

ASSESSMENT OF THE ANATOMICAL VARIATIONS IN THE PARANASAL SINUSES WITH CT

Original Article

PARANAZAL SİNÜSLERDEKİ ANATOMİK VARYASYONLARIN BT İLE DEĞERLENDİRİLMESİ

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ABSTRACT

INTRODUCTION

The presence of anatomic variations of paranasal sinuses must be noted in order to attain a full understanding and accurate diagnosis of chronic sinusitis. The aim of this study was to detect anatomical variations of the paranasal sinuses and their vicinity by using CT and, to investigate their correlation with paranasal sinus infections.

MATERIALS AND METHODS

High resolution multidetector CT of paranasal sinuses were acquired with a 64 detector CT system. The examinations of 170 patients with rhinosinusitis and 144 controls were reviewed. Anatomical variations of the both groups were assessed.

RESULTS

The anatomical variants detected in order of frequency were septal deviation (%60), aerated Ager nasi cells (%60), aeration of middle turbinates (%38), and septal spur (%30). Only septal deviation was associated with sinusitis significantly ($p < 0.005$).

CONCLUSION

Among many anatomical variations, septal deviation and aerated Ager nasi cells were the most commonly encountered in the paranasal CT examinations and only septal deviation was associated with sinusitis significantly.

Key words: Paranasal sinus; Anatomical variation; Chronic rhinosinusitis.

GİRİŞ

Kronik sinüzitlerin doğru tanısını tam olarak koyabilmek için paranazal sinüslerin anatomik varyasyonları dikkate alınmalıdır. Bu çalışmanın amacı paranazal sinüs anatomik varyasyonlarının

bilgisayarlı tomografi (BT) ile saptanması ve sinüzit ile ilişkilerinin değerlendirilmesidir.

MATERYAL VE METODLAR

Altmışdört dedektörlü BT cihazı ile paranasal sinüslerin yüksek rezolüsyonlu BT görüntüleri elde edildi. 170 sinüzitli hasta ve 144 olguluk kontrol grubunun BT görüntüleri incelendi. Her iki grubun anatomik varyasyonları değerlendirildi.

BULGULAR

Belirlenen anatomik varyasyonlar sıklık sırasına göre septal deviasyon (%60), pnömatize Ager nazi hücreleri (%60), pnömatize orta konka (%38), ve septal spur'dan oluşmaktaydı (%30). Sadece septal deviasyon sinüzit ile ilişkili bulundu ($p < 0.005$).

SONUÇ

Paranasal sinüs BT incelemelerinde saptanan bir çok varyasyon arasında en sık saptananlar septal deviasyon ve pnömatize Ager nazi hücreleri olup, sadece septal deviasyon grubunda sinüzit ile ilişki bulundu.

Anahtar Kelimeler: *Paranasal sinüs; anatomik varyasyon; kronik rinosinüzit.*

INTRODUCTION

Functional endoscopic sinus surgery (FESS) has gained widespread acceptance among otolaryngologists in recent years. One of the prerequisites for FESS is knowledge of the complex anatomy of the paranasal sinuses. The anatomy of the paranasal sinuses is variable and it is important to appreciate the clinical and surgical significance of these variations (1,2).

Preoperative planning for FESS requires high resolution computed tomography (CT) to provide detailed maps, which are used for navigation and the visualization of the anatomical variants that result in

sinus disease (3,4). CT is the most precise imaging technique to demonstrate paranasal sinuses. CT screening of paranasal sinuses has the advantages of showing bony details (using wide window settings) and good soft tissue outlines (using narrow window setting) with multiplanar views (5-7).

The purpose of this study was to assess the frequency of anatomic variations of nasal cavity using CT and, to investigate their correlation with paranasal sinus infections.

MATERIALS AND METHODS

The study comprised 314 CT scans of the paranasal sinus region, in patients suspected of inflammatory sinus pathology, attending Department of Radiology, between December 2009 and February 2011. Of the patients, 163 were male and 151 female, age ranged between 16 and 73 years (mean 32.6 year). CT images were acquired with a 64 detector Philips Brilliance system (Philips Healthcare, Best, the Netherlands) in the supine position, in three planes. The imaging parameters were as follows: voltage, 120 kV; current, 200 mA; matrix, 512x512; and section thickness, 2 mm. These images were reconstructed by using a bone algorithm. Reformations were performed from the superior wall of the frontal sinus to the inferior wall of the maxillary sinus on the axial plane, from the anterior wall of the frontal sinus to the posterior wall of the sphenoid sinus on the coronal plane, and from the lateral walls of maxillary sinuses bilaterally on the sagittal plane.

