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Retrospective Radiological Analysis of Ethmoid Roof Depth and Sinonasal Anatomical Variations in Septoplasty and Septorhinoplasty Patients

Septoplasti ve Septorinoplasti Hastalarında Etmoid Çatı Derinliğinin ve Sinonazal Anatomik Varyasyonların Retrospektif Radyolojik Analizi

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Abstract

Aim: Computed tomography (CT) provides an accurate assessment of sinonasal anatomy and osseocartilaginous pathologies in patients complaining of sinonasal symptoms. Although it is not a routine practice, CT is frequently used in preoperative screening of patients planned for septoplasty and septorhinoplasty. In this study, anatomical variations and ethmoid lateral lamella depths in preoperative CT images of septoplasty and septorhinoplasty operations performed in our clinic were analyzed retrospectively and discussed with current literature.

Material and Method: Septorhinoplasty and septoplasty surgeries performed in our clinic between January 2014 and August 2018 over the age of 18 years were reviewed retrospectively. Two hundred patients were included in the study. CT images were evaluated for anatomical variations and ethmoid lateral lamella depths.

Results: Of the 200 patients included in the study, 158 (79%) underwent septoplasty and 42 (21%) underwent septorhinoplasty. Concha bullosa was detected in 95 (47,5%) of the patients and was determined as the most common anatomical variation. Onodi cell variation was detected in 62 (31%) of the patients. Haller cell was detected in 37 patients (18,5%). Paradoxical middle turbinate was detected in 19 patients (9,5%), pneumatized anterior clinoid process in 17 patients (8,5%), and pneumatized crista galli in 4 patients (2%). In lateral lamella measurements; the median value of the lateral lamella depth on the right was 4,20 mm (0,40-7,40 mm) and the median value of the lateral lamella depth on the left was 4,20 mm (1,70-7,30 mm).

Conclusion: Anatomical variations that can be detected in CT imaging before septoplasty and septorhinoplasty operations and information about ethmoid roof anatomy will be useful in case management, surgical planning and complication management.

Keywords: Sinonasal anatomy, Keros, ethmoid roof, septoplasty, septorhinoplasty.

Öz

Giriş: Sinonazal semptomlardan şikayet eden hastalarda bilgisayarlı tomografi (BT), sinonazal anatomi ve osseokartilajinöz patolojilerin doğru bir şekilde değerlendirilmesini sağlar. Rutin olarak kabul edilen bir uygulama olmasa da septoplasti ve septorinoplasti planlanan hastaların preoperatif taramalarında BT sıklıkla kullanılmaktadır. Bu çalışmada kliniğimizde gerçekleştirilen septoplasti ve septorinoplasti ameliyatlarında preoperatif çekilen BT görüntülerde anatomik varyasyonlar ve etmoid lateral lamella yükseklikleri retrospektif analiz edilerek güncel literatür bilgileriyle tartışıldı.

Gereç ve Yöntem: Ocak 2014– Ağustos 2018 arasında kliniğimizde yapılan 18 yaş üstü septoplasti ve septorinoplasti ameliyatları retrospektif tarandı. 200 hasta çalışmaya dahil edildi. BT görüntüleri anatomik varyasyonlar ve etmoid lateral lamella yükseklikleri açısından değerlendirildi.

Bulgular: Çalışmaya dahil edilen 200 hastanın 158' i septoplasti (%79), 42' si (%21) septorinoplasti operasyonu geçirdi. Konka bülloza hastaların 95' inde (%47,5) saptanarak en sık anatomik varyasyon olarak belirlendi. Onodi hücre varyasyonu hastaların 62' sinde (%31) saptandı. Haller hücresi 37 hastada (%18,5) saptandı. Paradoks orta konka 19 hastada (%9,5), pnömatize anterior klinoid proses 17 hastada (%8,5) ve pnömatize krista galli 4 hastada (%2) saptandı. Lateral lamella ölçümlerinde; sağda lateral lamella yüksekliği median değeri 4,20 mm (0,40-7,40 mm) solda lateral lamella yüksekliği median değeri 4,20 mm (1,70-7,30 mm) olarak bulundu.

