

## **Variations of sphenoid sinus and their impact on related neurovascular structures**

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### **Abstract**

The sphenoid sinus is deeply seated in the skull and is the most inaccessible paranasal sinus intimately related to numerous vital neural and vascular structures. This work determines the incidence of the different anatomical variations of sphenoid sinus as detected by CT scan and their impact on related neurovascular structures, for the safe removal of inter sphenoid and pituitary lesions. The CT scan of 20 patients were reviewed regarding the different anatomical variations of the sphenoid sinus: degree of pneumatization, protrusion of internal carotid artery (ICA), optic nerve (ON), and dehiscence of the walls of ICN and ON, and the septation pattern. There were 10 cases with protrusion and 9 cases of dehiscence of the bony wall on ICA, 13 cases of optic nerve protrusion and 10 cases of dehiscence. Sellar pneumatization was present in majority of the patients (55%), with 5 patients having presellar (25%) and 4 patients having post sellar pneumatization (20%). Different anatomical configurations of the sphenoid sinus can seriously affect the access to the sella via the nose. The surgeon should be aware of these findings preoperatively to reach the sella safely and effectively.

**Key words:** Sphenoid sinus, skull. Neural, vascular, carotid artery, optic nerve, pituitary lesion

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### **Introduction**

Sphenoid sinuses are the most inaccessible paranasal sinuses and are surrounded by significant anatomical structures such as the orbit and its contents, cavernous sinus and ICA and the anterior cranial fossa. Only thin plates of bones separate these structures from the sphenoid sinus [1].

Pneumatization of these irregular cavities ranged from their absence to extensive. According to the extent of sinus pneumatization, the bone covering the carotid arteries and optic nerves can be thin or even absent, making these structures susceptible to iatrogenic injury [2].

Injury to internal carotid artery or optic nerve is a serious complication of transphenoidal surgery [3]. The different routes to the sella include transethmoidal, transnasal, trans-septal, whether microscopic or endoscopic, ultimately pass through the sphenoid sinus to reach the sella.

Therefore the anatomical variations of the sphenoid sinus have major impact on the surgical access and the possibility of complications [4].

Computed tomography is the most precise imaging technique to demonstrate paranasal sinuses. Axial and coronal views may be useful for delineating the anatomical landmarks of the sinonasal cavity, but coronal scans shows progressively deeper structures as they are encountered by the surgeon during the operation [2].

The aim of the study is to evaluate the incidence of the different anatomical variations of the sphenoid sinus that are relevant to trans-sphenoid pituitary surgery.

### **Materials and Methods**

This prospective study comprised 20 paranasal computerized tomography scan of South Indian patients attending

E.N.T.Department of our medical college between May 2008 to May 2009.

Patients aged between 16 to 50 years, who are subjected to radiological investigations after a clinical examination and diagnosis is sinusitis were included for the study. Patients with prior sinus surgery, sinonasal tumors, facial trauma and patients younger than 16 years were excluded because according to Gray, the extension of the nasal cavity into the body of the sphenoid bone to form the sphenoid sinus is present before birth but does not reach its full extension until adolescence[8].

For the tomographic studies, systemic studies of the nasal sinus region were performed in coronal scans of all cases. In all the patients, the protrusion of internal carotid artery (ICA) and optic nerve (ON), dehiscence of the bony wall of ICA and ON, degree of pneumatization, presence or absence of septa and or accessory septa were noted.

In coronal sections, protrusion of ICA and ON was determined by finding any degree of protrusion of the structures into the sinus cavity and dehiscence is defined as absence of visible bone density separating the sinus from the concerned structure. Whenever a clear decision between

very thin wall and total dehiscence was not feasible the results were accepted as dehiscence.

**Results**

**Internal carotid artery**

ICA produced a definite bulge in the supero-lateral wall of the sinus in 10 (50 %) patients, of which 3 (15%) were bilateral, 6 (30%) were left sided, and one on right side. A definite dehiscence of the bony wall was seen in 9 (45 %) cases, of which 3 (15%) were bilateral, 6 (30%) were on the left and one on the right.

