Original Article / Çalışma - Araştırma

Prevalence of pneumatized uncinate process and accompanying neighboring variations

Pnömatize unsinat proses prevalansı ve komşu varyasyonlar ile birlikteliği

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ABSTRACT

Objectives: This study aims to investigate the prevalence of uncinate process (UP) pneumatization and also to investigate the association of UP pneumatization with concurrent morphological variations in neighboring structures and the presence of maxillary sinusitis.

Patients and Methods: This was a retrospective study where coronal computed tomography scans of 1,500 UPs in 750 patients (483 males, 267 females; mean age 36.3±14.7 years; range 7 to 84 years) were examined to determine the prevalence of UP pneumatization and to assess any concurrent neighboring anatomical structures and the presence of maxillary sinusitis between January 2013 and June 2013.

Results: Uncinate process pneumatization was identified in a total of 6.26% of our patients with 1.60% being bilateral, 2.53% on the right only, and 2.13% on the left side only. Other than concurrent occurrences of right maxillary sinus septa (p=0.046), growth of the right ethmoidal bulla (p=0.044) and presence of maxillary sinusitis (right side: p=0.046, left side: p=0.035) were seen.

Conclusion: We detected a 6.2% prevalence of UP pneumatization in our study group. An abnormally sized and over-pneumatized UP can cause narrowing of the infundibulum and impaired sinus drainage. Such functional blockage can lead to recurrent maxillary sinusitis, stuffiness, and decreased olfaction.

Keywords: Computed tomography; paranasal sinus; pneumatized; sinusitis; uncinate process.

ÖZ

Amaç: Bu çalışmada pnömatizasyon unsinat proses (UP) prevalansı ve UP pnömatizasyonun komşu yapılarda eşzamanlı morfolojik varyasyonları ve maksiller sinüzit varlığı ile ilişkisi araştırıldı.

Hastalar ve Yöntemler: Bu retrospektif çalışmada, Ocak 2013 - Haziran 2013 tarihleri arasında, 750 hastanın (483 erkek, 267 kadın; ort. yaş 36.3±14.7 yıl; dağılım 7-84 yıl) 1500 UP koronal bilgisayarlı tomografi taramaları, UP pnömatizasyonu prevalansını belirlemek ve herhangi bir eşzamanlı komşu anatomik yapıyı ve maksiller sinüzit varlığını değerlendirmek üzere incelendi.

Bulgular: Unsinat proses pnömatizasyonu, hastalarımızın %1.60'ında iki taraflı, %2.53'ünde yalnız sağ tarafta ve %2.13'ünde yalnız sol tarafta olmak üzere toplam %6.26'sında tespit edildi. Sağ maksiller sinus septanın (p=0.046) eşzamanlı oluşumu dışında, sağ etmoidal bulla büyümesi (p=0.044) ve maksiller sinüzit varlığı (sağ taraf: p=0.046, sol taraf: p=0.035) görüldü.

Sonuç: Çalışma grubumuzda %6.2 UP pnömatizasyon prevalansı tespit edildi. Anormal büyüklükte ve aşırı pnömatize UP, infundibulum daralmasına ve bozulmuş sinüs drenajına neden olabilir. Bu tür fonksiyonel blokaj tekrarlayan maksiller sinüzit, burun tıkanıklığı ve koku alma duyusunun azalmasına yol açabilir.

Anahtar Sözcükler: Bilgisayarlı tomografi; paranazal sinüs; pnömatize; sinüzit; unsinat proses.