Sonuç: Septoplasti ve septorinoplasti operasyonları öncesi BT görüntülemede saptanabilecek anatomik varyasyonlar ve etmoid çatı anatomisi hakkında elde edilebilecek bilgiler vaka yönetiminde, cerrahi planlamasında ve komplikasyon yönetiminde faydalı olacaktır.

Anahtar Kelimeler: Sinonazal anatomi, Keros, etmoid çatı, septoplasti, septorinoplasti

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INTRODUCTION

Computed tomography (CT) is a perioperative examination mostly used in the evaluation of osseocartilaginous structures, and magnetic resonance imaging (MRI) is generally used in the evaluation of soft tissues (1). CT scan is the preferred method for the evaluation of paranasal anatomy and inflammatory paranasal sinus pathologies (2, 3). Although it is not a routine practice, CT is frequently used in preoperative screening of patients planned for septoplasty and septorhinoplasty (4).

However, there is still controversy about the routine use of preoperative CT in septoplasty and septorhinoplasty. Some authors object the use of CT because of radiation exposure. However, some authors also support its routine use, as it not only provides detailed information about septal and bone deformities, but also helps detect occult sinus pathologies (5).

Keros has described three different surgically important configurations of the ethmoid roof. This classification is done according to the length of lateral lamella of the cribriform plate (6). In type I, the depth of olfactory fossa is 1 to 3 mm, the lateral lamella is short, and the ethmoid roof is almost in the same plane as the cribriform plate. In type II, the depth of olfactory fossa is 4 to 7 mm and the lateral lamella is longer. In type III, the depth of olfactory fossa is 8 to 16 mm and the ethmoid roof is located significantly above the cribriform plate. Because of the risk of damage to the thin and delicate lateral lamella by surgical instruments, Type 3 is the most dangerous and important type for sinus surgery (7).

Pneumatization of the middle turbinate is usually originated from the frontal recess or agger nasi (6). The Haller cell grows towards the bony orbital floor that forms the roof of the maxillary sinus, can be distinguished from the bulla, and together with a narrowed ethmoid infundibulum or maxillary sinus ostium constitutes a potential etiology of chronic sinusitis (6). Posterior ethmoid cells may be pneumatized lateral to and somewhat superior to the sphenoid sinus, in this case, they are called sphenoethmoid cells (cellulae sphenoethmoidales) or Onodi cells (6). The paradoxical middle turbinate is the medial curving of the middle turbinate into the septum in two consecutive coronal sections (6).

In this study, anatomical variations and ethmoid lateral lamella lengths of patients in preoperative CT images of septoplasty and septorhinoplasty operations performed in our clinic were analyzed retrospectively and discussed with current literature. It was thought that it would contribute to the literature, as it is one of the largest national case series.

MATERIAL AND METHOD

The study was carried out with the permission of Taksim Training and Research Hospital Ethics Committee (Date: 01.07.2020, Decision No: 2020/111). Patients over the age of 18 who had undergone septoplasty and septorhinoplasty between January 2014 and August 2017 and who had paranasal sinus CT in the preoperative period in our hospital's imaging archive were included in the study. Patients with a history of sinonasal polyp, sinonasal tumor, head trauma and were not included in the study.

Variables in two separate categories were analyzed in paranasal sinus CT scans. GE OPTIMA CT660 (GE Healthcare, mikwaukee, WI) device was used to perform CT scans which was used in this study. CT scans (128-slice) were performed using 110 mA, 120 kV, standard dose in 1 mm section. Axial and coronal reformatted images were used. Firstly, anatomical variations were scanned. Anatomical variations screened were: concha bullosa, Haller cell, Onodi cell, paradoxical middle turbinate, pneumatized crista galli, anterior clinoid process pneumotization. Secondly, the depth of the olfactory fossa was measured bilaterally with 1 mm precision in the images and classified according to Keros calcification. All images were evaluated with the PACS (Picture archiving and communications system) program.

The average of the measurements made independently and at different times in all images by both researchers was taken and these averages were used in the study.

