. Some of the variations cause many problems during intrasphenoidal surgery. Therefore, physicians should evaluate patients completely before surgery.

Keywords: Paranasal sinus; internal carotid artery; median nerve; maxillary nerve; optical canal.

1. INTRODUCTION

In medical science, accurate diagnosis needs exact knowledge about common anatomy [1]. Sphenoid sinus is the most inaccessible and variable sinus of paranasal [2-4] sphenoid sinus variation is widely used in skull base surgeries in a procedure called functional endoscopic sinus surgery (FESS). FESS is one of the best choices in a variety of surgeries such as endoscopic orbital surgery, Sino nasal tumours and endoscopic pituitary surgery [5-6].

It worth noting that numerous nerves and vessels (maxillary nerve, vain nerve, internal carotid artery,..) are present around of sphenoid sinus which may be damaged during surgery. These structures injury will be produced by anatomical variations such as protrusion, dehiscence, pneumatisation of these elements [2,7].

Computed tomography is a valuable technique for investigation of paranasal sinuses variation. Beside diagnostic importance of this technique, CT scan may be used for assessment of risk factors mentioned before [7-8].

Some studies have focused on a variety of variations but the aim of this article is to cover different measurements of variations of sphenoid sinus especially in Iranian population.

2. MATERIALS AND METHODS

This is a retrospective study of cross-sectional paranasal sinus images obtained from computed tomography (CT) (120 kv, 210 mAs, 1.25 mm). Patient's data recorded in Imam Hussein hospital, radiology department of Shahid Beheshti University, Tehran. These patients were referred to CT scan ward for evaluation

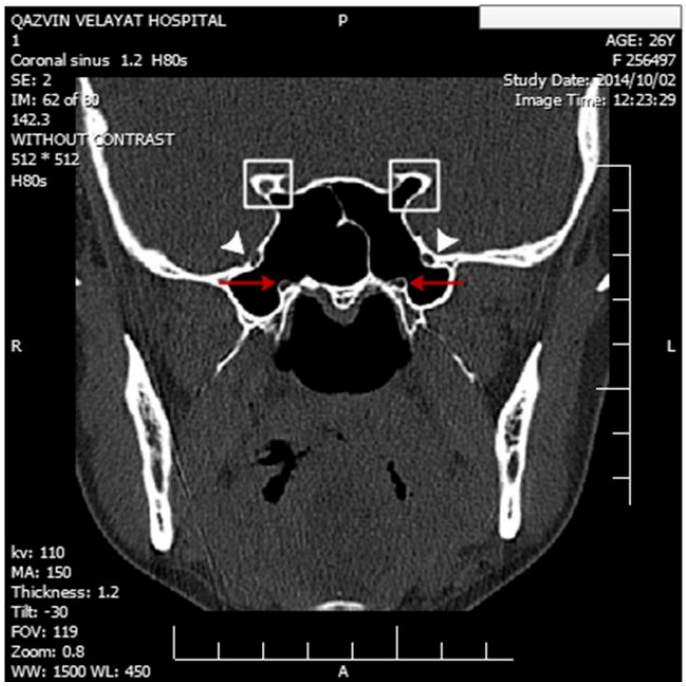

Fig. 1. Coronal CT scan revealed Pneumatization (presence of air cells in the anterior clinoid processes) [rectangulars], Dehiscence (bone coverage missing in pterygoid canal) [red arrow] and also Protrusion (bone bulging around foramen rotundum)

Fig. 2. The coronal slice CT scan, Pneumatization in the pterygoid process (stars) and anatomical place of the common carotid (white arrow) and dehiscence of vidian canal are seen

of sinusitis, trauma, facial surgery and etc. This study performed during 2015 to 2017. Total cases were 213 from CT Scan device database and 84 patients were excluded. Some of them had head and neck surgery or trauma (because of possible changes in sinus parameters) and others were under 13 or older than 86 years old age (because of immaturity in sinus structure). Finally, 129 patients were included [9].

Imaging protocols were reviewed and approved by radiology attendant of Shahid Beheshti medical science university. Images were studied in 3D (axial, sagittal and coronal) plans and measurement carried out by Siemens™ measurement device and viewer software. Measurement of the sinus length was performed at maximum length in three directions: length, width and height.

