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Original Research Article

Anatomical variations of intra-sphenoid sinus septations in a sample of Kashmiri population: a non-contrast computed tomography study

Abdul Haseeb Wani[1], Yassar Shiekh[2]*, Arshed Hussain Parry[1], Zahid Qayoom[1]

[1]Department of Radiodiagnosis, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, Jammu and Kashmir, India
[2]Department of Radiodiagnosis, Government Medical College Srinagar, Jammu and Kashmir, India

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***Correspondence:**
Dr. Yassar Shiekh,
E-mail: dr.yassarsheikh@gmail.com

ABSTRACT

Background: The sphenoid sinus shows multitude of variations in pneumatization, size and pattern of septations leading to differences in its segmentation. Pre-operative knowledge of their attachment especially to posterolateral bony walls covering vital structures is of utmost importance for a safe trans-sphenoidal approach for various surgical procedures involving skull base. Non-contrast computed tomography (NCCT) with its ability to provide multiplanar reformations (MPR) with sharp algorithms is now a reference standard for visualization of these intra-sphenoid sinus septations preoperatively. The objective of this study was to determine the number and attachment of intra-sphenoid sinus septations in a Kashmiri population sample.
Methods: NCCT head images of 591 patients in the age range of 16 to 75 years were analyzed retrospectively. Individuals with age less than 16 years, previous surgery involving skull base/sphenoid sinus, trauma causing hem sinus/fractures around skull base or having space occupying lesions around skull base/sphenoid sinus were excluded from the study. On the CT workstation multi-planar coronal, sagittal and axial reconstructions were performed and subsequently examined.
Results: The age range was 16 to 75 years with mean age of 43.56 years of which 453 (76.6%) were males and 138 (23.4%) were females. Single intra-sphenoid septation was the most common anatomic variant in present study (79.7%) being complete in 71.7% and partial or incomplete in 8% of the examined subjects. Double septa were found in 11% inpresent study and more than 2 septae in 3.4%. After sellar attachment (51%) the next most common site of attachment was to the carotid canal (29.5%) (23% to left ICA and 6.5% to the right ICA).
Conclusions: Intricate knowledge about sphenoid sinus, its pneumatization and anatomical variations in intra-sphenoid sinus septations and its relationship with the surrounding vital structures is of utmost importance before performing any endoscopic/open surgery involving skull base via trans-sphenoidal approach. The present study shows that a significant percentage of septal attachment to the carotid canal makes main sphenoidal septum as not so reliable landmark for endoscopic procedures as used to be in the pre-imaging era. Thus, preoperative CT is mandatory to avoid injuries to para-sellar neurovascular and glandular structures.

Keywords: Computed tomography, Intra sphenoid sinus, Intra-sphenoid sinus septation, Multi-planar reformation, Para-sellar, Trans-nasal trans-sphenoid surgery

INTRODUCTION

Nestled between various vital structures at the skull base, sphenoid sinus makes its first appearance in the third month of foetal life as an evagination from the spheno-ethmoidal recess. The progression of sphenoid sinus pneumatization seen as a small/potential cavity at birth starts at the age of 4 years, reaches the sellar floor by

seven and attains adult volumes by 12 to 15 years of age in the majority of population.[1-4] The sphenoid sinus shows multitude of variations in pneumatization, size and pattern of septations leading to differences in its segmentation.[5,6] Intra-sphenoid sinus septations which can be absent, single or multiple, complete or incomplete, thin or thick divide the sphenoid sinus into two or more compartments.[7,8] These septations are often deviated to either side attaching to the bony wall covering various vital structures.[9] Preoperative knowledge of their attachment especially to posterolateral bony walls covering vital structures is of utmost importance for a safe trans-sphenoidal approach for various surgical procedures involving skull base.[10] Non-contrast computed tomography (NCCT) with its ability to provide multiplanar reformations (MPR) with sharp algorithms is now a reference standard for visualization of these intra-sphenoid sinus septations preoperatively.

Ethnic variations being very common in the prevalence of these septations, authors undertook this study to investigate these variations in Kashmiri population.