Exclusion criterias were prior sinus surgery, sinonasal tumors, nasal polyposis, or head or neck injury. In all cases, the existence of the following variants was investigated : *nasal septum*: septal deviation, septal bony spur; *middle nasal concha*: concha bullosa (**Figure-1**).



Figure-1: Coronal CT scan shows bulbous pneumatization of right middle turbinate (CB: concha bullosa), variant ending of left uncinete process (small arrows) at the left lamina papyracea, also nasal septum is deviated to the left side.

paradoxical middle concha; uncinete process (**Figure-2,3**):



Figure-2: Coronal CT scan shows pneumatization of the middle turbinates which in turn bulbous on the right (CB: concha bullosa) and lamellar on the left side, variant ending of left uncinete process (small arrows) at the level of lamina cribrosa, also nasal septum is deviated to the left side.

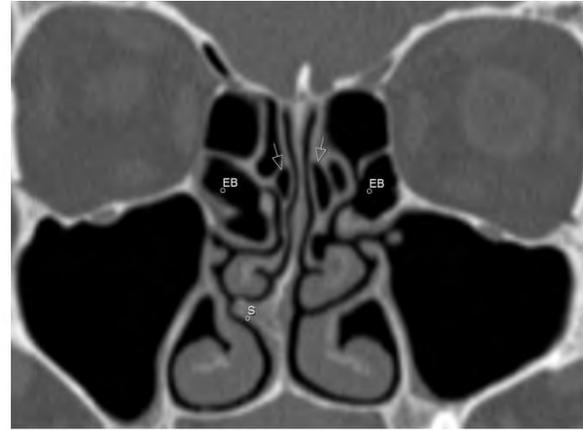


Figure-3: Coronal CT scan reveals lamellar pneumatization (small arrows: pneumatized vertical portions), along with paradoxical appearance of the middle turbinates, uncinete processes are medially deviated, outflow of both maxillary sinuses are obstructed by large ethmoid bullae (EB), conchae are hypertrophic and there is a right sided bony spur (S) extending to right middle meatus.

deviation of the upper edge, pneumatization; ethmoid air cells: agger nasi cells, Haller cells, great ethmoid bulla, Onodi cells (extramural sphenoid cells); other variants (**Figure-4,5**):

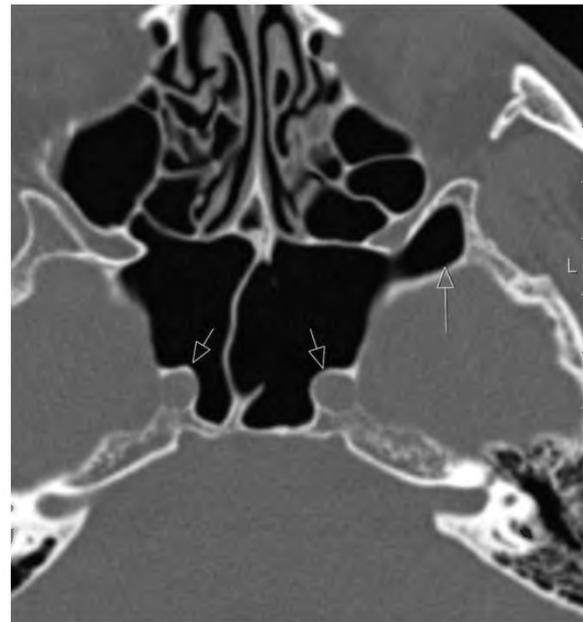


Figure-4: Axial CT scan shows pneumatization of the left pterygoid recess of the sphenoid sinus (long arrow). Also posteriorly, both of the carotid canals are protruded into the sinus (short arrows).



Figure-5: Coronal CT section demonstrates bilateral pneumatization of pterygoid recesses (long arrows), and the right Vidian canal is protruded into the sphenoid sinus (short arrow).

protrusion of internal carotid artery (ICA), accessory maxillary ostium, pneumatization of superior conchae and crista galli, and associated sinusitis. Chi-square test was used for statistical analysis of the data, and $p < 0.05$ was considered statistically significant.

