

A Study to Assess the Bilateral Sphenoidal Sinus Parameters and Determine the Number and Pattern of Attachment of Intra-Sphenoidal Sinus Separation by Computed Tomography

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Abstract

Background: Computerized tomography (CT) scan is the most precise imaging technique to demonstrate paranasal sinuses. Bony details are assessed by wide window settings and soft tissue by narrow window settings. Triplanar cuts are used to read anatomical details. The aim of this study is to assess the bilateral sphenoidal sinus parameters & determine the number & pattern of attachment of intra-sphenoidal sinus separation by computed tomography. **Materials & Methods:** It is a cross sectional study. Patients attending ENT Outpatient Department at Government hospital, Pali, India with features of sinonasal disease and were advised CT scan depending upon the symptoms and course of the disease were included. One (1) mm. thickness cuts were taken from anterior table of frontal sinus to posterior extent of sphenoid sinus. Images were acquired in the axial plane and then reconstructed in coronal and sagittal planes. **Results:** No conchal type of sphenoid sinus was detected in this study population. Prevalence of anterior clinoid process pneumatization found in 18% cases (n=9). The prevalence of Internal Carotid Artery (ICA) protrusion & dehiscence into the sphenoid sinus encountered in 28% & 12% respectively. Optic Nerve protrusion was present in 26% (n=13) patients. A total of 100 septa were seen in axial plane and 140 in coronal plane. Septa attachment to optic nerve was seen in 28% (n=14) patients, of whom 5 patients (10%), 6 patients (12%) and 3 patients (6%) had attachment related to right optic nerve, left optic nerve and both optic nerves, respectively. **Conclusion:** In our study we used CT scan with 1 mm section thickness. This resolution helped in better demonstration of complicated sphenoid sinus anatomy well.

Keywords: CT scan, Sphenoid Sinus, Pneumatization, Protrusion, Dehiscence.

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Introduction

The sphenoid sinus is the deepest air-filled space in the human head, connected with the nose cavity through the natural ostium located in its frontal wall. Historically, early noninvasive methods to assess the anatomy and measure the parameters of the sphenoid sinus volume were based on radiography, although they had limited accuracy[1]. Later methods based on two-dimensional CT scans of the sinus volumes were developed. To compensate for the unavailability of complete 3D reconstructions, they relied upon mathematical models to predict the volume based on a limited number of 2D projections and hypothesized the paranasal sinus volume and other anatomical features. This approach nevertheless had inevitable limitations once there were any anomalies in the sphenoid sinus anatomy, as it did not take into account the possible formations of edema of the mucosa, as well as the volume of bone margins, thus limiting the information provided to the surgeon at both the pre- and postoperative stages. Recently, more advanced techniques that rely upon complete 3D reconstructions based on CT scan-based measurements became available, allowing for better surgery planning[2]. A recent approach based on the computational fluid dynamics (CFD) model requires double CT scan-based validation and does not provide measurements of one specific sinus but of all pneumatized structures at the same time[3]. Computerized tomography (CT) scan is the most precise imaging technique to demonstrate paranasal sinuses. Bony details are assessed

by wide window settings and soft tissue by narrow window settings. Triplanar cuts are used to read anatomical details. Among them coronal cuts give most of the information from operative point of view. Radiological anatomy is evaluated in three dimensions for preoperative and paroperative surgical planning, which helps the surgeon to identify his or her limits of dissection during surgery and avoid complications. The aim of this study to assess the bilateral sphenoidal sinus parameters & determine the number & pattern of attachment of intra-sphenoidal sinus separation by computer tomography.

Materials & methods

This cross-sectional study was carried out including patients attending ENT Outpatient Department at Government hospital, Pali, India with features of sinonasal disease and were advised CT scan depending upon the symptoms and course of the disease.

Inclusion Criteria

All CT scans of paranasal sinuses of patients greater than or equal to 18 yrs. of age.

