

EVALUATION OF ANATOMICAL VARIATIONS OF NASAL CAVITY AND PARANASAL SINUSES WITH CONE BEAM COMPUTED TOMOGRAPHY

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ABSTRACT

Objective: The aim of this study is to evaluate anatomical variations of nasal cavity and paranasal sinuses using cone beam computed tomography (CBCT), which is currently used in dentistry radiology.

Material and Method: In this study, 251 patients' nasal cavities and paranasal sinuses were evaluated using CBCT (Newtom 5G, Verona Italy) images in terms of anatomical variations. The high-resolution (voxel and slice thickness: 0.2 mm) multiplanar reformatting images (MPR) were used for the evaluation of the variations.

Results: The most common anatomical variation of nasal cavity and paranasal sinuses found in this study was agger nasi cell (95.6%). The most rarely observed variation was sphenoid sinus aplasia (0.8%). There was no statistically significant relationship between concha bullosa and nasal septum deviation.

Conclusion: CBCT is a preferred alternative and reliable method for evaluation of anatomical variations of the nasal cavity and paranasal sinuses.

Keywords: Anatomical variation, nasal cavity, paranasal sinus. Nobel Med 2017; 13(2): 36-41

NAZAL KAVİTE VE PARANAZAL SİNÜSLERİN KONİK IŞINLI BİLGİSAYARLI TOMOGRAFİ İLE DEĞERLENDİRİLMESİ

ÖZET

Amaç: Bu çalışmanın amacı günümüz diş hekimliğinde kullanılan konik ışınli bilgisayarlı tomografi (KİBT) kullanarak nazal kavite ve paranasal sinüslerin anatomic varyasyonlarını deđerlendirmektir.

Materyal ve Metot: Bu çalışmada 251 hastanın nazal kavite ve paranasal sinüsleri KİBT (Newtom 5G, Verona Italy) görüntüleri kullanılarak anatomic varyasyon açısından deđerlendirildi. Varyasyonların deđerlendirilmesinde yüksek çözünürlüklü (voksel ve

aksiyal deđer: 0,2 mm) multiplanar reformat imajlar (MPR) kullanıldı.

Bulgular: Bu çalışmada nazal kavite ve paranasal sinüslerin en fazla görülen anatomic varyasyonu agger nasi hücresi (%95,6) olarak bulundu. Sfenoid sinüs aplazisi (%0,8) en az görülen varyasyon olarak bulundu. Konka bulloza ve nazal septal deviasyon arasında istatistiksel olarak anlamlı farklılık bulunmadı.

Sonuç: KİBT nazal kavite ve paranasal sinüslerin anatomic varyasyonlarının deđerlendirilmesinde alternatif bir metot olarak tercih edilebilir.

Anahtar kelimeler: Anatomic varyasyon, nazal kavite, paranasal sinüs. Nobel Med 2017; 13(2): 36-41

INTRODUCTION

The clinical and surgical importance of variations in paranasal sinuses should be investigated.¹ Sinusitis may be caused by sinonasal cavity anatomic variations. The osteomeatal unit can be narrowed or obstructed by these variations.^{2,3} The paranasal sinuses are separated from the orbital and cranial fossae by very thin bone lamina. Anatomic variations of this region must be understood in detail, otherwise serious complications, such as cerebrospinal fluid leakage, meningitis or blindness may occur during surgery.⁴

Radiological imaging is a standard diagnostic method before surgery for chronic diseases of the nasal cavity and paranasal sinuses. However, conventional radiographs are insufficient for the imaging of this region because of superimpositions.⁵ Computed tomography (CT) is considered as the gold standard for sinonasal imaging, but the radiation dose is a disadvantage of CT, with lenses and thyroid glands being especially negatively affected by the exposure.^{6,7} Cone beam computed tomography (CBCT) is a low-dose and low-cost scanning system. It has been specifically designed for maxillofacial skeleton imaging. CBCT is now considered as a preferable alternative method to CT for sinonasal imaging.⁸

The aim of this study is to evaluate frequency of anatomical variations of the nasal cavity and paranasal sinuses using with CBCT, which has a low radiation dose and high resolution.