Reference points for lateral lamella length measurement were fovea ethmoidalis, lamina cribrosa and bilateral infraorbital nerves. The length of the lateral lamella was calculated by determining the reference line with a horizontal line passing through the two infraorbital nerves in the section where both infraorbital nerves were seen symmetrically (**Figure 1**). Line A was drawn between reference line and fovea ethmoidalis. Line B was drawn between reference line and lamina cribrosa. Ethmoid roof depth measurements were calculated by subtracting the line B length from the Line A length as shown in **Figure 1**. It was recorded separately as right and left, and classified according to Keros (7, 8).

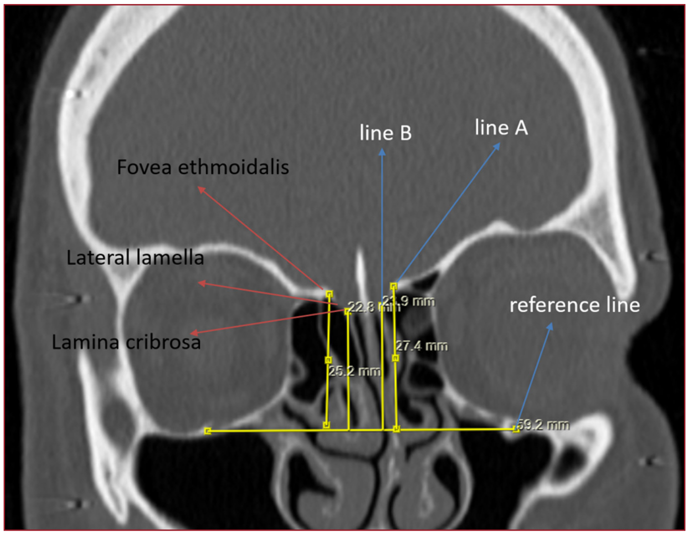

Figure 1. Ethmoid roof depth measurements were calculated by subtracting the line B length from the Line A length as mm as shown

Statistical analysis was performed using the SPSS version 22.0 (IBM SPSS Statistics, Chicago, IL, USA). Descriptive variables were evaluated in terms of normal distribution with the Kolmogorov-Smirnov Test. Mann-Whitney U Test was used for comparisons between groups. A value of $p<0.05$ was accepted as the criterion of significance in all statistical analyses.

RESULTS

Paranasal sinuses CT scans of 200 subjects were included in the study. Among 200 subjects, 110 were males (55%) and 90 were females (45%). One hundred fifty eight of patients (79%) underwent septoplasty, 42 of them (21%) underwent septorhinoplasty. The median age was 31 in men (18-59), 25 in women (18-64). The median age in septoplasty patients was 31 (18-64), 24 (18-63) in septorhinoplasty patients.

Concha bullosa was observed in 95 (47.5%) of the patients as the most common anatomic variation. Onodi cell variation was identified in 62 (31%) of the patients. Haller cell was identified in 37 patients (18.5%). Paradoxical middle turbinate (**Figure 2**) was observed in 19 patients (9.5%), pneumatized anterior clinoid process in 17 patients (8.5%), and pneumatized crista galli (**Figure 2**) in 4 patients (2%).

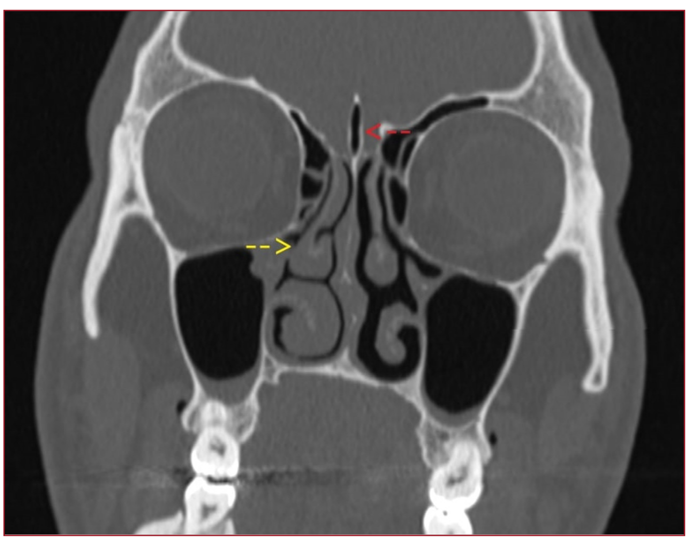

Figure 2. Anatomical variations in the coronal plane CT image. yellow arrow: paradoxical middle turbinate. red arrow: pneumatized crista galli.