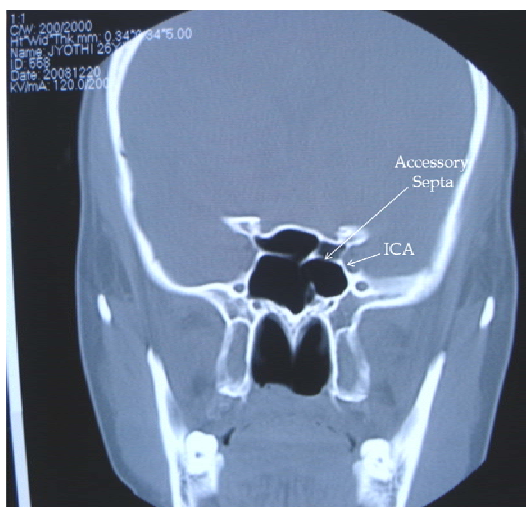
**Optic nerve**

The protrusion of the optic nerve was observed in 13 (65%) patients. Protrusion were bilateral in 9 (45%) patients, while in 2 (10%) patients on the right and 2 (10%) on the left. Dehiscence of the bony wall of the optic canal was observed in 10 (50%) patients, of which and (40%) were bilateral and 2 (10%) on the left side.

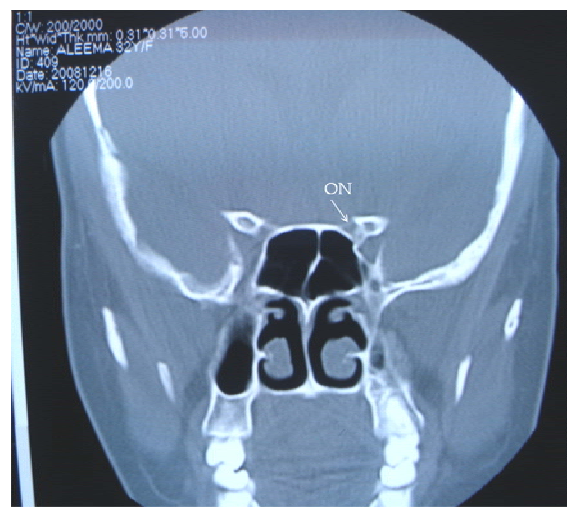
Regarding the degree of pneumatization of the sphenoid sinus, there were 6 cases with presellar pneumatization (25%), 11 patients with sellar type (55%), and 4 patients with post sellar pneumatization (20%).

**Table 1. Anatomic variants of sphenoid sinus in the present study**

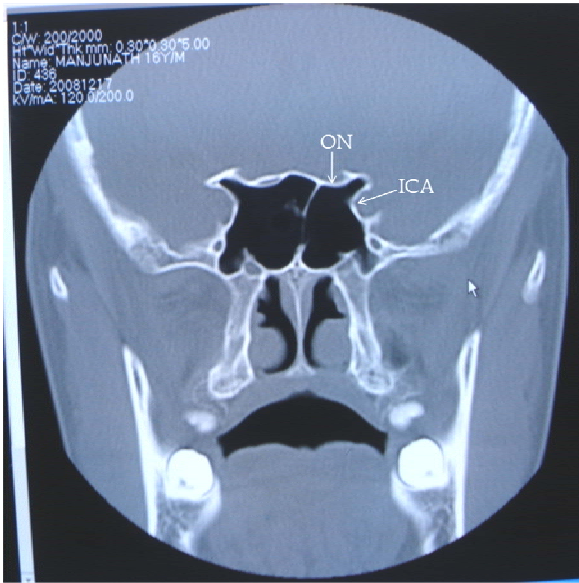
Characteristics	Bilateral No. (%)	Unilateral		Total No. (%)
		Rt Side No. (%)	Lt Side No. (%)	
<b>1. Protrusion</b>				
ICA	3 (15%)	1 (5%)	6 (30%)	10 (50%)
ON	9 (45%)	2 (10%)	2 (10%)	13 (65%)
<b>2. Dehiscence</b>				
ICA	3 (15%)	0	6 (30%)	9 (45%)
ON	8 (40%)	0	2 (10%)	10 (50%)