METHODS

This was a retrospective study where authors analyzed the NCCT head images of 591 patients done in their accident and emergency CT section for various indications between January 2018 to January 2019.

Individuals in the age range of 16 to 75 years were included in the study. Individuals with age less than 16 years, previous surgery involving skull base/sphenoid sinus, trauma causing hemosinus/ fractures around skull base or having space occupying lesions around skull base/sphenoid sinus were excluded from the study. On the CT workstation after retrieval of data from picture archiving and communication system (PACS) multi-planar coronal, sagittal and axial reconstructions were performed. Reconstruction parameters were slice thickness 1.5 mm, recon increment 1.3 mm, field of view (FOV) 223 x 223 mm, window: osteo and kernel as H70 s sharp FR (head 70 smooth sharp fast reconstruction). Analysis of CT images was done on a picture (PACS) workstation monitor by an experienced radiologist. Sphenoid sinus was examined for number of compartments depending on absence or presence/number of septations and the place of attachment of these septations to the bony wall of sphenoid sinus.

Statistical analysis

The data was analyzed using statistical software's SPSS v 20 and STATA v 11.

Categorical variables were described in terms of frequency and percentage and the continuous variables in terms of descriptive statistics like mean, standard deviation, minimum, maximum and range. The p value of <0.05 indicated a significant statistical difference in chi-square test.

RESULTS

A total of 591 head NCCTs were evaluated retrospectively. The age range was 16 to 70 years with mean age of 43.56 years of which 453 (76.6%) were males and 138 (23.4%) were females. There was no significant statistical difference in the number and attachment of these septations to bony wall between male and female subjects.

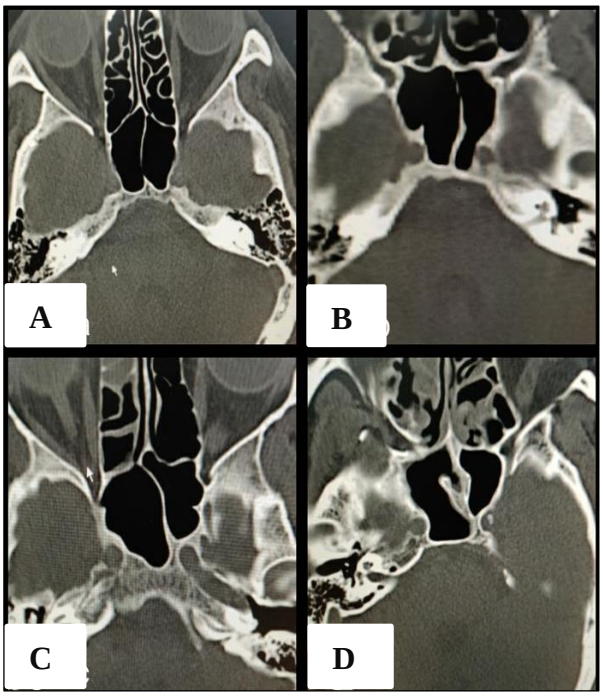

Figure 1: Axial NCCT images showing single complete intra- sphenoid septation attaching to the posterior wall in the Midline (A): in left paramedian position (B): to the left carotid canal (C): to the left postero-lateral corner with septation being thick and (D): branched.

The commonest pattern of intra-sphenoid sinus septation was presence of a single and complete septation (71.7%) (Figure 1), followed by presence of single and incomplete septation (8%). Double and complete septation was seen in 4.1% subjects (Figure 2).

Absent intra-sphenoid sinus septation was seen in 5.9% (Figure 3).

The number of sphenoid sinus septations (presence/absence, main as well as accessory) and their prevalence is summarized in (Table 1).

The attachment of intra-sphenoid sinus septation is named after the underlying structure to which the posterior end of the septation is attached.