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The sickle- or boomerang-shaped uncinate process (UP) was first identified by Johann Friedrich Blumenbach in 1790. The structure represents a thin, brittle, osseous lamella that is orientated sagittally and has a dorsal concave margin and an anterior convex one.[1] The UP is a thin osseous structure, resembling a boomerang. It extends from the ethmoid bone to the ethmoid process of the inferior concha. During weeks 10-12 of intrauterine development, invagination of the middle meatus becomes discernible and the maxillary sinus is formed.[2] During this phase, the UP and bulla ethmoidalis are seen as a narrow groove (the hiatus semilunaris). The UP plays an important role in the regulation of ventilation of the paranasal sinus and, in normal physiology, drainage of the sinuses. During endoscopic sinus surgery, the UP is a significant landmark on the lateral nasal wall.[3]

Several anatomical variants of UP have been identified. Two are medial or lateral deviations of the UP. Two others are the atelectatic or hypertrophic UP which may originate from pneumatization.[4] Diverse anatomical variations of pneumatized maxillofacial osseous structures have been frequently reported in the medical literature. However, there still is no definite explanation for why pneumatizations occur with such anatomical variation.[3] Uncinate process pneumatization (UPP) may cause narrowing of the middle meatus, interfering with drainage throughout the infundibulum.[5] Computed tomography (CT) is considered the best method of visualizing the paranasal sinuses and UP.[6]

The maxillary sinuses are cavities inside the maxillary bone, inferior to the orbit in the upper section of the cheek.[7] Sinusitis is the inflammation of a sinus, generally caused by bacterial, viral, or fungal infection, and all types share common symptoms of fever, blocked nose, and rhinorrhea, or runny nose. Maxillary sinusitis is distinct in its presence of a suborbital, which is increased when the patient tilts his or her head forward. Typical treatment for acute sinusitis is based on antibiotics and nasal decongestants, sometimes accompanied by corticosteroids.[7]

We aimed to investigate the frequency of UPP and its concurrent presence of morphological variations in neighboring anatomical structures.

PATIENTS AND METHODS

In this study we investigated the prevalence of UPP and any concurrent occurrences of morphological variations such as maxillary sinus septa, agger nasi and Haller cells, pneumatization of the middle concha, growth of ethmoidal bulla, septal deviation in neighboring tissues and presence of maxillary sinusitis.

Local institutional review board approved the study. The study was conducted in accordance with the principles of the Declaration of Helsinki. We evaluated coronal paranasal sinus CT (Brilliance 64-slice CT scanner, Philips Medical Imaging, The Netherlands) images, taken at 3 mm sections. The coronal CT scanning was performed on patients positioned supinely with the head position adjusted so that the hard palate was parallel to, while the sagittal plane was perpendicular to, the floor. Uncinate process pneumatization was defined as an UP in which there was an air gap completely surrounded by tissue, as in concha bullosa.

All paranasal CT images were ordered for sinonasal, otologic, and maxillofacial inquiries, between January 2013 and June 2013. Patients with maxillofacial trauma, nasal polyposis or sinus anomalies and those who had undergone previous sinus surgery were excluded. Coronal sectional CT scans of 1500 UPs in 750 patients (483 males, 267 females; mean age 36.3±14.7 years; range 7 to 84 years) were evaluated for the prevalence of UPP and for any concurrent occurrences of morphological variants in neighboring anatomical structures and presence of maxillary sinusitis.

Statistical analysis

The data were evaluated statistically using the chi square test. P values <0.05 and $p<0.001$ were considered to indicate statistically significant differences.

RESULTS

Uncinate process pneumatization was detected in a total of 47 patients (6.26%). In 2.53% (n=19) of the patients UPP was located at the right side, in 2.13% (n=16) of the patients on the left side, and 1.60% (n=12) of the patients had bilateral UPP. Of the patients with UPP, 34 (72.3%) were males, 13 (27.7%) were females, and their ages

ranged between 16 and 75 years, with a mean age of 31.1±13.9 years.

Maxillary sinusitis was detected in 22.8% of the 47 UPP patients (94 sides): 21.3% located on the right and 24.3% at the left side. The simultaneous occurrence of UPP and the presence of maxillary sinusitis was found to be statistically significant on the right and left sides (right side: p=0.046, left side: p=0.035; Table 1).

