

Anatomical variations of sphenoid sinus, studied by CT scan

ABSTRACT

Aims: The sphenoid sinus is surrounded by many neurovascular structures that is very vulnerable in intrasphenoid sinus surgeries. The purpose of this study was to investigate variation of sphenoid sinus structure by CT scan images.

Methodology: This is a retrospective study of 3D images of paranasal sinus in 129 cases. In this study measurement of sphenoid sinus, additional septum, pneumatization of petrigod process (PP), anterior clinoid process (ACP) and greater wing of sphenoid and protrusion and dehiscence of adjacent structures were assessed.

Results: Protrusion of internal carotid artery (ICA), 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 were 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 seen in 76% of population.

Conclusion: This study demonstrates numerous variations in sphenoid sinus structure. Some of variation can cause many problems during lifetime. Therefore physicians have evaluated patient in detail before surgery.

Keywords: paranasal sinus, internal carotid artery, vidian nerve, maxillary nerve, optical canal

1. INTRODUCTION

In medicine for an accurate diagnosis, having exact knowledge about common anatomy is very necessary [1]. Sphenoid sinus is the most inaccessible and most variable sinus of paranasal sinuses [2-4]. Regardless these features it is widely used in skull base surgeries in a procedure that called functional endoscopic sinus surgery (FESS). Today FESS is one of the best choices in variety of surgeries such as endoscopic orbital surgery, Sino nasal tumors and endoscopic pituitary surgery [5-6].

It worth noting that numerous nerves and vessels (maxillary nerve, vidain nerve, internal carotid artery,...) are present in around of sphenoid sinus which can be harmed during surgery. Injury to these structures can be produced by anatomical variations such as protrusion, dehiscence, pneumatization of this elements [2,7].

One of the most valuable tools for paranasal sinuses evaluation is computed tomography. Beside diagnostic value of this technique, CT scan may be used for assessment of risk factors that mentioned before [7-8].

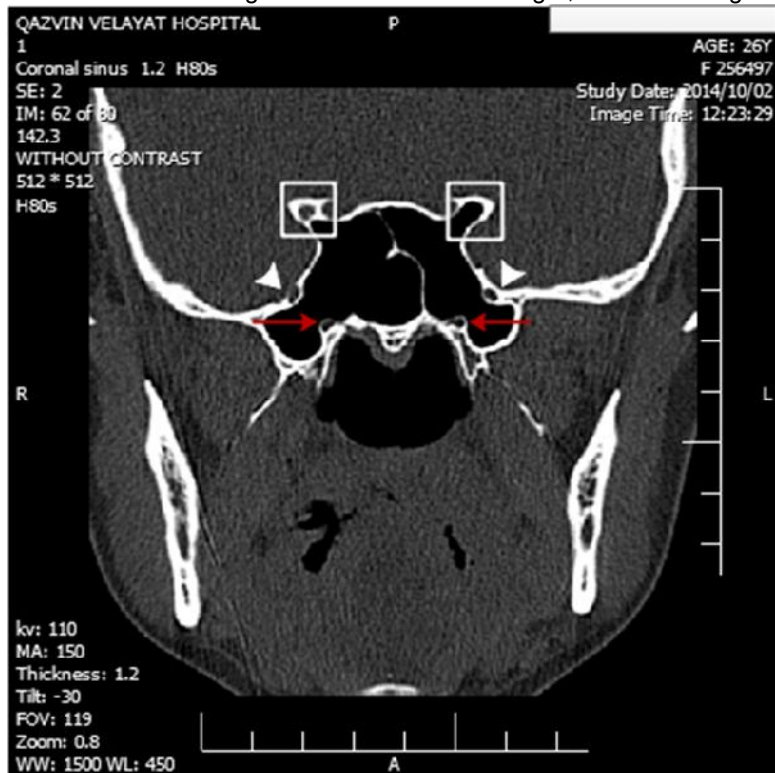
Although some studies focused on variety of variations but lack of proper survey to cover different measurements and variations made the aim of this article.

2. MATERIAL AND METHODS

This is a retrospective study of cross-sectional paranasal sinus graphies obtain from computed tomography (CT) (120kv, 210mAs, 1.25 mm). Patient's data were acquired from Imam hussein hospital. These patients were refer to CT scan ward for evaluation about sinusitis, trauma, facial surgery and etc. This study performed 2015 to 2017. 213 cases were obtained from database and 84 patients were excluded with history of head and neck surgery or trauma (because of possible changes in sinus parameters) and also patients who have 14 years old or younger age (because immaturity in sinus structure) from this study, finally 129 patients were included [9].