Exclusion Criteria

Presence of neoplastic pathology or radiological signs of trauma altering sphenoid sinus anatomy

Methods

CT scans were performed following a course of antibiotic and nasal decongestant. CT scan cuts were taken while patients were lying supine and gantry angulation was set at perpendicular to orbitomeatal line. One (1) mm. thickness cuts were taken from anterior table of frontal sinus to posterior extent of sphenoid sinus. Images were acquired in the axial plane and then reconstructed in coronal and sagittal planes.

CT scan analysis began with reading of coronal cuts in anterior to posterior directions. In more anteriorly placed cuts the superolateral cells are from posterior ethmoidal group and inferomedial is the

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sphenoid sinus; subsequent posterior cuts show sphenoid anatomy more clearly. Sphenoid sinus pneumatization is better seen in sagittal cuts. If non-pneumatized it presents as a small pit, conchal type. Sphenoid sinus invariably deviates to one side creating two unequal sinus cavities giving rise to sphenoid dominance on the other side. Anterior and posterior deviation of the intersphenoid septum are better assessed in axial cuts. The sphenoid sinus ostium is better identified in sagittal cuts. If present each accessory septa within sphenoid sinus is traced and looked for any attachment to Internal carotid artery (ICA) and optic nerve. Position of opticocarotid recess (OCR) should be looked for. The entire course of the optic nerve and its relation to Onodi cell is assessed in axial cuts. Anterior clinoid process pneumatization were looked into. Bony thickness over the ICA with or without dehiscence were noted. Any protrusion or dehiscence of maxillary and vidian nerve in the lateral recess of the sphenoid were noted. Extension of pneumatization beyond sphenoid sinus were also documented.

Results

The present study showed that average age of the patients was 39.6 years with male preponderance (60%). No conchal type of sphenoid sinus was detected in this study population. Prevalence of anterior clinoid process pneumatization found in 18% cases (n=9) and it was present bilaterally in 10% (n=5), on the right side in 6% (n=3) and on the left side in 2% (n=1) patient. The prevalence of pneumatization of greater wing of sphenoid was 4%, among which 2% (n=1) and 2% (n=1) were involving right and

left sides respectively. Pneumatized pterygoid process found in 34% (n=17) of study subjects (right 10%, left 10%, bilateral 14%).

Internal Carotid Artery (ICA): ICA protrusion into the sphenoid sinus encountered in 28% (n=14) patients of whom 8 patients (16%) were bilateral, & 4 patients (8%) were right sided and 2 patients (4%) were left sided. Dehiscence of bony wall on the ICA were seen in 12% of patients (n=6) of whom 1 patient (2%) were bilateral, 3 patients (6%) were right sided and 2 patients (4%) were left sided.

Optic Nerve (ON): Optic Nerve protrusion was present in 26% (n=13) patients. Protrusion were bilateral, right sided left sided in 7 (14%), 3 (6%) and 3 (6%) respectively. Bony wall of optic canal showed dehiscence 18% (n=9) patients of whom 3 (6%) were bilateral, 4 (8%) were right sided and 2 (4%) were left sided.

Maxillary Nerve (MN)

The protrusion of maxillary canal (Foramen Rotundum) was encountered in 24% (n=12) patients of whom 4 (8%) were bilateral, 4 (8%) were right sided and 4 (8%) were left sided. Bony wall of the maxillary nerve canal was dehiscence in 4% (n=2) patients of whom 1 patient (2%) and 1 patient (2%) were right sided and left sided respectively.

Vidian Nerve (VN): The vidian canal protruding into the sphenoid sinus cavity was present in 18% (n=9) patients of whom 5 patients (10%) were bilateral, 2 patients (4%) were right sided and 3 patients (6%) were left sided. The bony wall of the vidian canal was identified dehiscence in 20% (n=10) patients of whom 2 patients (4%), 3 patients (6%) and 5 patients (10%) were bilateral, right sided and left sided respectively (table 1).