MATERIAL AND METHOD

The CBCT images of 251 patients (141 female, 110 male) were evaluated in this study. The patients ages ranged between 18 and 74 years. These patients referred for various complaints from November 2011 to January 2014. Retrospectively registered patients in archive provided the evaluated images. Except registered patients in archive, other patients included in this study whose CBCT scanning was necessary including sinonasal region for any reason. These patients signed informed consent forms. The study was approved by the Ethics Committee of Atatürk University, Faculty of Dentistry (2013/006).

Patients who had undergone surgery of the sinonasal region and had advanced inflammatory diseases, massive polyposis, enlarged benign and malignant diseases within the study field, congenital anomalies, fibrous dysplasia and other fibroosseous lesions were excluded from study.

In this study, the Newtom 5G (Verona Italy) CBCT device was used. The kilovoltage setting was 110 with 1–20 mA intensity. The multiplanar reformatting images (MPR) including axial, coronal and sagittal sections were used for the evaluation of the nasal cavity and paranasal sinus variations. The images voxel and slice thickness values were 0.2 mm.

Concha bullosa, paradoxical concha, nasal septum deviation, agger nasi cell, haller cell, supraorbital, suprabullar and frontalbullar cell, onodi cell, kuhn cells, maxillary sinus septum, sphenoid sinus pneumatizations of conchal and presellar types were evaluated.

The images were evaluated by a radiologist experienced in the analysis of CBCT scans. The relation between nasal septum deviation with concha bullosa was statistically examined.

The chi-square test was used for the statistical analysis and a p value of <0.05 was considered as statistically significant.

RESULTS

In our study, frequencies of nasal cavity and paranasal sinus anatomical variations were found as follows: concha bullosa in 201 patients (80.1%) (Figure 1a), paradoxical concha in 47 patients (18.8%) (Figure 1b), nasal septum deviation was found in 185 patients (73.7%) (Figure 1c), agger nasi cell was found in 240 patients (95.6%) (Figure 2a), haller cell in 121 patients (48.2%) (Figure 2b), supraorbital cell in 118 patients (47%) (Figure 2c), suprabullar cell in 134 patients (53.4%) (Figure 3a), frontalbullar cell in 70 patients (27.9%) (Figure 3b), onodi cell in 82 patients (32.7%) (Figure 3c). Kuhn cells type I in 87 patients (34.7%) (Figure 4), type II in 47 patients (18.7%) (Figure 5), type III in 52 patients (20.7%) (Figure 6) and type IV cell was not found. Maxillary sinus septa in 100 patients (39.8%) (Figure 7), sphenoid sinus hypoplasia in 18 patients (7.2%) (Figure 8) and sphenoid sinus aplasia in 2 patients (0.8%) (Figure 8) was found.

There was no statistically significant relationship between concha bullosa and nasal septum deviation ($p= 0.441$).

DISCUSSION

Concha bullosa is a pneumatization formation of the middle concha. The low-degree pneumatization

