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Original Research Article

Role of High Resolution Computed Tomography in the Evaluation of Anatomical Variations of Sphenoid Sinus and its Clinical Importance

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Abstract:

Background and Objectives: Coronal high resolution computed tomographic study has become the most requested and precise imaging technique to demonstrate paranasal sinuses. The advantage of coronal sections in HRCT is that it shows progressively deeper structures as encountered by the surgeon during functional endoscopic sinus surgery. Out of the entire paranasal sinuses, sphenoid sinus is generally the most inaccessible sinus to the surgeons. The trans-sphenoid route is considered to be the standard approach for surgery of pituitary adenomas. Knowing the details of the anatomy of sphenoid sinus and the extent of pneumatization can guide the surgeon through difficult corners of the approach. This work determines the incidence of the different anatomical variations of sphenoid sinus as detected by HRCT scan and their impact on related neurovascular structures for the safe removal of inter sphenoid and pituitary lesions.

Objectives: To demonstrate the anatomical variations of sphenoid sinus and related structures on High Resolution Computed Tomography (HRCT). To establish the relations of the sphenoid sinus variations to adjacent crucial anatomical structures.

Materials and Methods: The study data was collected from a total of 150 patients referred for High Resolution Computed Tomography (HRCT) of the paranasal sinuses to the Department of Radiodiagnosis of ESIC medical college and Hospital, Bihta over a period of 12 months. After obtaining a written informed consent and history, all the patients underwent HRCT axial section of paranasal sinuses (PNS).Once the axial sections were obtained through the paranasal sinuses, these images were reconstructed into coronal sections by multiplanar reconstruction (MPR) technique without exposing the patient.

Conclusion: Sphenoid sinuses are the most inaccessible paranasal sinuses and are surrounded by significant anatomical structures such as the orbit and its contents, cavernous sinus, internal carotid artery (ICA) and the anterior cranial fossa. High resolution computed tomography of sphenoid sinus for the demonstration of the anatomical variations and its relation to the vital adjacent crucial anatomical structures helps in reducing the complications during trans-sphenoidal surgeries and functional endoscopic sinus surgery.

Keywords: High Resolution Computed Tomography, Sphenoid Sinus, FESS.

Introduction

The sphenoid sinus is deeply seated in the skull and is the most inaccessible paranasal sinus. It is surrounded by vital structures such as the internal carotid artery, optic nerve and cavernous sinus [1]. Development wise, sphenoid sinus emerges in the fourth month as evagination from posterior nasal capsule into the sphenoid bone. Sinus will obtain the adult configuration by the age of 10 to 12 years [2]. The degree of pneumatization of sphenoid sinus varies & depending on that the sinus is classified as non-pneumatized, presellar and sellar [2]. As a result of extensive pneumatization of sphenoid sinus vital structures like internal carotid artery, optic nerve, vidian nerve and maxillary nerve can be protruded into the sinus with or without bony walls [2].

Coronal computed tomographic study has become the most requested and precise imaging technique to demonstrate paranasal sinuses [3]. The advantage of coronal sections is that it shows progressively deeper structures as encountered by the surgeon during functional endoscopic sinus surgery [4].

Out of all the paranasal sinuses, sphenoid sinus is the most inaccessible sinus to the surgeons [5]. The trans-sphenoid route is considered the standard approach for surgery of pituitary adenomas. Knowing the details of the anatomy of sphenoid sinus and the extent of pneumatization can guide the surgeon through difficult corners of theapproach [6]. The endoscopic transnasal approach to sphenoid sinus is a technique which hasestablished itself in the recent years and demands a thorough knowledge of the surgical anatomy and a huge amount of anatomical variations involving the sphenoid sinus [7]. In our study we intend to evaluate the anatomical variations of sphenoid sinus and its effect on the adjacent neurovascular structure. Functional endoscopic sinus surgery (FESS) needs detailed guiding anatomical map of the paranasal sinuses especially of the sphenoid sinus because of its critical location and large variations in its appearance.

Objectives: To establish the impact of the HRCT findings of variations in sphenoid sinus during functional endoscopic sinus surgery (FESS) for planning and to reduce the possible complications.

Materials and Methods

Hospital based cross sectional study. The study data was collected from a total of 150 patients referred for High Resolution Computed Tomography (HRCT) of the paranasal sinuses to the Department of Radiodiagnosis of ESIC medical college and hospital, Bihta, Patna, Bihar. over a period of 12 months. After obtaining a written informed consent and history, all the patients underwent HRCT axial section of paranasal sinuses (PNS).Once the axial sections were obtained through the paranasal sinuses, these images were reconstructed into coronal sections by multiplanar reconstruction (MPR) technique without exposing the patient.

Inclusion Criteria

Patients above 15 years of age who were referred for High resolution Computed Tomography (HRCT) of the paranasal sinuses to the Department of Radiodiagnosis of ESIC medical College and Hospital are included in this study.