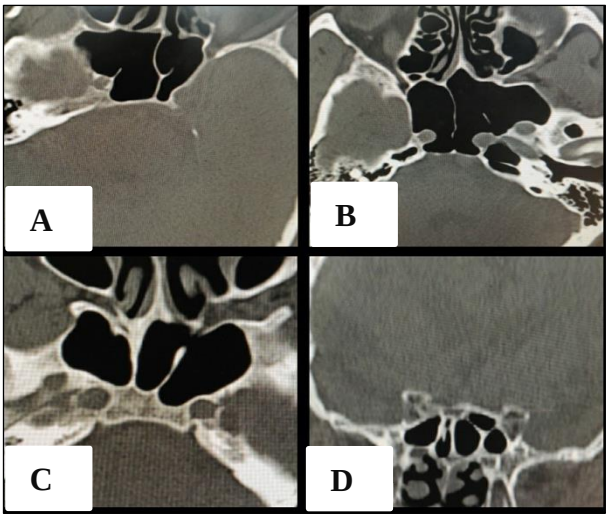

Figure 2: Axial NCCT images showing double septae with complete one attaching to posterior wall in left paramedian position and incomplete one to right carotid canal (A): and to the posterior wall in midline and to left carotid canal (B): Axial NCC image showing double and complete septations attaching to the posterior wall (C): and coronal image (D): multiple septations.

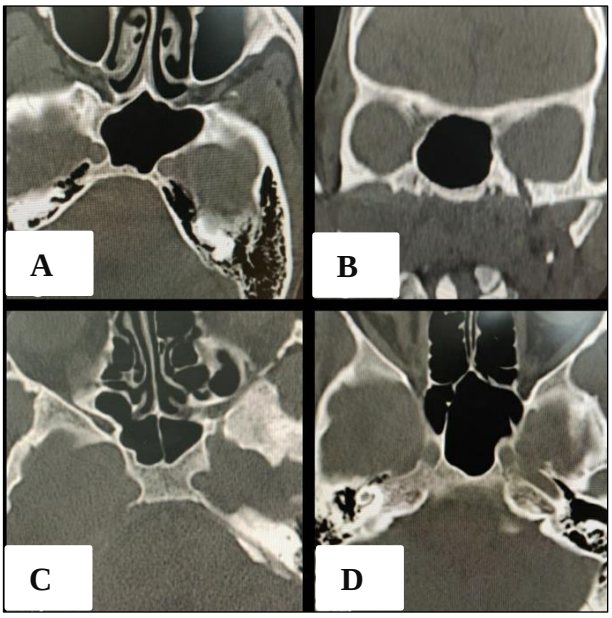

Figure 3: Axial (A) and coronal (B) Non-contrast computed tomography (NCCT) images showing absences of any septations in the sphenoid sinus. Single midline septations (C) and double septations attached to right and left carotid canal (D).

The most common pattern of attachment of intra-sphenoid sinus septation is sellar type followed by left ICA type with attachment to optic canal and lateral wall being the least common (Figure 4).

The various types of attachment of the sphenoid sinus septa to the bony wall (named as per the underlying various vital structures) of sphenoid sinus and their prevalence is summarized in (Table 2).

Table 1: Number of sphenoid sinus septations and their percentage.

Number of sphenoid sinus septation	Number of individuals (N = 591) n (%)
Absent	35 (5.9)
Single and complete	424 (71.7)
Single and incomplete	47 (8.0)
Double and complete	24 (4.1)
Double septa (one complete and the other one incomplete)	41 (6.9)
More than two septa (one main and others accessory)	20 (3.4)