RESULTS

The study group consisted of 314 subjects age ranged between 16 and 73 years (mean 32.6 year). Of the study group 170 had sinusitis (%54.1), and the rest 144 patients (%45.9) were accepted as the control group. The frequency of variations in paranasal sinuses in our patient and control group is listed in **Table-1**.

Anatomic variation	Prevalance in normal patients (%) (144)	Prevalance in sinusitis group (%) (170)	Total (%) (314)	p value
Septal deviation	50	62	56	<0.005
Septal osseous spur	28	32	30	>0.005
Middle turbinate pneumatization	35	41	38	>0.005
Superior turbinate pneumatization	16	18	17	>0.005
Inferior turbinate pneumatization	1	2	2	>0.005
Paradoxical middle concha	13	14	14	>0.005
Mucosal thickening of conchae	20	24	21	>0.005
Aerated septum nasi	12	14	13	>0.005
Aerated crista galli	10	13	11	>0.005
Aerated anterior clinoid process	16	19	18	>0.005
Aerated uncinata	2	3	3	>0.005
Agger nasi cell aeration	60	54	56	>0.005
Haller cell	9	12	11	>0.005
Onodi cell	12	14	13	>0.005

Ethmoid bullae	7	9	8	>0.005
Accessory maxillary sinus ostium	19	18	18	>0.005
Protrusion of carotid canal	27	24	25	>0.005

Table-1: The list of the paranasal sinus anatomical variations in the patient and control group

The most frequent variations detected were septal deviation (%62 patient group versus %50 control group), pneumatization of agger nasi cells (%54 patient group versus %60 control group), and middle turbinates (%41 patient group versus %35 control group). In the patient (sinusitis) group the most frequently encountered sinusitis was maxillary (%76), followed with anterior ethmoidal (%68), frontal (%32), posterior ethmoidal (%23) and sphenoidal sinusitis (%16). The frequencies of variations were higher in sinusitis group however, among the long list of variations only septal deviation was associated with sinusitis significantly ($p < 0.05$).

DISCUSSION

The current study revealed that among all the observed paranasal sinus anatomic variants, septal deviations was associated with the occurrence of chronic sinusitis. Although statistically non-significant also the other anatomical variations were more frequently encountered in the patients with sinusitis than the control group.

In a previous study 35% of 151 patients with chronic sinusitis had middle turbinate concha bullosa, and after resection of the anterior third of the pneumatized turbinate, 80% of the patients showed improvement in their symptoms (8,9). Also another study by Lom on 100 patients with signs and symptoms of chronic sinusitis, spiral CT scan of the paranasal sinuses yielded 47 cases of concha bullosa and a significant relationship between this finding and chronic sinusitis was observed (10). Moreover, Masegur reported 4 cases of concha bullosa with chronic sinusitis who underwent endoscopic operation on the middle turbinate, and all the 4 patients were relieved of their symptoms. There are other studies indicating the role and association of concha bullosa in chronic sinusitis (8). However, a few studies like Tatlı's in 2001 and Unlu's in 1994 found no relationship between the anatomic abnormalities and chronic sinusitis (11,12).

In a study by Danase et al, no correlation was found between sinusitis and anatomic variations such as concha bullosa, paradoxical middle concha, pneumatized uncinate process, large ethmoidal bulla, and Haller cell (13).

The paranasal sinus CT scan is generally considered the gold standard diagnostic radiologic study in sinusitis. It is widely believed to be extremely sensitive for mucosal inflammation in the paranasal sinuses also the below listed variants.

Agger nasi: This is a bony prominence that is often pneumatized in the ascending

process of the maxilla. Its location below the frontal sinus also defines the anterior limit of the frontal recess (14).

Concha bullosa: Concha bullosa is the pneumatization of the middle turbinate and, less commonly, of the inferior and superior turbinate. An enlarged middle turbinate may obstruct the middle meatus and the infundibulum causing recurrent disease. It may also serve as a focal area of sinus disease (14).