Imaging protocols were reviewed and approved by radiology attendant of shahid beheshti medical science university. Final images were studied in 3dimentional (axial, sagittal and coronal) plans and

40 measurement carried out by siemens™ measurement tools and viewer software. Measurement of the
 41 sinus was performed at maximum length in three directions: length, width and height.



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



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 47 **Fig. 2. The coronal slice CT scan, Pneumatization in petrygoid process(stars) and anatomical**
 48 **place of common carotid (white arrow) and dehiscence of vidian canal are seen.**
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50 **3. RESULTS**

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52 In this study we evaluated 129 CT 3D images of sphenoid sinus. Of these, 70 cases are men and
 53 cases 59 are female. 3D paranasal sinus CT scans were analysed for Determine the amount of sinus
 54 pneumatization and variation of adjacent neurovascular structures.

55 One of the important variation referred to additional septum that could best determine on coronal and
 56 axial section. Additional sphenoid sinus septum was observed at 76% of population. Which this
 57 variation in male 76.8% more than women 72.9%. Other data including dehiscence and protrusion of
 58 neurovascular structure presented in four table below:
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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)
thickness of posterior wall of 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)

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63 **Table1. Pituitary-floor distance:** vertical distance between lowest side of gland and floor of
 64 sphenoid sinus. **Pituitary to ostium of sinus:** distance between most anterior part of gland & ostium
 65 of sphenoid sinus.
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	No protrusion & dehiscence		Both side protrusion		Left protrusion		Right protrusion	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Vidian 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%
	T=65	50.4%	T=32	24.8%	T=11	8.5%	T=6	4.7%

Carotid artery	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%

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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).

	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%

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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).

	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%

	32	24.8	97	75.2%
pterygoid process	M=15	46.87%	M=53	54.63%
	F=17	53.12%	F=44	45.37%

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Table 4: Rate of Pneumatization in Clinoid process, Greater wing of sphenoid and pterygoid process.

4.CONCLUSION

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[For inner location of sphenoid sinus, intrasphenoidal surgery can be seen with multiple complication [10-13]. Because of immature sinus structure until 14 years, participants in this study are older than 14 years [14-15].

Sphenoid sinus enclosed by the sphenoid bone and closely connected to number of critical elements for example optic nerve, carotid artery, vidian nerve and maxillary nerve [12,16-18]. Sphenoid sinus expansion is in all direction. In pervious study pterygoid process bone pneumatization was reported approximately 25%-57% [1,15,19-20]. We found in 24.8% of patients pneumatization of pterygoid process occur. Also rate of pneumatization in women compared to man is 2% more. The floor of the sinus shows a certain border that communicate to the vidian (pterygoid) canal (VC) [12,19,21]. When pneumatization extend into the plates, in pervious study show that protrusion of VC in sphenoid sinus Varies from 7 to 10% [4,12,21]. But Our study showed rate of protrusion of VC in both side is 22.5% and dehiscence in both side is 7% and 5.4 % have only left protrusion and right protrusion have 3.1%. But only left dehiscence is approximately 3.9 % and right dehiscence is 8%. Our study and previous study shows significant relationship between pneumatization of PP and VC protrusion and dehiscence.

The sphenoid pneumatization upward, result in anterior clinoid process (APC). Subsequent pneumatisation of ACP, optic nerve protrudes or dehiscents to sphenoid process. Thus inflammation of sphenoid sinus and blind intrasphenoidal Surgery causes Damage to 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 pervious study were 8-77.7%. But our observations shows that optic canal protrusion is 54.3%. 8.7% of protrusion for left sinus and the 8.7% percent of protrusion is for right sinus and remain are protrusion in both sinus. Dehiscence of optic canal in both side 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 increases the risk of injury in intrasphenoidal surgery is carotid artery; because carotid canal (CC) located in lateral wall of sphenoid sinus. In the past article reported 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 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 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. Previous study demonstrated percentage of v2 protrution was between 8.3% to 28.2% and dehiscence was between 6.4% 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 variation in sphenoid sinus is additional septum that cover ICA. In intrasphenoidal surgery for exposure of sphenoidal sinus roof, surgeon have 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 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.

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In conclusion sphenoid sinus possess numerous and diverse type of variations. Some of variation can cause many problems during lifetime. Therefore physicians have evaluated patient in detail. Also

131 specially radiologist should evaluate images in multiplane and should report different variation
132 because it is necessary for appropriate management of patient.

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