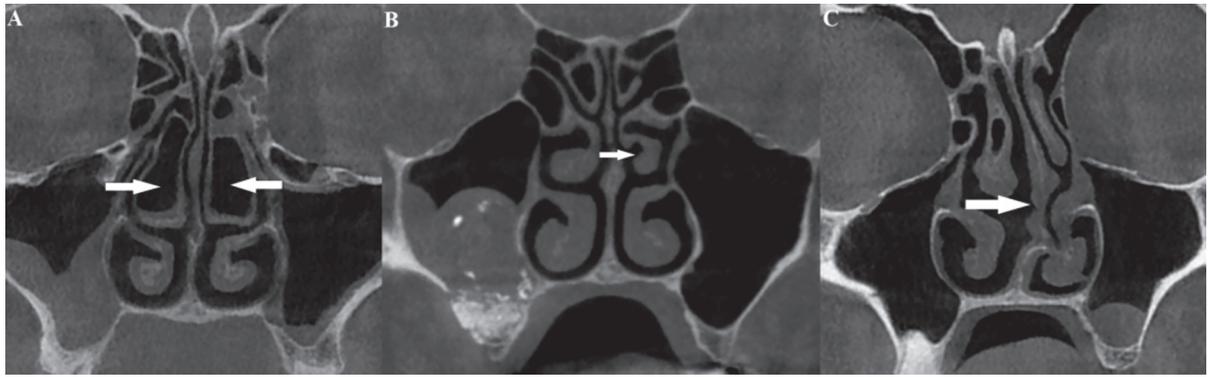


Figure 1. The coronal CBCT scans showing (A) the bilateral concha bullosa, (B) the paradoxical concha and the (C) nasal septum deviation.

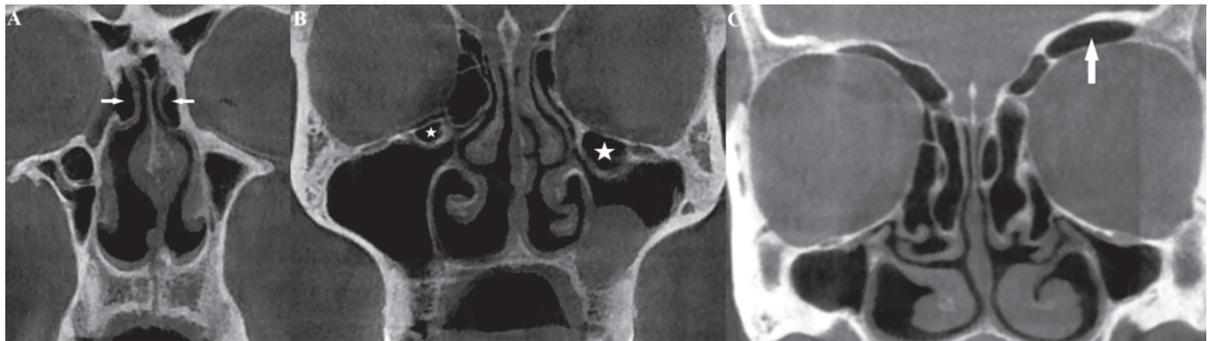


Figure 2. The coronal CBCT scans showing (A) the bilateral agger nasi cells (arrows), (B) the bilateral haller cells (stars) and (C) the supraorbital cell (arrow).

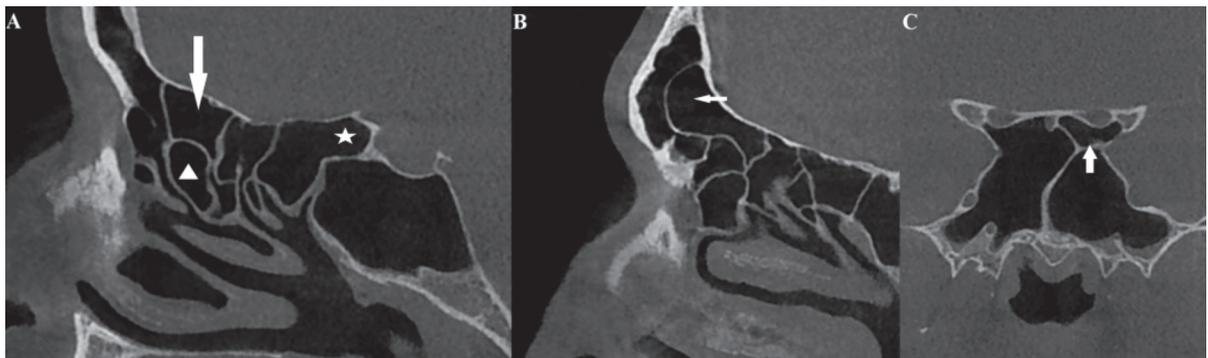


Figure 3. The sagittal CBCT scan showing (A) the suprabullar cell (arrow) above the agger nasi (arrowhead) and onodi cell (star), the sagittal scan (B) showing the frontalbullar cell (arrow), the coronal scan (C) showing the onodi cell (arrow).

does not have a clinical significance. Large concha bullosa may obstruct the antrum drainage channel and ethmoid infundibulum.⁹ In the literature, the frequency of concha bullosa varies from 3.1 to 67%.^{5,10-12} In our study, the incidence of concha bullosa was found to be 80.1% (Figure 1a).