Table 1: Prevalence of anatomic variations of sphenoidal sinus & related structures (N=50)

Anatomic variations	Bilateral	Right side	Left side	Total
Pneumatization				
Anterior clinoid Process (ACP)	5 (10%)	3 (6%)	1 (2%)	9 (18%)
Greater wing of sphenoid (GWS)	0 (0%)	1 (2%)	1 (2%)	2 (4%)
Pterygoid process (PP)	7 (14%)	5 (10%)	5 (10%)	17 (34%)
Protrusion				
Internal Carotid Artery (ICA)	8 (16%)	4 (8%)	2 (4%)	14 (28%)
Optic nerve (ON)	7 (14%)	3 (6%)	3 (6%)	13 (26%)
Maxillary nerve (MN)	4 (8%)	4 (8%)	4 (8%)	12 (24%)
Vidian nerve (VN)	5 (10%)	2 (4%)	3 (6%)	9 (18%)
Dehiscence				
Internal Carotid Artery (ICA)	1 (2%)	3 (6%)	2 (4%)	6 (12%)
Optic nerve (ON)	3 (6%)	4 (8%)	2 (4%)	9 (18%)
Maxillary nerve (MN)	0 (0%)	1 (2%)	1 (2%)	2 (4%)
Vidian nerve (VN)	2 (4%)	3 (6%)	5 (10%)	10 (20%)

Septations

In this study total of 100 septa were seen in axial plane and 140 in coronal plane. Septa attachment to optic nerve is seen in 28% (n=14) patients, of whom 5 patients (10%), 6 patients (12%) and 3 patients (6%) had attachment related to right optic nerve, left optic nerve and both optic nerves, respectively. On the right-side ICA protrusion and pneumatization of ACP were both cant association present in 4 (8%) patients and on the left side in 3 (6%) patients. Chi Square test indicated a statistically significant (P< 0.001).

Pneumatized ACP and ON protrusion consistently encountered on the right and left side in 3 patients (6%) and 4 patients (8%) respectively. Chi-Square test indicated a significant association between ACP pneumatization and ON protrusion (P<0.001).

Table 2: Wall thickness of sphenoid sinus & adjacent to ICA with or without septa

	Right ICA		Left ICA	
	Septa	Without septa	Septa	Without septa
Mean width (mm)	0.79	0.88	0.83	0.92

Discussion

A detailed understanding of preoperative surgical anatomy of sphenoid sinus and surroundings by CT scan is essential for planning of surgical approach and preventing complication. Special considerations are to be given to course, protrusion and dehiscence of ICA and Optic Nerve (ON) along with evaluation of intersinus septa and its attachments.

Our study showed that the prevalence of ICA protrusion & dehiscence into the sphenoid sinus encountered in 28% & 12% respectively. Previous studies demonstrated ICA protrusion between 26%-30.3% cases[4-6] dehiscence between 4.8% - 23% cases[4-8].

In this study optic nerve protrusion were found in 26% (n=13) patients and dehiscence in 18% (n=9) patients. In prior studies optic nerve protrusion were demonstrated between 8%-38.2% and optic nerve dehiscence was found in 4% -24% cases[9-11]. If there is protrusion or dehiscence the chances of optic nerve injury is more. And if the surgeon damages the nerve within the sinus, the risk of blindness is high[12].

The protruded or dehiscence maxillary nerve is likely to be injured during functional endoscopic sinus surgery(FESS) and may give rise to neuralgia later. In our study maxillary nerve protrusion is seen in 24% (n=12) patients and dehiscence in 4% (n=2) patient which correlate well with study conducted by Unal Birsen et al[5].

The total cases with vidian nerve protrusion stands 18% (n=9) patients in our study. It correlates well with the study conducted by Lang and Keller et al [13]. Dehiscence of the vidian nerve are encountered in 20% cases in this study population. In literature percentage of dehiscences reported between 22%-37% [14,15].

The intersphenoid septum varies in number and point(s) of attachment on the sphenoid sinus wall. But it often inserts on the bony covering of the ICA. In previous studies the prevalence of inter sphenoid septum insertion into the bony covering of ICA in between 4.9%-89% [16,17].

The sphenoid sinus pneumatization pattern can be directly fed into computer workstation and used for navigation. It is important to assess variations of sphenoid sinus to decrease complications and to perform surgery accurately.

Conclusion

In our study we used CT scan with 1 mm section thickness. This resolution helped in better demonstration of complicated sphenoid sinus anatomy well.

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