Exclusion Criteria

- Patients younger than 15 years of age.
- Patients with prior surgery of paranasal sinuses (PNS).
- Patients with Sino nasal tumors and head & neck injuries.

We conducted a study based on anatomical variations of sphenoid sinus and its clinical importance in 150 patients who were referred to our Department of radiology for HRCT PNS.

Presence of air density around the vidian nerve and maxillary nerve in at least one coronal section was considered as protrusion of vidian nerve and maxillary nerve. Presence of more than half of the circumference of ICA in to the sinus cavity at any degree were considered as protrusion of ICA. Absence of visible bone density separating the sinus from the ICA, optic nerve, maxillary nerve and vidian nerve as dehiscence of bony wall.

Figure 1: Siemens 128 slice Somatom Definition ASMulti detector CT Machine

Results

During the period of one year of the study,150 patients who fulfilled inclusion criteriawere studied, out of which 72 were female and 78 were male. These patients were between the age group of 19- 69 years of age.

Table1: Percentage distribution of the sample according to gender

Sex	Count	Percent
Male	78	52.0
Female	72	48.0

Table 2: Pneumatization of anterior clinoid process.

Anterior clinoid process pneumatization	Count	Percent
Absent	114	76.0
Present	36	24.0

In our study, this variation was found in 36(24%)/150 patients and found bilaterally in 28/36 patients. Right sided pneumatization of anterior clinoid process were noted in 5 patients and left sided in 3 patients.19 male patients and 17 female patients had pneumatization of anterior clinoid process in our study.

Table 3: Side distribution of anterior clinoid process pneumatization

Anterior Clinoid Process Pneumatization	Count	Percent
Right	5	13.9
Left	3	8.3
Bilateral	28	77.8

Dehiscence of the bony wall of the maxillary nerve (canal) was seen in 10(6.7%) patients, of whom 5 (50%) were bilateral, 2 (20%) were right sided and 3 (30%) were left sided. This variation observed equally distributed (5 patients each) among both males and female patients in our study.

Table 4: Dehiscence of bony wall ofmaxillary nerve in percentage

Maxillary Nerve BonyWall Dehiscence	Count	Percent
Absent	140	93.3
Present	10	6.7

Table 5: Side distribution of maxillary nerve bony wall dehiscence in percentage

Maxillary Nerve Bony Wall Dehiscence	Count	Percent
Right	2	20.0
Left	3	30.0
Bilateral	5	50.0

Dehiscence of the bony wall of the vidian nerve (canal) was identified in 38(25.3%) patients, of whom 50 (19%), 11(28.9%) and 8 (21.1%) were bilateral, right sided and left sided respectively. This variation found equally distributed (19 patients each)among both males and female patients in our study.

Table 6: Percentage distribution of dehiscence of bony wall of vidian nerve

Vidian nerve bony wall dehiscence	Count	Percent
Absent	112	74.7
Present	38	25.3

Dehiscence of the bony wall on the internal carotid artery was seen in 6 patients (4%)of whom 3 (50%) were bilateral, 1(16.7%) were on the right and 2 (33.3%) were on the left. Dehiscence of the bony wall of the optic canal was observed in 6 (4%) patients, ofwhom 3 (50%) were bilateral, 2 (33.3%) were right sided and 1 (16.7%) were left sided. Dehiscence of the bony wall of the maxillary canal was seen in 10(6.7%) patients, ofwhom 5 (50%) were bilateral, 2 (20%) were right sided and 3 (30%) were left sided. Dehiscence of the bony wall of the vidian canal was identified in 38(25.3%) patients,of whom 50 (19%), 11(28.9%), and 8 (21.1%) were bilateral, right sided and left sided respectively.

Presence of septations in sphenoid sinus were found in 133 patients, of whom 77(57.4%) patients had single septations and 56 (42%) had multiple septations.67 patients were males and 66 females with septations of sphenoid sinus in our study. In addition to the analysis of the number of septa, special emphasis is placed to their insertion in relation to the carotid and optic canal. Attachment of sphenoid septations to optic canal were seen in 32(24%) cases and to carotid canal in 12 (9%) cases.

Table 7: Distribution of presence of sphenoid septations in percentage

Septations	Count	Percent
Absent	17	11.3
Present	133	88.7

Table 8: Type of sphenoid septations and attachment to optic canal and carotid canal

Type of Septations	Single	Muliple
Positive Cases (Out of 133 Cases)	77	56
	Optic Canal	Carotid Canal
Attachment	32	12

Table 9: Percentage distribution of attachment of septation to optic canal

Attachment to Optic Canal	Count	Percent
Absent	101	76
Present	32	24

Table 10: Percentage distribution of attachment of septation to carotid canal

Attachment to Carotid Canal	Count	Percent
Absent	121	91.0
Present	12	9.0

Discussion

A total of 150 patients who met the study inclusion criteria were included in the analysis of data and compared variations in the anatomical configuration of surrounding structures including protrusion or dehiscence of internal carotid artery, optic nerve, vidian nerve and maxillary nerve ; presence of pneumatization of pterygoid process, anterior clinoid process, greater wing of sphenoid ; presence of onodi cells; septations and its attachment to optic and carotid canal .