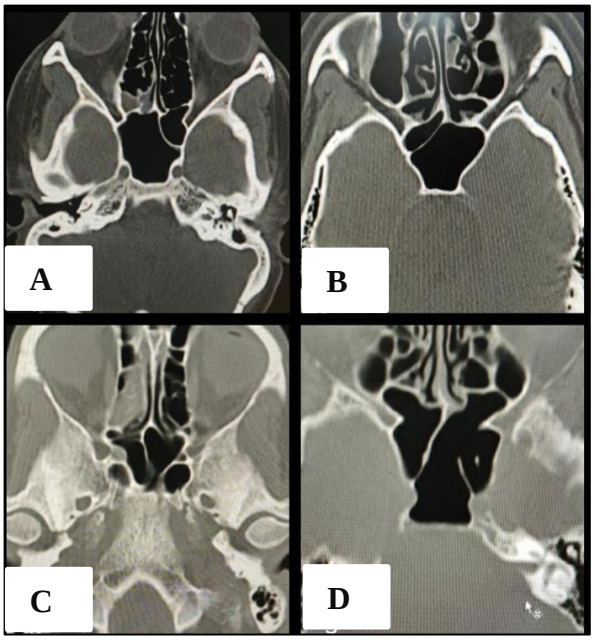

Figure 4: Axial NCCT images showing single septations attaching posteriorly to the left (A): and right (B): lateral sphenoid sinus walls, (C): Double septations with one of the septations attaching to the left optic canal, (D) to bilateral carotid canals.

Table 2: Type of attachment of septations to sphenoid sinus wall and their percentage.

Type of attachment to the wall of sphenoid sinus	(N = 556) n (%)
Left internal carotid artery (ICA)	128 (23.0)
Right ICA	36 (6.5)
Posterior wall (sellar)	284 (51.0)
Lateral wall	23 (4.1)
Posterior wall and left ICA	45 (8.1)
Posterior wall and right ICA	21 (3.8)
Lateral wall and carotids	17 (3.1)
Optic nerve	2 (0.4)

DISCUSSION

Intricate knowledge about sphenoid sinus, its pneumatization and anatomical variations in intra-sphenoid sinus septations and its relationship with the surrounding vital structures like ICA, pituitary gland, optic nerve and cavernous sinus is of utmost importance before performing any endoscopic/open surgery involving skull base via trans-sphenoidal approach. Overlooking these septal variations preoperatively can increase the risk of injuring surrounding neurovascular and other vital para-sellar structures as well as unnecessarily increase the procedure time.[10,11]

NCCT with its multiplanar reformation ability and isotropic resolution is now the reference standard to obtain necessary information about the para-sellar region preoperatively. Authors found no gender variation in the number or attachment of sphenoid sinus septations in present study. Single intra-sphenoid septation was the most common anatomic variant in present study (79.7%) being complete in 71.7% and partial or incomplete in 8%of the examined subjects. Absent septation was seen in 5.9%. The single septa attached to the posterior wall (sellar) in 51% of the cases with left paramedian being the most common site of attachment. Banna M et al, Hamid O et al and Idowu OE et al, also reported single septation as the most common anatomic variation in their study.[7,8,12]

However, Idowu et al, reported the septum towards right side in most cases.[12] World literature shows great variation in the prevalence of more than one intra-sphenoid sinus septations from as high as 95% to as low as 7.1%.[8,9,12-15] Double septa were found in 11% in present study and more than 2 septa in 3.4%. The attributable factor for these variations seems to be small sample size in majority of these studies. Insertion of these multiple septa to the walls of sphenoid sinus is crucial for trans-sphenoidal surgery.[16-19] After sellar attachment, the next most common site of attachment was to the internal carotid artery (29.5%) in present study (23% to left ICA and 6.5% to the right ICA). Double septations attached most commonly to the posterior wall and to either of ICA (11.9%).

Other rare sites of attachment in present study were lateral wall, combined lateral wall and ICA and optic nerve. Bademci G et al, reported septal insertion to either of the carotid canal in 25.5% cases, however Abdullah BJ et al, reports carotid canal attachment in 12.9% cases, and Hamid O et al, in 6.75% cases.[20,8]

Present study shows that a significant percentage of septal attachment to the carotid canal makes main sphenoidal septum as not so reliable landmark for endoscopic procedures as used to be in the pre-imaging era. The anterior attachment can be deceptive during surgery as its posterior attachment is not always in the midline but can be to either of the carotid canals with potentially catastrophic implications to the operating surgeon. Thus, preoperative CT is mandatory to avoid injuries to para-sellar neurovascular and glandular structures.

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