The median value of lateral lamella length measured 4.20 mm (0,40 -7,40 mm) in the right and 4.20 mm (1,70 -7,30 mm) in the left. Among males, the median value of the right lateral lamella length was 4.60 mm (2.20 -7.40 mm), and the median value of the left lateral lamella length was 4.60 mm (2.41 -7.30 mm). Among females, the median value of the right lateral lamella length was 3,60 mm (0.40-7.00 mm) and the median value of the left lateral lamella length was 4,20 mm (1.70 -7.00 mm).

Keros measurements were compared between men and women separately for the right and left sides. There was a statistically significant difference between the two groups in terms of both sides ($p<0.001$ for both groups, **Table 1**, **Figure 3**).

Right and left side Keros measurements of those who underwent septoplasty and those who underwent septorhinoplasty were compared. In the septoplasty group, the median value was 4.15 mm (0.40 -7.40 mm) on the right and 4.40 mm (1.80 -7.30 mm) on the left. In the septorhinoplasty group, the median was 4.20 mm (1.90 -7.00 mm) on the right side and 4.00 mm (1.70 -7.00 mm) on the left side. While no statistically significant difference was observed on the right side ($p=0.57$), it was higher in the left side in the septoplasty group, and this difference was statistically significant ($p=0.025$, **Table 1**).

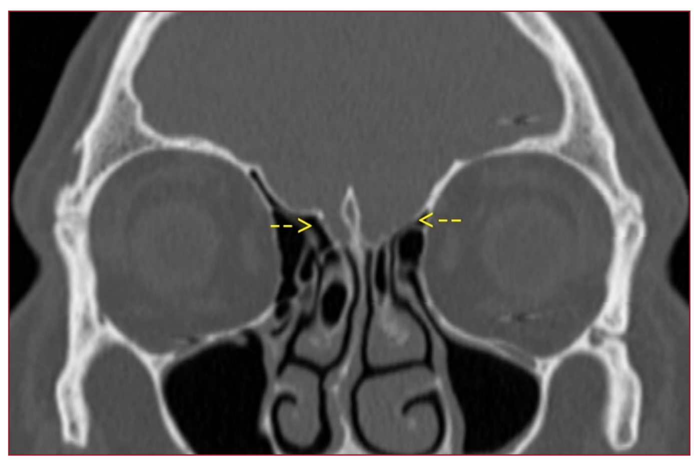

Figure 3. Asymmetric ethmoid roof (yellow arrows) on the coronal plane CT image.

Table 1. Comparison of bilateral ethmoid roof depth (Keros) due to type of surgery and gender.

		Keros (Right, mm)	p	Keros (Left, mm)	p
Gender	Male	4.64±1.12 [a]	<0.001[c]	4.67±1.06	<0.001[c]
		4.60 (2.20-7.40) [b]		4.60 (2.41-7.30)	
	Female	3.69±1.10		3.78±1.08	
		3.60 (0.40-7.00)		3.65 (1.70-7.00)	
Operation	Septoplasty	4.25±1.22	0.57[c]	4.37±1.15	0.025 [c]
		4.15 (0.40-7.40)		4.40 (1.80-7.30)	
	Septorhinoplasty	4.08±1.15		3.89±1.09	
		4.20 (1.90-7.00)		4.00 (1.70-7.00)	
Total		4.21±1.21		4.27±1.15	
		4.20 (0.40-7.40)		4.20 (1.70-7.30)	

a Data are presented as mean ± standart deviation. b Data are presented as median (min-max). c P-value for Mann-Whitney U test.