Growth of the ethmoidal bulla was detected in 1.06% of the 47 UPP patients (94 sides): 0.7% located on the right and 2.1% located on the left side. The simultaneous occurrence of UPP and growth of the ethmoidal bulla was statistically significant on the right but not significant on the left side (right side: p=0.044, left side: p=0.405; Table 1).

Maxillary sinus septa were detected in 12.8% of the 47 UPP patients (94 sides), 21.3% located on the right and 4.3% on the left side. Simultaneous occurrence of UPP and maxillary sinus septa was found to be statistically significant on the right side, while no significance was found on the left side (right side: p=0.046, left side: p=0.345; Table 1). Agger nasi cells were detected in 85% of the 47 UPP patients (94 sides), 95% located on the right and 75% on the left. The simultaneous occurrence of UPP and agger nasi cells showed no statistical significance (right side: p=0.553, left side: p=0.345; Table 1). Haller cells were detected in 4.2% of the 47 UPP patients (94 sides): 2.1% located on the right and 6.3% located on the left side. The simultaneous occurrence of UPP and Haller cell was not statistically significant on either side (right side: p=0.626, left side p=0.140; Table 1). Pneumatization of the middle concha was detected in 26.5% of the 47 UPP patients (94 sides), 27.6% located on the right and 25.5% located on the left side. The simultaneous occurrence of UPP and pneumatization of the middle turbinate was not statistically significant on either side (right side: p=0.905, left side: p=0.959; Table 1). Septal deviation was detected in 17.0% of the 47 UPP patients. The simultaneous occurrence of UPP and septal deviation was not statistically significant on either side (right side: p=0.693, left side: p=0.865; Table 1).

One case of UPP on the right side originated from the medial face of the orbit and the superior wall of the maxillary sinus (Figure 4).

Table 1. Simultaneous occurrence of uncinate process pneumatization and morphological variations of neighboring structures

Variations	UPP right	UPP left
	p	*p*
Maxillary sinus septa	0.046*	0.345
Agger nasi cell	0.553	0.345
Haller cell	0.626	0.140
Pneumatization of middle concha	0.905	0.959
Growth of ethmoidal bulla	0.044*	0.405
Nasal septal deviation	0.693	0.865
Presences of sinusitis	0.046*	0.035*

UPP: Uncinate process pneumatization; Chi square test; * p<0.05; ** p<0.001.

DISCUSSION

The UP is a thin, sickle-shaped osseous structure located between the middle and inferior conchae. In normal physiological conditions, the UP is effective in the aeration of the sinuses and their drainage.[5] The tip of the UP articulates with the perpendicular lamina of the palatine bone, the superior wall of maxillary sinus, the basal lamella of ethmoid bone, and the lamina papyracea.[8] The diversity of such joints provides clues for analyzing the morphology of the nasal fontanelles.[5] Little is known about the morphology of the UP. In some cases, an abnormally grown UP and its extensive pneumatization can lead to narrowing of the paranasal sinus drainage route.[9]

In sinus surgery, the UP is dissected first during a middle meatal antrostomy.[10] Later, the

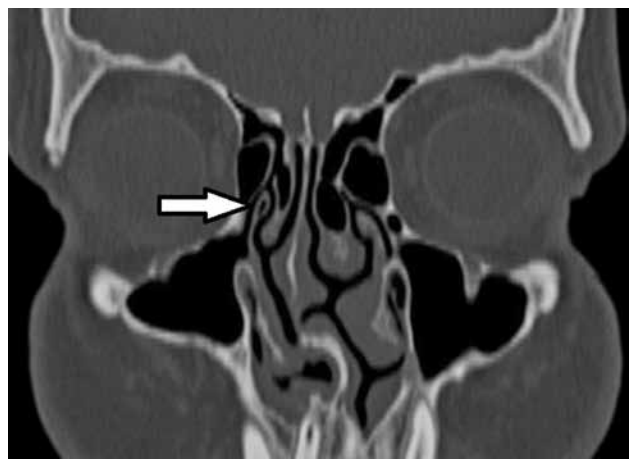

Figure 1. *Uncinate process pneumatization on the right with bilateral middle concha pneumatization.*

