Septation of the Sphenoid Sinus and its Clinical Significance

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Abstract

Introduction: Sphenoid sinus is located in the body of sphenoid, closed with a thin plate of bone tissue that separates it from the important structures such as the optic nerve, optic chiasm, cavernous sinus, pituitary gland, and internal carotid artery. It is divided by one or more vertical septa that are often asymmetric. Because of its location and the relationships with important neurovascular and glandular structures, sphenoid sinus represents a great diagnostic and therapeutic challenge.

Aim: The aim of this study was to assess the septation of the sphenoid sinus and relationship between the number and position of septa and internal carotid artery in the adult BH population.

Participants and Methods: A retrospective study of the CT analysis of the paranasal sinuses in 200 patients (104 male, 96 female) were performed using Siemens Somatom Art with the following parameters: 130 mAs: 120 kV, Slice: 3 mm. For the coronal scan, patients were placed in supine position with their chin hyper extended and scan plane angled such that it was as perpendicular to the hard palate. Scanning was completed from the anterior frontal sinus to the sphenoid sinus. Axial scans were performed from the maxillary sinus floor to the level of the frontal sinus roof, in a plane parallel with the hard palate. Since the aim of this study was to evaluate anatomical variations of sphenoid sinus septation, only patients with no diseases within sphenoid sinus were included.

Results: Based on analysis of CT scans of patients we come to the conclusion of existence more than 1 sphenoid septum in 32% of male patients and 22.1% of female patients. In total,

tying for the septum to the carotid canal at posterolateral wall of sinus was registered in 19.4% of male, and 16.8% female patients.

Conclusion: Performing CT of paranasal sinuses before surgery is essential to avoid potential complications resulting from anatomical variations.

Keywords: sphenoid sinus, septation, computed tomography

Introduction

Sphenoid sinus is located in the body of sphenoid bone, closed with a thin plate of bone tissue that separates it from the surrounding important structures such as the optic nerve, optic chiasm, cavernous sinus, pituitary gland, and internal carotid artery. It is divided by one or more vertical septa that are often asymmetric. Because of its location and the previously mentioned relationships with important neurovascular and glandular structures, sphenoid sinus represents a great diagnostic and therapeutic challenge.[1] Knowing and visualization of these relationships, and possibly present variations in this area is the key to successful surgical approach to these elements, as well as appropriate functional endoscopic procedures.[2] To perform high quality and safe functional endoscopic sinus surgery for the removal of pathological tissue changes, preoperative preparation and adequate diagnosis (primarily computed tomography and magnetic resonance imaging) is essential.[3]

CT is becoming the gold standard in the preoperative evaluation of patients with planned surgical removal of pituitary tumors by transsphenoidal approach.[4,5] Today over 95% of pituitary tumors are removed in this way. Natural free spaces of the nasal cavity and sphenoid sinus are used to access the center of the base of the skull, in sella turcica, and then in the wider perisellar region with minimal surgical trauma. It is important to note, that in this micro neurosurgical intervention, both holes of sphenoid sinus must be show and after that frontal wall of the sinus along with rostrum is being resected. Sinus septum, which is often located lateral of sagittal plane and the sphenoid sinus mucosa, is being removed. After a good preparation and inspection, sphenoid sinus as well as bottom of sella turcica is being shown and after their detailed inspection it approaches opening of sella turcica by microsurgical instruments. Various modifications and expanded transsphenoidal approach allow removal of tumors that grow beyond the sella turcica and suprasellar region. Approach can be extended superiorly for resection of suprasellar lesion, inferiorly for resection of the clivus lesion and laterally for the cavernous sinus lesions.[6]

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.[6,7] Although there are several reports about the sphenoid sinus, none has been carried out in our country. Due to the large anatomical variations of the sphenoid sinus, it is crucial to know in detail about its septation in order to safely perform the endoscopic approaches, and even more so in an environment where intra-operative neuronavigation is absent.[8]

The objecive of this study was to access the septation of the sphenoid sinuses, as well as the relationship between these septa and bony wall cover of internal carotid artery in adult BH population.