**Figure 1.** Coronal CT image showing multiple septation with dehiscence of internal carotid artery (ICA)



**Figure 2.** Coronal CT image showing Dehiscence of optic nerve (ON)



**Figure 3.** Coronal CT image showing Extensive sinus Pneumatization with protruding internal carotid artery (ICA) and optic nerve (ON)

## Discussion

Sphenoid sinus is extremely variable in size, shape and relation to the sella. A detailed description of all possible variations of the sphenoid sinus were presented by Renn and Rhoton [5].

### Internal carotid artery

Hewadi et al., reported that the internal carotid artery was protruded into the sinus cavity in 41% of patients, and dehiscence of the artery in 30% [2]. Sirikei et al., encountered least incidence of 26.1% protrusion of ICA and Sareen et al found dehiscence of the carotid artery in 5%. Whereas higher incidence of protrusion of ICA was reported by Sethi et al., 93% and dehiscence by Davoodi et al., 41.95% [2,3]. In this study, we found that protrusion of internal carotid artery into the sphenoid in 50% of patients, and dehiscence of the artery in 45%. The discrepancy between these prevalence rates may be due to different techniques or else it may reflect ethnic differences between the populations [2,3].

If the surgeon is unaware of dehiscence or protrusion of the artery, fatal hemorrhage can occur because it is hardly possible to control the bleeding from a ruptured ICA within the sphenoid sinus.

### Optic nerve

Previous studies reported a wide range of protrusion rates of 8 to 70%. Bademci et al., reported 34.4% of protrusion of the ON into sinus cavity and Fuji et al., found only 4%

of optic nerves were dehiscent if bone in the lateral sphenoid [2]. Higher rates of protrusion of ON was reported by Davoodi et al., 36.45% [3]. In the present study, we found that the protrusion of the optic nerve was seen in 65% and dehiscence of the optic nerve in 50% of the patients. These were obviously very high and most likely explained by our criteria for defining protrusion and dehiscence.

The optic canal is the place where optic nerve is least nourished, which makes it very susceptible to injury. Hence compression of the optic nerve can cause ischemia and venous congestion of the nerve. Optic nerve injury can occur in case of protrusion or dehiscence either due to surgical trauma or as a complication of sinus disease. If the surgeon damages the nerve within the sinus, the risk of blindness is high. Moreover, visual deficits may result from sphenoid sinus infection or from a mucocele compressing the optic canal or nerve.

The degree of pneumatization of the sphenoid was the prime concern for accessing the sella [4]. Type of sphenoid sinus pneumatization depends on the position of the sinus in relation to the sella turcica. In the present study, the most common type of pneumatization of the sphenoid sinus was the sellar type 55%, followed by presellar and the least encountered was post sellar with 20%. Similar observations were noted by Hamid O. et al [4]. It is comparatively lesser than the earlier observations of Romano A. et al., Odowy OE et al., Banna M et al., [5,6,7].

The septa of the sphenoid sinus were found to be variable. In most cases, the septum deviates quite laterally and terminates on the carotid artery [4]. Multiple septa were found in half of the cases, these could have been transverse, or vertical and some were difficult to remove. In this situation it is wise to use extreme caution while removing the septum in order to prevent accidental and disastrous injury to the carotid artery.

## Conclusion

In order to avoid morbid consequences during surgery, it is imperative that clinicians determine the location and extent of the walls of the sphenoid sinus and its relationship into adjacent vital structures whenever trans-sphenoid pituitary surgery is contemplated.

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