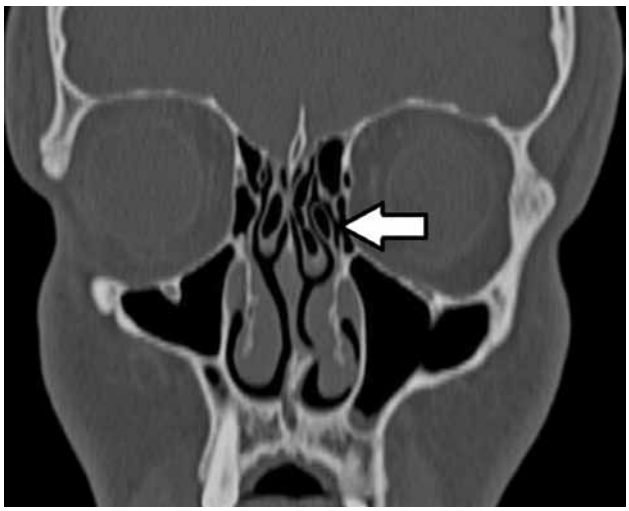

Figure 2. *Uncinate process pneumatization on the left with bilateral middle concha pneumatization.*

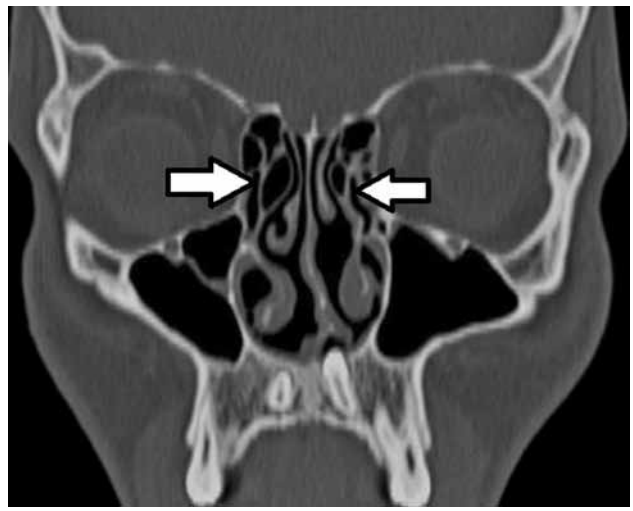

Figure 3. *Bilateral uncinate process pneumatization with maxillary sinus septa on the right.*

natural ostium is widened and nasal fontanelles are opened. Measurements have been made between UP and the nasolacrimal duct, the sphenopalatine foramen, and other lateral nasal wall structures, highlighting the UP's importance; however, they were not sufficient for understanding the detailed morphology of the UP.[10,11]

The UP constitutes the medial border of the ethmoid infundibulum. Thus, when pneumatized and in mucosal contact with the neighboring ethmoid bulla and/or the middle concha, it can interfere with sinus drainage throughout the infundibulum and may cause obstruction of the osteomeatal unit or recurrent maxillary sinusitis.[12] Such a functional blockade is seen at the contact point of the UP and the middle concha.[12] Developmental pneumatization may be seen most frequently at the anterosuperior region, with the extension of an air cell inside the UP.[5] In our study, we observed a statistically significant correlation with the presence of maxillary sinusitis (right side: p=0.046, left side: p=0.035; Table 1).