Participants and methods

A retrospective study was done on 200 patients at Clinical Centre University of Sarajevo. There were 104 males and 96 females, with an age range of 20 to 74 years (males, 48.6 ± 14.7 yrs; females, 49.9±17.9 yrs). The study excluded patients younger than 16 years, and patients who have had sinus operations, patients with head and neck trauma, and patients with tumors and polyps of the nasal cavity and paranasal sinuses.

CT images were made on the CT scanner SOMATOM ART SIEMENS (130 kV, 120 mAs), 3 mm thickness and an image matrix 512X512. Scans were done in both axial and coronal plane, with identical fields of view. For the coronal scan, patients were placed in supine position with their chin hyper extended and scan plane angled such that it was as perpendicular to the hard palate. Scanning was completed from the anterior frontal sinus to the sphenoid sinus. Axial scans were performed from the maxillary sinus floor to the level of the frontal sinus roof, in a plane parallel with the hard palate. Images were reviewed on the console with varying window levels and widths. The sphenoid sinuses were reviewed in both axial and coronal planes, and the total number of septa were counted (main and accessory) and compared in both planes. The data were processed by computer software's DICOM WORKS 1.3.5. (Digital Imaging and Communication in Medicine) SANTE DICOM VIEWER and OZIRIS 4.

Results

By analysis of CT images of patients of the Clinic of Radiology of Clinical Centre University of Sarajevo it is found that only 2 (2%) had no septum within the sphenoid sinus, one male and one female. Other respondents (98%) possessed the so-called intersphenoid septum.

Only one so-called intersphenoid or how we also defined it the main septum had 70 (68%) men. By analysis of axial CT images of male respondents was found that the main septum exists in 87 (84.5%) (from the 103 men with the existence of one or more septa) had not been placed in the median line, at its posterior point, but paramedially, on the left or right side. Of the 87 analyzed images of men, the right-set intersphenoid septum had 56 (64.4%), and left-set 31 (35.6%).

From the 103 male patients who had verified existence of intersphenoid septum, 20 of them (19.4%) had one more so-called accessory septa, a total of two in one sphenoid sinus. Of the 20 people who had registered the existence of accessory septum, in 13 cases, accessory septum was located to the right of the so-called main septum, and in 7 cases left of it.

Presence of 3 septa (1 main, 2 accessory) in male patients was found in 8 (7.8%) patients. In 5 cases one septum was located to the right and left of the so-called main intersphenoid septum, in 2 cases each additional septum was to the right from the main one, and in one case left from the main septum.

The existence of sphenoid sinuses with 4 septa (1 main and 3 accessory) was registered in 5 (4.8%) male patients. Schedule was as follows: in 3 cases - 2 right, 1 left from the so-called main septum, in 1 case-2 left, 1 right of the main septum (Figure 1), and in 1 case all 3 accessory septa were located to the right of the main septum.

Based on analysis of CT scans of male patients we come to the conclusion of existence more than 1 sphenoid septum in the sinus in 33 cases (32%). All the above data refer to the sample of 103 male individuals, since in one case it had not been registerated existence of a septum.