3. RESULTS

In this study, 129 CT 3D images of sphenoid sinus were evaluated. 70 cases were male and 59 cases were female. 3D paranasal sinus CT scans were analysed for Determination the amount of sinus pneumatisation and variation of adjacent neurovascular structures.

One of the important variations is additional septum that could be observed on the coronal and axial section. Additional sphenoid sinus septum was observed in 76% of the population. This variation in male were 76.8% and 72.9% female cases. Other data including dehiscence and protrusion of neurovascular structure are presented in following four tables.

4. DISCUSSION

Because of the anatomical location of the sphenoid sinus, intrasphenoidal surgery leads to multiple complications [10-13]. Because of immature sinus structure under 13, participants in this study are older than 14 years [14-15].

Sphenoid sinus is enclosed by the sphenoid bone and closely connected to a number of critical elements for example optic nerve, carotid artery, median nerve and maxillary nerve [12,16-18]. Sphenoid sinus expansion is in all directions. In pervious studies pterygoid process bone pneumatization was reported approximately 25%-57% [1,15,19-20]. It is found in 24.8% pneumatization of the pterygoid process in considered cases. Also, the rate of pneumatization in women is 2% more compared to man. The floor of the sinus shows a certain border that communicates to the vidian(pterygoid) canal (VC) [12,19,21]. When pneumatization extend into the plates, in the pervious study show that protrusion of VC in

sphenoid sinus Varies from 7 to 10% [4,12,21]. But Our study showed a rate of protrusion of VC on both sides is 22.5% and dehiscence on both sides is 7% and 5.4% have an only left protrusion and right protrusion have 3.1%. Left dehiscence is approximately 3.9% and right dehiscence is 8%. Our study and the previous study shows a significant relationship between pneumatization of PP and VC protrusion and dehiscence.

Table 1. Pituitary-floor distance: Vertical distance between the lowest side of gland and floor of the sphenoid sinus. Pituitary to the ostium of sinus: Distance between the most anterior part of gland & Ostium of a sphenoid sinus

Variables	Minimum	Maximum	Mean	Mean ±SD
Age	13.00 (y)	86.00 (y)		
Length of Pituitary fossa	7.80(mm)	51.90(mm)	28.78(mm)	6.65(mm)
Wide of Pituitary fossa	12.80(mm)	42.00(mm)	27.37(mm)	5.30(mm)
Height of Pituitary fossa	6.70 (mm)	39.70(mm)	24.10(mm)	6.25(mm)
Pituitary to floor of sinus	3.90(mm)	37.00(mm)	19.65(mm)	7.42(mm)
Pituitary to ostium of sinus	9.30(mm)	35.70(cm)	18.75(cm)	6.06(mm)
Floor thickness of Pituitary fossa	.20(mm)	30.10(mm)	7.50(mm)	9.58(mm)
the thickness of the posterior wall of the sphenoid sinus	.60(mm)	20.80(mm)	2.65(mm)	2.88(mm)
Distance between Sinus ostium to ANS	22.40(mm)	72.70(mm)	57.15(mm)	9.65(mm)

Table 2. Number and percentage of normal position and protrusion of vidian nerve, v2, carotid artery and optic canal (T=total number, M=male, F=female)

	No protrusion& dehiscence		Both side protrusion		Left protrusion		Right protrusion	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Vivian nerve	T=74	57.36%	T=29	22.48%	T=7	5.4%	T=4	3.1%
	M=45	61%	M=14	48.27%	M=3	42.85%	M=1	25%
	F=29	39%	F=15	51.73%	F=4	57.15%	F=3	75%
V2	T=80	62.5%	T=27	20.9%	T=8	6.2%	T=7	5.4%
	M=44	55%	M=19	70%	M=4	50%	M=1	15%
	F=36	45%	F=8	30%	F=4	50%	F=6	85%
Carotid artery	T=65	50.4%	T=32	24.8%	T=11	8.5%	T=6	4.7%
	M=32	49%	M=16	50%	M=7	64%	M=4	66%
	F=33	51%	F=16	50%	F=4	36%	F=2	34%
Optic canal	T=70	54.3%	T=24	18.6%	T=11	8.5%	T=9	7%
	M=39	56%	M=14	58%	M=6	54%	M=1	100%
	F=31	44%	F=10	42%	F=5	46%	F=0	0%

Table 3. Number and percentage of normal position and dehiscence of vidian nerve, v2, carotid artery and optic canal (T=total number, M=male, F=female)