Ethmoidal bulla: The ethmoid bulla is a prominent anterior ethmoid cell, constituting a reliable anatomical landmark. The degree of pneumatization varies considerably ranging from failure of pneumatization to a giant ethmoid bulla insinuating between the middle turbinate and uncinate process, displacing the uncinate process medially. The ethmoid bulla is bordered inferomedially by the infundibulum and hiatus semilunaris; laterally by the lamina papyracea and superoposteriorly by the sinus lateralis and basal lamina (4,7,14).

Haller cell (infraorbital cell): Haller cells are ethmoid cells that extend along the floor of the orbit. They vary in size and when large can narrow the ostium of the maxillary sinus or the ethmoid infundibulum. Enlarged Haller cells may contribute to narrowing of the ethmoidal infundibulum and recurrent sinus disease, despite previous (incomplete) surgery (4,8,9,14).

Frontal recess: This is an hourglass-shaped space between the inferomedial aspect of the frontal sinus and the anterior middle meatus. Unfavorable variations of the structures that define its borders may cause problems with the frontal sinus outflow tract. These structures include the agger nasi cell, supraorbital ethmoid cells, and the ethmoid bulla (4,14).

Maxillary sinus ostium: This is the opening of the maxillary sinus to the nasal

cavity and a part of the ostiomeatal complex (14).

Ostiomeatal complex or unit: This term refers to a collection of middle meatal structures and is not a discrete anatomic entity. It consists of the ethmoid infundibulum, anterior ethmoid cells, and the uncinate process. It also represents the final common pathway of drainage for the frontal, maxillary, and anterior ethmoid cells. A patent ostiomeatal complex is essential for the improvement of patients with sinus disease (3,4,8).

Uncinate process: This is a 3-dimensional sickle-shaped (also described as a hook- or L-shaped) bone of the lateral nasal wall. Anteriorly, the uncinate process attaches to the lacrimal bone; inferiorly, the uncinate process attaches to the ethmoidal process of the inferior turbinate. The posterior edge lies in the hiatus semilunaris inferioris. Superiorly, the uncinate process may attach to the middle turbinate, lamina papyracea, and/or the skull base (4,14,15).

Paradoxical middle turbinate: The major curvature of the middle turbinate may project laterally, leading to narrowing of the middle meatus (15).

Sphenoethmoid cell (Onodi cell): An Onodi cell is a posterior ethmoid cell that extends lateral and superior to the sphenoid sinus and abuts the optic nerve. Kainz and Stammberger defined an Onodi cell as a posterior ethmoid cell with an endoscopically visible bulge of the optic canal. The vulnerability of the optic nerve with or without the presence of an Onodi cell is further compounded by the thin lamina papyracea in the posterior ethmoid area (4,15).

The radiologist's role is to report on five key points are the extent of sinus opacification, opacification of sinus drainage pathways, anatomic variants, critical variants, and condition of soft tissues of the brain, neck, and orbits. These goals can be covered with a

systematic approach to CT in the coronal, axial, and sagittal planes (16).

In the examination of patients with inflammatory sinus disease, coronal sections are routinely obtained in the area located between the frontal sinus anteriorly to the sphenoid sinus posteriorly. The coronal plane correlates with the surgical approach used during endoscopic surgery, and displays optimally the ostiomeatal unit, the relationship of the brain and ethmoidal roof, the anterior ethmoidal air cells, the course of the optic nerve, and the optic foramen (17).

An optimally performed coronal CT examination of the sinuses is essential and enough for the detection of sinusal disease. The routine axial images, however, are not always necessary. The axial CT, which extends from the maxillary teeth inferiorly to the supracellar region superiorly, is indicated for the patients who are candidates for FESS. An axial CT scan will help for optimal display of the anatomy of the sinuses, optic nerves, carotid arteries, and the anterior and posterior posterior walls of the frontal sinus, as well as the relationships between these structures. The sphenoethmoidal bony plate, pterygomaxillary fissure, and pterygopalatine fossa are also best evaluated on axial CT scans (4,17).

Sagittal multiplanar reconstructions, performed only if required, better define the distance from the priform apertura to sites such as frontal recess, basal lamella, or anterior rim of the sphenoidal sinus, contributing to a safer and more accurate endoscopic procedure (17).

CONCLUSION

The incidence of anatomical variants are higher in patients with sinusitis. The radiologist must pay close attention to anatomical variants in the preoperative evaluation. It is important for surgeon to be aware of variations that may predispose patients to increased risk of intraoperative complications and help

avoid possible complications and improve success of management strategies.

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