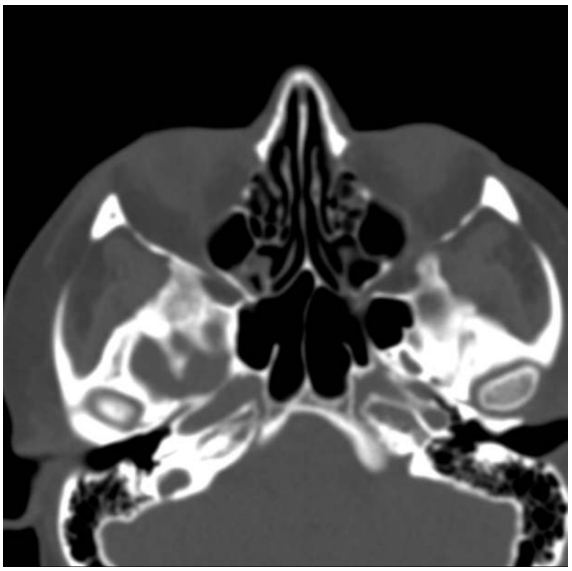
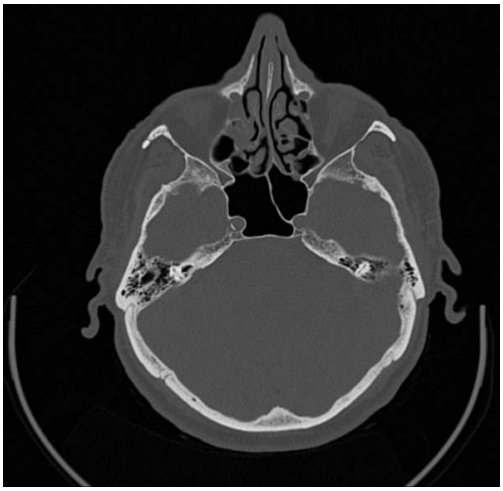


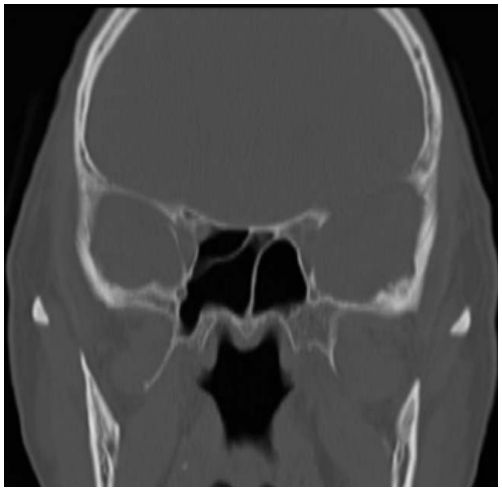
Figure 1: Axial CT head scan of male patient (38 year-old)
Visible existence of multiple septa in the sphenoid sinus

In addition to the analysis of the number of septa, in this paper special emphasis is placed to their insertion, primarily in relation to the carotid canal on posterolateral wall of sphenoid sinus. In men with the existence of one septum it is established it's insertion in the projection of the carotid canal, one on the right and one on the left. From 20 men with the existence of an accessory septa, it's insertion in the carotid canal was visualized in 10 cases, 6 left and 4 right (Figures 2 and 3). In cases of two accessory septa (8 men), it has been noted their starting point in the projection of the carotid canal in 5 patients, 3 right, 2 left. In men with 3 accessory septa it has been registered their association with carotid canal in all cases, 3 right and 2 left. In total, tying for the septum to the carotid canal at posterolateral wall of sphenoid sinus was registered in 22 men or (19.4%) of cases.

Table 1: Distribution of main and accessory septa towards carotid canal in male patients

Number of septa (main+accessory)	Carotid canal	
	Right	Left
1	1	1
2	4	6
3	3	2
4	3	2
Total	11	11





Figures 2 and 3: Axial and coronal CT head scan of male patient (48 year-old). Visible existence of 2 septa at coronal scan, one inserts at carotid canal that is also visualised at axial scan as well.

By analysis of CT images in women, it was established, as well as in men, lack of septum in one case. Only one so-called intersphenoid or how we also define it as the main septum had 74 (77.9%) women. Out of 95 females with intersphenoid septum in 75 (78.8%), the septum was located paramedially and in 56 (74.7%) cases in the right and in 19 cases (25.3%) to the left from of the median line.