Pterygoid Process

Pterygoid process pneumatization is recognized if it extends beyond a horizontal plane crossing the vidian canal.

In our study, pneumatization of the pterygoid process was found in 76 patients (50.7%) of whom 54 (71.7%), 13 (17.1%) and 9 (11.8%) were bilateral, right sided and left sided respectively. There is no significant change in distribution of this pneumatization among males and female patients (37 cases among males and 39 among female patients). Without explaining their criterion, Bolger et al. [8] identified pterygoid process pneumatization in 43.6% of patients. This wide range of prevalence may be attributed to the use of different criteria. Presence of Pterygoid process pneumatization is an important pathway for access to the central skull base. For instance, extended trans nasal endoscopic approaches may reach the pterygoid process through the medial part of the posterior maxillary wall [9]. These techniques may provide a route for endoscopic repair of cerebrospinal fluid leaks and endoscopic biopsy of skull base lesions. Such information may be important in preoperative planning for skull base surgery. Pneumatization of pterygoid process thins the bony floor of the scaphoid fossa to as little as 0.2mm producing an intimate relation between the sinus and the auditory tube. Sirikci et al. [10] reported pneumatization of the pterygoid process in 29.3%. They recognized pterygoid process pneumatization if it extended beyond a plane tangential to the most infero-lateral aspect of the maxillary division of the trigeminal and vidian nerves. Dehiscence of the bony wall of the maxillary canal was seen in 10(6.7%) patients, of whom 5 (50%) were bilateral, 2 (20%) were right sided and 3 (30%) were left sided. Dehiscence of bony wall of maxillary nerve were observed equally distributed (5 patients each) among both males and female patients in our study. Birsen et al. encountered maxillary nerve protrusion in 30.3% and dehiscence in 3.5%. Sareenet al. [7] in their anatomical study found neither of the sinuses with protrusion nor dehiscence of maxillary nerve. The discrepancy between these prevalence rates may be due to different techniques or else it may reflect ethnic differences between the populations. In endoscopic sphenoid surgery, a protruded or dehiscent maxillary nerve is liable to iatrogenic injury. Furthermore, neuritis of a dehiscent maxillary nerve may result from sphenoid sinusitis and present as trigeminal neuralgia [11]. In our study, protruding vidian nerve into the sinus cavity was present in 62 (41.3%) patients of whom 45 (72.6%) were bilateral, 10 (16.1%) were on the right side and 7 (11.3%) were on the left side. Vidian nerve protrusion were observed equally distributed (31 patients each) among both male and female patients in our study. Dehiscence of the bony wall of the vidian canal was identified in 38(25.3%) patients, of whom 19 (50%), 11(28.9%) and 8 (21.1%) were bilateral, right sided and left sided respectively. This variation were found equally distributed (19 patients each) among both males and female patients in our study. Lang and Keller [12] reported that the vidian nerve was protruded into the sinus cavity in 18%. Pandolfo et al. [13] emphasized that there is a variable relationship between the vidian canal and the sphenoid sinus. They also suggested that the vidian nerve can cause a clinical syndrome characterized by pain referred deeply in the nasal cavity (vidian neuralgia). Anatomic relationship of the vidian canal to the sphenoid sinus cavity help in decreasing the complication of the endoscopic transsphenoidal and vidian neurectomy surgery. The septations of the sphenoid sinus were found to be variable. Usually one intersphenoid septum separates sphenoid sinus in to two parts, but multiple septations also not uncommon. In our study, presence of septations were present in 133(89.3%) patients of whom 77 (57.4%) patients had single septations and 56 (42%) had multiple septations. Out of 133 cases, 67 patients were males and 66 female patients with septations of sphenoid sinus in our study. Attachment of septation to carotid canal found in 12(9%) patients and to optic canal in 32(24%)

patients. Karpur et al. [14] found septation of sphenoid sinus and its clinical significance in a retrospective study of the CT analysis of the paranasal sinuses in 200 patients. They reported multiple septations in 32% of male patients and 22. 1% of female patients. Sareen et al7found multiple septations in 80% of cases and Abdullah et al15in 81.8% cases. The sphenoid septum is an important landmark during the endonasal endoscopic transsphenoidal approach to important structures such as the carotid artery, optic canal and skull base.

Conclusion

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. Pneumatization of sphenoid sinuses 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. Computed tomography of the sphenoid sinus has improved the visualisation of sphenoid sinus anatomy and has allowed greater accuracy in evaluating sphenoid sinus and adjacent neuro-vascular structures. CT helps in the evaluation of anatomical variations which is not possible with other imaging modalities.

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