DISCUSSION

In this study, the preoperative CT images of patients who underwent septoplasty and septorhinoplasty were evaluated retrospectively, and the anatomical variations of the paranasal sinuses and the depth of the olfactory fossa were compared with the criteria of age, gender, and type of operation.

Endoscopic approach is widely used today in the surgery of chronic rhinosinusitis and nasal cavity tumors. Endoscopic sinus surgery is performed frequently in orbita and skull base region. CT imaging, together with other examination methods, is a frequently preferred evaluation to prevent major complications and for anatomical variations and incidental pathologies. These images provide useful information for the surgeon in planning the operation. One of the most important of these information is the anatomy of the ethmoid roof. Because of its proximity to the anterior skull base; ethmoid roof is the region with the highest risk of intracranial trauma during endonasal surgeries. Therefore, Keros et al. examined the ethmoid roofs of 450 skulls in their study and recommended three categories for olfactory fossa depth according to lateral lamella length (7). Type I olfactory fossa depth, which was 12% in Keros' study, was 40% in our study. While Type II was seen in 70% in Keros' study, it was seen in 60% in our study. Type III olfactory fossa, which was found in 18% in Keros' study, was not detected in our study.

Although anterior rhinoscopy and nasal endoscopy can provide sufficient information in most of the patients who are planned for septoplasty and septorhinoplasty, there are some cases where the specified examinations are insufficient in preoperative surgical planning. According to the study of Günbey et al., if one or more of the conditions such as severe anterior deviations that cannot be passed behind the deviation, inability to evaluate the middle meatus and posterior nasal cavity, need for investigation of a polyp or mass detected in nasal endoscopy, presence of obstructive middle turbinate hypertrophy, suspicion of chronic rhinosinusitis, or osteomaetal complex pathology in endoscopic examination are available, preoperative CT imaging is recommended (2). In our study, we retrospectively scanned the olfactory fossa depth and paranasal sinus anatomical variations which can be guiding in surgery, in our patients for whom we requested CT images in the preoperative period. The most common type of Keros classification in our study was determined as type II and type I, respectively, and this result was found similar with many other studies.

Alazzawi et al. found type I, type II and type III olfactory fossa depths in order of incidence in their study. They reported that the divergence of results from other studies may be due to population differences. Similarly, Paber et al. found type I as 81.8%, type II as 17.7% and type III as 0.5% (9). The fact that we did not find a type 3 olfactory fossa according to the Keros classification in our study may be due to the population difference as well as the relatively low number of imaging (10).

Another parameter we investigated in our study was the anatomical variations of the paranasal sinuses. We found concha bullosa (47.5%), Onodi cell (31%), Haller cell (18.5%), paradoxical middle turbinate (9.5%), anterior clinoid process pneumotization (8.5%) and crista galli pneumotization (2%), respectively. Arslan et al. similarly, reported concha bullosa as the most common anatomical variation in their study (11). Again, in the study of Kaplanoğlu et al., the most common (30.4%) anatomical variation was concha bullosa (12). In the same study, Onodi variation was reported with a frequency of 10.6%.

Sarı et al. found weak correlation between preoperative CT and septoplasty outcomes in their retrospective study of 61 septoplasty patients (13). Based on this study and our study, routine CT may not be recommended in patients undergoing septoplasty and septorhinoplasty.

The limitations of our study are; the exclusion of many CT images due to the inability to have coronal reformatted images because of low resolution in the module of our image processing system, which we can reach as ENT physicians and the absence of a radiologist among the team members. In addition, the retrospective nature of our study is an important limitation. Although there are no significant differences between the number of images examined with similar studies, studies with more samples will contribute to updating the information on the subject.

CONCLUSION

Although CT imaging is not routinely recommended in most studies before septoplasty and septorhinoplasty operations, CT imaging may be required in some indications. Information to be obtained about the anatomical variations that can be detected in CT imaging and the anatomy of the ethmoid roof may be useful in case management, surgical planning, as well as provide an insight into the risks of complications and will also be useful in complication management.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Taksim Training and Research Hospital Ethics Committee (Date: 01.07.2020, Decision No: 2020/111).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The author has no conflicts of interest to declare.

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