Kennedy and Zinreich[13] found 1 UPP patient in their series of 230 patients and reported a prevalence of 0.4%. Bolger et al.[14] detected UPP in eight patients in their series of 263 patients and reported the prevalence of UPP as 2.5%. In their cases, UPP was unilateral in four patients, bilateral in one, with only slight pneumatization in three patients. In the study by Cumberworth et al.[15] of 250 patients, UPP was present in three cases and the prevalence was calculated as 1.2%. Kantarcı et al.[16] investigated 512 cases and reported a 5% UPP prevalence. In one of their

Table 2. Uncinate process pneumatization series in the medical literature

Authors	Number of cases	Date of publication	Study type	Prevalence
				%
Kennedy et al.[13]	230	1988	Retrospective	0.4
Bolger et al.[14]	263	1990	Retrospective	2.5
Cumberworth et al.[15]	250	1993	Retrospective	1.2
Kantarci et al.[16]	512	2004	Retrospective	5
Christmas et al.[17]	1	2005	Case report	-
Burrows.[3]	1	2011	Case report	-
Lee and Kim[18]	1	2011	Case report	-
Our study	750	2014	Retrospective	6.2

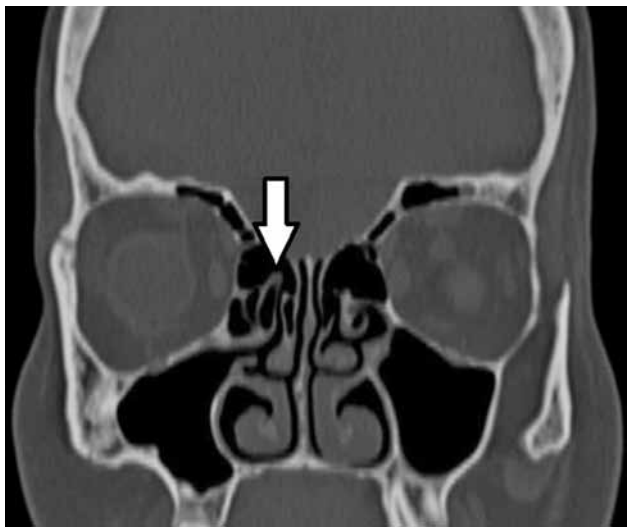

Figure 4. *Uncinate process pneumatization on the right, originating from the medial face of orbita and the superior wall of the maxillary sinus.*

patients, UPP was accompanied by a Haller cell on the same side. Christmas et al.[17] reported their clinical approach in a case with UPP on the right side. Burrows reported a case with UPP and mucocele.[3] Lee and Kim[18] reported a case with an UP pyocele.

In our study, we observed UPP in 47 (6.2%) of our 750 patients, similar to other results in the literature (Table 2). We have observed increased prevalence of UPP in our study compared to previous studies (Table 2). One reason for this may be the development of imaging techniques in recent years. Another reason may be the heterogeneity of the patients studied, including differences in age and ethnicity.

Our investigation of the simultaneous occurrence of morphological variations of neighboring structures such as maxillary sinus septa, agger nasi cells, Haller cells, middle concha pneumatization, growth of the ethmoidal bulla, nasal septal deviation, and maxillary sinusitis in our 47 patients with UPP did not reveal any significant association between UPP and morphological variants of neighboring structures other than right maxillary sinus septa (p=0.046) and growth of the ethmoidal bulla (p=0.044). Although statistically significant, we consider that these simultaneous occurrences may not be clinically significant and may prove to be insignificant in larger series. The coexistence of UPP and maxillary sinusitis was observed to be statistically significant on the both sides (right side: p=0.046, left side: p=0.035).

In all but one of our cases with UPP, the UP was in the form of an extension of the medial wall of the maxillary sinus or the inferior concha. In one case, UPP on the right side originated from the medial face of the orbit and the superior wall of the maxillary sinus (Figure 4).

In this study, we did not investigate the histological aspect of UPP for a relationship between the UPP and maxillary sinus. In the future, histologic study can be done on mucosa of UP. This was a preliminary study; therefore, future studies with more patients are needed to confirm our findings.

In conclusion, this study may shows that in a relationship between the UPP and maxillary sinusitis at the first time. When planning a surgical intervention for osteomeatal complex problems, UPP has to be kept in mind in cases with hypertrophic UP. We also concluded that CT examinations play an important role in the diagnosis of variations in both UP and neighboring anatomical structures.

Declaration of conflicting interests

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