Paradoxical concha is characterized by its convexity aspect located on the lateral side. Paradoxical middle concha may lead to middle meatus obstruction, and therefore, the ethmoid infundibulum may narrow. The degree of convexity is a significant factor in the development of obstruction.¹³ In the literature, the frequency of paradoxical middle concha was found as follows: Arslan *et al.* 3% and Perez Pinas *et al.* 27%.^{5,11}

In our study, the incidence of paradoxical middle concha was found to be 18.8% (Figure 1b).

The over deviation of the nasal septum may laterally tilt the middle concha and cause obstruction and secondary inflammations.¹⁴ In the literature, the frequency of septum deviation varies from 14.1 to 89.2%.^{5, 11,15-18} In our study, the incidence of septum deviation was 73.7% (Figure 1c).

Sazgar *et al.* recommended that nasal septum deviation is an indirect consequence of concha bullosa.¹⁹ Smith *et al.* found that the relationship between the presence of concha bullosa and nasal septum deviation was not statistically significant.²⁰ Aktas *et al.* also found this

relationship to be statistically significant with regard to the unilateral concha bullosa and nasal septum deviation.²¹ In our study, the incidence of these two variations was 78.9%, and the relationship between the two variations was not found to be statistically significant ($p > 0.05$).

Agger nasi are the most anterior ethmoid air cells. Agger nasi are formed by lacrimal bone pneumatization. The enlarged agger nasi cell can lead to sinusitis by narrowing the frontal recess.²² The agger nasi cells that are affected by sinusitis can cause ocular complications as well.¹⁴ The surgical removal of the agger nasi cell can provide access to the frontal recess.¹ In the literature, agger nasi cell frequency varies from 13.5 to 100%.^{5,13,16,17,22} In our study, the incidence of agger nasi cell was 95.6% (Figure 2a).

Haller cells are localized under the orbita and on the roof of the maxillary sinus. Over pneumatization of this cell can obstruct the pathway of the maxillary sinus and cause ethmoiditis.^{11,23} Moreover, this may negatively affect the maxillary sinus ventilation and can lead to recurrent maxillary sinusitis.²² An enlarged haller cell can lead to an increased risk of ocular complications during endoscopic ethmoidectomy.^{11,23} In the literature, haller cell frequency varies from 1 to 56.7%.^{11,13,15,22} In our study, the incidence of haller cells was 48.2% (Figure 2b).

Supraorbital cells may resemble the appearance of a frontal sinus septum, and can exist as a single cell or as multiple cells.²³ In the literature, supraorbital cell frequency varies from 2.6 to 64.6%.^{11,17,24-26} In our study, the incidence of supraorbital cells was 47% (Figure 2c).

Suprabullar cells are localized superior to the ethmoid bulla and posterior to the frontal recess. Supraorbital cells may be similar to frontalbullar cells, but do not extend in the frontal sinus.²⁴ In the literature, suprabullar cell frequency varies from 7.8 to 68%.^{24,26-28} In our study, the incidence of suprabullar cell was 53.4% (Figure 3a).

Frontalbullar cells are localized superior to the ethmoid bulla, and the anterior border of this cell extends into the frontal cell and throughout the skull base into the frontal sinus from the posterior frontal recess.²⁴ In the literature, frontalbullar cell frequency varies from 9 to 16%.^{24,26-28} In our study, the incidence of frontalbullar cells was 27.9% (Figure 3b).