One accessory septum was registered in 14 women (14.8%), in 9 cases to right and 5 cases to the left from the main septum. The existence of three septa (1 main and 2 accessory) was visualized in 5 cases with the following distribution: in 3 cases, accessory septum was placed to the right and left from the main septum and in 2 cases to the right from the main septum.

The existences of three accessory septa was found in 2 cases, and in one patient 2 accessory septa were located to the right and in one to the left from the main septum, while in other patients three accessory septa were located to the left of the main septum. Based on analysis of CT images we come to the conclusion about existing more then one septum in sphenoid sinus in 21 patients, or 22.1%. In cases of existing three accessory septa in male and female,

sphenoid sinuses were hiperpneumatiziated towards greater wings and pterygoid process. We also observed transversal septum in projection of the optic canal with consecutive formation of Onodi cell, which will be the subject of future studies (Figure 4).

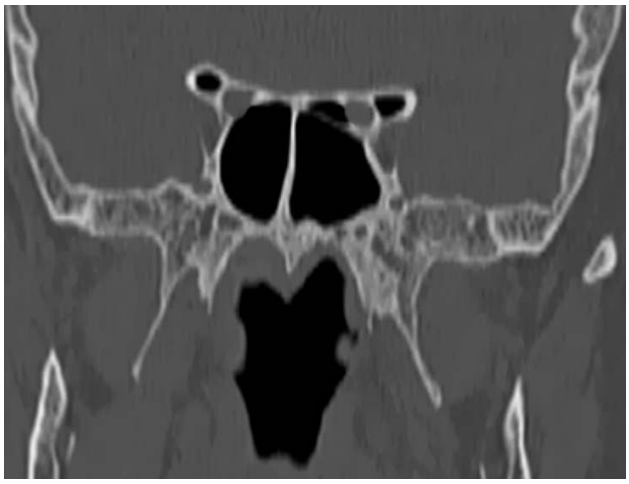


Figure 4: Coronal CT head scan of male patient (52 year-old). It is percepted transversal septum in projection of left optic canal as well as pneumatization of anterior clinoid processes

Insertion of septum to the posterolateral wall of sphenoid sinus in projection of carotid canal was registrated in 16 female patients (16.8%). Results are shown in table 2.

Table 2: Distribution of main and accessory septa towards carotid canal in female patients

Number of septa (main+accessory)	Carotid canal	
	Right	Left
1	1	1
2	5	3
3	4	
4	1	1
Total	11	5

Discussion

Functional endoscopic sinus surgery (FESS) has gained wide popularity in the treatment of benign, chronic inflammatory disease of the paranasal sinuses. In recent years, endoscopes have been used to perform surgery beyond the boundaries of the paranasal sinuses.[9] Diagnosis and treatment of cerebrospinal fluid fistulas, identification and cauterization of posterior epistaxis, transnasal decompression of disthyroid orbitopathy and intranasal laser surgery have all been performed with transnasal endoscopic techniques. Also, lesions at the base of skull

base can be accessed endoscopically, especially lesions in the region of sella turcica. This approach avoids retraction of the brain along with excellent visualization of the pituitary gland and surrounding structures. Endoscopic approaches reduce morbidity and mortality in comparisons to the transcranial approaches.

Knowledge of anatomical variations of sphenoid sinus in the broadest sense of the word, as well as knowledge of his relationship with the surrounding structures like optic nerve, internal carotid artery, cavernous sinus and pituitary gland using computed tomography devices is paramount in preoperative analysis, whether is endoscopic surgery on sinus or sellar microsurgical transsphenoidal approach or parasellar area; shortens the operation, reduces the number of complications during and after surgery. Also, good knowledge of anatomical variations of sphenoid sinus contributes to a better understanding of the possible spread of any tumor or any inflammatory process in the sphenoid sinus and surrounding structures and influences the choice and duration of therapeutic procedures.[10,11]