	Both side dehiscence		Left dehiscence		Right dehiscence	
	Number	Percent	Number	Percent	Number	Percent
Vidian nerve	T=9	7.0%	T=5	3.9%	T=1	0.8%
	M=6	66.6%	M=1	20%	M=0	0%
	F=3	33.4%	F=4	80%	F=1	100%
V2	T=5	3.9%	T=2	1.6%	T=0	0%
	M=1	20%	M=1	50%	M=0	0%
	F=4	80%	F=1	50%	F=0	0%
Carotid canal	T=11	8.5%	2	1.6%	T=2	1.6%
	M=0	0%	M=0	0%	M=0	0%
	F=11	100%	F=2	100%	F=2	100%
Optic canal	T=8	6.2%	T=5	3.9%	T=2	1.6%
	M=5	62.5%	M=3	60%	M=0	0%
	F=3	37.5%	F=2	40%	F=2	100%

Table 4. Rate of pneumatization in clinoid process, greater wing of the sphenoid and pterygoid process

	Pneumatization		NO pneumatization	
	Number	**Percent**	**Number**	**Percent**
Clinoid process	56	43.4	T=73	56.6%
	M=32	57.14%	M=38	52.5%
	F=24	42.86%	F=35	47.5%
Greater wing of sphenoid	T=53	41.1%	T=76	58.9%
	M=32	60.37%	M=38	50%
	F=21	39.63%	F=38	50%
Pterigoid process	32	24.8	97	75.2%
	M=15	46.87%	M=53	54.63%
	F=17	53.12%	F=44	45.37%

The sphenoid pneumatization upward, resulting in the anterior clinoid process (APC). Subsequent pneumatisation of ACP, optic nerve protrudes or dehiscence to sphenoid process. Thus inflammation of sphenoid sinus and blind intrasphenoidal Surgery causes Damage to the optic nerve. In pervious study rate of ACP pneumatization were between 6-17% [22-23]. In our study, ACP pneumatization is 43.4% but optic canal protrusion in the pervious study were 8-77.7%. But our observations show that optic canal protrusion is 54.3%. 8.7% of protrusion for left sinus and the 8.7% percent of the protrusion is for right sinus and remain are a protrusion in both sinuses. Dehiscence of the optic canal on both sides is 6.2%, only right sinus 1.6% and only left sinus 3.9%. Our obvious don't show between man and woman ACP pneumatization and protrusion of optic canal. Therefore paying attention to sphenoid sinus roof to Iranian patient for surgeons is important because prevents optic nerve injuries.

One of the elements that increase the risk of injury in intrasphenoidal surgery is carotid artery; because carotid canal (CC) located in the lateral wall of the sphenoid sinus. In the past article reported the percentage of CC protrude was 5.2% to 72.2% [4,24-25]. But our study shows that in 49.6% of population CC protrudes to a sphenoid sinus that 24.8% is bilateral, 8.5% left side and 7% right side. But in 8.5% both side dehiscence, 1.6% left side and 1.6% right side dehiscence.

V2 or maxillary nerve located on the inferolateral wall of sinus in foramen rotundum. Our study shows in 20.9% v2 protrudes to sphenoid sinus but 6.2% only left protrude and 5.4% right. The previous study demonstrated percentage of v2 protrusion was between 8.3% to 28.2% and dehiscence was between6.4% to 10.7% [15,25-26].but our Findings Revealed percentage of V2 dehiscence is 3.9% both side, 1.6% left side and 0% right side. Overall our study exhibit variation in left sinus is more than right sphenoid sinus.

One of the variations in sphenoid sinus is additional septum that covers ICA. In intrasphenoidal surgery for exposure of sphenoidal sinus roof, surgeon has to remove sinus roof, Therefore Can cause damage to this element. In pervious study seen in 68.8% to 69.6% of cases exist additional septum in both side [7,9,17]. But in our study shows in Iranian population that the rate of the additional septum is 76% that our study shows this variation in men is 4% more than women. It should be noted that most people have more than one septum on sphenoid sinus.

5. CONCLUSION

In conclusion, sphenoid sinus possesses numerous and diverse type of variations. Some of the variation can cause many problems during a lifetime. Therefore physicians have evaluated the patient in detail. Also specially radiologist should evaluate images in multiplane and should report different variation because it is necessary for appropriate management of the patient.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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