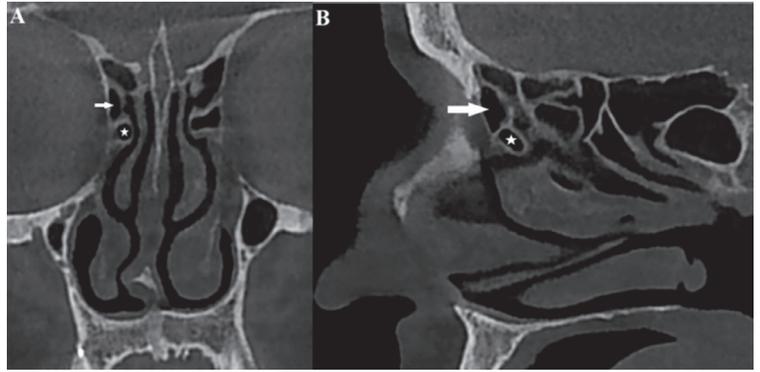


Figure 4. The Coronal (A) and sagittal (B) scans showing the frontoethmoidal cell Kuhn type I (arrow) upper the agger nasi cell (star) in a same patient.

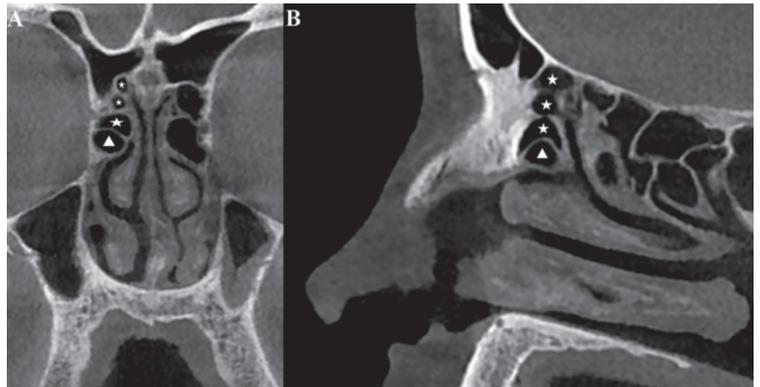


Figure 5. The Coronal (A) and sagittal (B) scans showing the frontoethmoidal cell Kuhn type II as three cells (stars) upper the agger nasi cell (arrowhead) in a same patient.

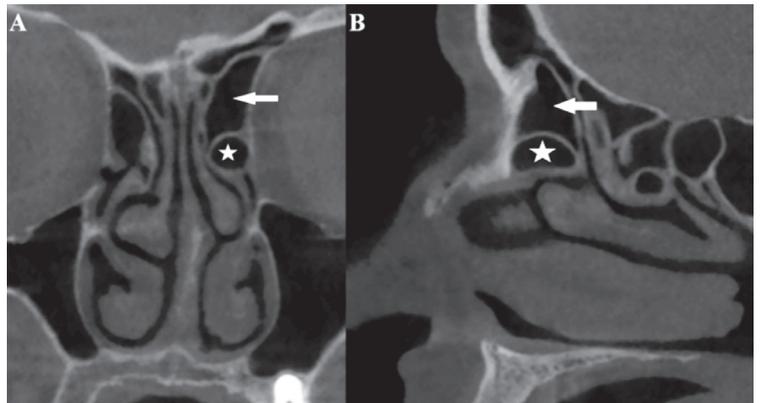


Figure 6. The Coronal (A) and sagittal (B) scans showing the frontoethmoidal cell Kuhn type III (arrow) upper the agger nasi cell (star) in a same patient.