Higher number of anatomical variations of sphenoid sinus can lead to increased risk in terms of injury of important neurovascular and glandular structures. Extensive hiperpneumatization of sphenoid sinus with consecutive pneumatization of ethmoid sinus can lead to injury of the optic nerve.[12] Protrusion of internal carotid artery into the lumen of the sinuses can also lead to its injury during endoscopic surgical procedures, especially in cases of variation in positions, numbers and insertions within the sinus septum.[13]

Usually there is one intersphenoid septum which separates cavity of sphenoid sinus into two parts. Analysis of CT images revealed that only two patients (one male and one female) have no main septum within sphenoid sinus. Chmielik et al.[14] in their study in children, average age of 10.9 years, cited the existence of the main septum in all cases, Idowu constants lack of septum in only one case of 60 analyzed patients, while Hamid et al.[15] register septal deficiency in 10.8% of cases. In our study, only one septum had 68% men and 77.9% of women. Analysis of other studies revealed existence of single septum in the range of 33% to 95%.[8] The position of main septum analyzed at axial CT images, in majority of cases was not in the median line (84.5% males and 78.8% in women), but was located paramedian, with greater frequency at right side.

The existence of more than one septum (multiple septa) was registered in 32% of male and 22.1%, of female which differs significantly from the results of studies that were available to us. So Sareen et al.[16] cited the existence of multiple septa in 80% of cases, Idowu at al in 48.3% [8] and Abdullah et al.[11] in 81.8%. A higher percentage of multiple septa are registries in the study of Jaworeka et al.[17], while Hamid et al.[15] cited the existence of 10.8% multiple septa. It was percepted that multiple accessory septa appear more frequently to the right of the main septum both in men and women. In men, 35 accessory septa were located to the right and 19 left of the main septum. In women, this ratio was 18 to the right, 12 to the left of the main septum.

But regardless of the existence of different percentages of multiple septa, all authors agree that it is crucial insertion of these septa to walls of sphenoid sinus. In this study we've emphasized insertion in the projection of the carotid canal at posterolateral sinus wall. We found insertion of main or accessory septa to carotid canal in 38 cases which makes 19% of patients. From

this number, tying the carotid canal in men occurred in 22 cases, and women in 16 cases. Bademci and Ünal[18] evidenced septal insertion to carotid canal in 25.5% cases (without specifying the side and sex); Abdullah cites their presence in 12.9% cases, and Hamid in 6.75% cases. Of the 22 male patients, 11 accessory septa inserts to the bony wall of the carotid canal on the right, and 11 on the left side. In females, in 11 cases insertion in the projection of the carotid canal was on the right, in 5 cases on the left. Filho et al[19] cited a higher frequency of insertions of accessory or main septum in the carotid canal in men than women (25% : 7.1%) which is consistent with the results of our study, while Abdullah states that it doesn't exist statistical significance with respect to gender of patients.

The main septum can not be taken as a reliable landmark for endoscopic procedures.[9,15] Its position, as we saw in our study, is not always in the median line, but shifted to the right or the left side. Besides, the medial-placed septum not necessarily follows the entire length of the medial line, but on its front or rear end howled laterally, when analyzing the axial images. Also, great attention must be paid to the insertion of the main and accessory septa, both in the optic canal, and the area of the carotid canal were one of the goals of our study. During transeptal sphenoidectomy it must be taken of the septum manipulation, especially if preoperative CT diagnosis taken into consideration it's insertion to the walls of the carotid or optic canal.[20] Otherwise we risk damaging these structures.

Because of the foregoing reasons, the preoperative radiological evaluation using CT has to play a major role in patients with indicated endoscopic surgical procedures in the sinuses or the sellar region. By CT scans we detect variations that increase the risk of intraoperative or postoperative complications.

Conclusion

The sphenoid sinus septa are highly variable. Computed tomography is the method of choice in the detection and evaluation of anatomy of the sphenoid sinus, especially for sinus anatomical variations as well as of sinus diseases. This knowledge will provide an accurate assessment of the normal variants and pathological changes required for successful FESS.

Conflict of Interest: None declared.

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