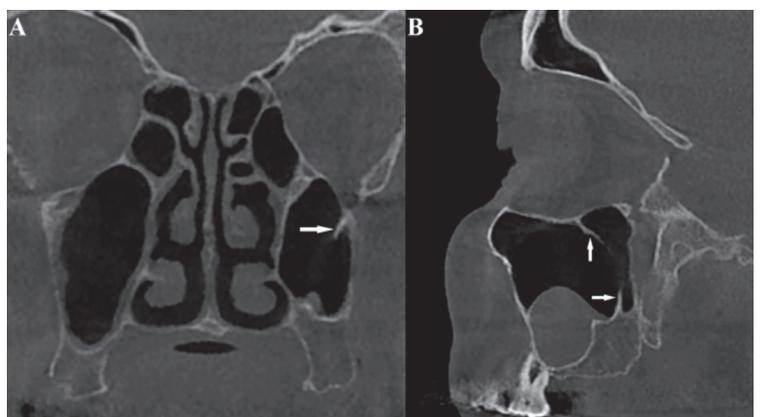


Figure 7. The coronal (B) and sagittal (C) scans showing the maxillary sinus septum (arrows) on the left side in a same patient.



Figure 8. The axial scan showing the sphenoid sinus hypoplasia (star) and sphenoid sinus aplasia (arrow) in a same patient.

The onodi cell is a posterior ethmoid cell. It elongates superiorly to the sphenoid sinus and is located between the sphenoid sinus and skull base. Because of its direct relation to the optic nerve, this cell is very important. Moreover, the skull base is located at the posterior wall of the onodi cell.⁹ In the literature, onodi cell frequency varies from 8.4 to 65.3%.^{5,17,27,29,30} In our study, the incidence of onodi cells was 32.7% (Figure 3c).

Kuhn classified the frontoethmoid cell and described four types. Type I is a single cell above the agger nasi and does not elongate into the frontal sinus. Type II is two or more cells located above the agger nasi. Type III is a large single cell above the agger nasi that extends into the frontal sinus. Type IV is an isolated cell within the frontal sinus.³¹ These cells alter the frontal recess anatomy, narrowing the frontal sinus ostium and can cause pathological changes. For achieving access to the frontal sinus ostium during endoscopic surgery, the removal of Kuhn cells may be required. In the literature, type I cell frequency varies from 17 to 37%, type II frequency varies from 4.2 to 19% and type III frequency varies from 3,1 to 12.5%.^{24,26-28} Only Leunig *et al.*²⁷ encountered type IV cell and its frequency was found to be 0.1%. In our study, the incidence of the

type I cell was 34.7% (Figure 4), type II was 18.7% (Figure 5) and type III was 20.7% (Figure 6). The type IV cell was not encountered.

In cases where maxillary sinus septa are present, the risk of schneiderian membrane perforation increases. The determination of prevalence, location and morphology of septa can prevent surgical complications.³² In the literature, maxillary sinus septa frequency varies from 22.8 to 44.8 %.^{32,33} In our study, the incidence of maxillary sinus septa was 39.8% (Figure 7).

The sphenoid sinus pneumatization is classified into three types (presellar, sellar and conchal) according to the vertical plane crossed from the tuberculum sellae.³⁴ The presellar type pneumatization is located anterior to the vertical plane, while the sellar type pneumatization elongates beyond this plane. In the conchal type, there is no pneumatization but the conchal bone fills the sphenoid sinus.

The conchal type of sphenoid sinus variation is also known as sphenoid sinus aplasia. In the literature, sphenoid sinus aplasia frequency was found to vary from 0.13 to 2%.^{35,36}

In our study, the incidence of sphenoid sinus aplasia was 0.8% (Figure 8).

The presellar type of sphenoid sinus pneumatization is also known as sphenoid sinus hypoplasia.³⁷ The frequency of sphenoid sinus was found by Güldner *et al.* to be 6.6%, Kajoak *et al.* found 15% and Hamid *et al.* found 21%.^{29,36,38} In our study, the incidence of sphenoid sinus hypoplasia was 7.2 % (Figure 8).

CONCLUSION

CBCT can be considered as an alternative method for evaluation of anatomical variations with the nasal cavity and paranasal sinuses. In this study, agger nasi cell was the most common sinonasal anatomic variation. Sphenoid sinus aplasia was the least variation. We found no statistically significant relationship between the concha bullosa and nasal septal deviation

*The authors declare that there are no conflicts of interest.

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