Research Article / Araştırma Makalesi

Evaluation of Paranasal Sinus Volumes and Anatomic Variations in Patients With Rhinogenic Headache

Rinojenik Baş Ağrısı Olan Hastalarda Paranazal Sinüs Hacimlerinin ve Anatomik Varyasyonların Değerlendirilmesi

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Abstract

Background: Rhinogenic headache is a common finding that may occur due to features related to the nasal cavity and paranasal sinuses without any underlying rhinological disease. It is thought that paranasal sinus volumes and anatomical variations may have an effect on this symptom. The aim of this study is; to investigate the paranasal sinus volumes and remarkable anatomical variations in patients with rhinogenic headache.
Materials and Methods: Paranasal sinus tomography images and hospital files of 72 patients who were referred to the otolaryngology department were evaluated retrospectively. The volumes were calculated by the sinus volume index method and the presence of septal spur, concha bullosa, onodi cell, haller cell, agger nasi cell and paradoxical middle turbinate were evaluated as anatomical variations. As the control group, the data of 40 patients who were operated with open technique rhinoplasty for esthetic purposes were taken and the results were compared statistically.
Results: The frontal sinus volume index was 4.57 cm^3 in the patient group and 6.02 cm^3 in the control group, and this difference was statistically significant. No significant difference was found between the two groups in other paranasal sinus volumes. The presence of septal spur was observed more frequently in the patient group, and this result was found to be statistically significant. There was no significant difference between the two groups regarding other anatomical variations.
Conclusions: The low sinus volume may have an effect on the formation of rhinogenic headache. The presence of a septal spur may create a possible mucosal contact point, leading to rhinogenic headache.

Key Words: Headache, Paranasal sinus, Anatomic Variation, Volume

ÖZ.

Amaç: Rinojenik baş ağrısı; altta yatan herhangi bir rinolojik hastalık olmadan nazal kavite ve paranazal sinüslerle ilgili özellikler nedeniyle ortaya çıkabilen, yaygın bir bulgudur. Rinojenik baş ağrısının oluşumunda paranazal sinüs hacimleri ve anatomik varyasyonların etkisi olabileceği düşünülmektedir. Çalışmamızın amacı; rinojenik baş ağrısı olan hastaların paranazal sinüs hacimlerini ve sık karşılaşılan anatomik varyasyonların sıklığını ve bu parametrelerin bu bulgunun gelişimindeki etkisini araştırmaktır.
Materyal ve Metod: Rinojenik baş ağrısı nedeniyle nöroloji bölümü tarafından kulak burun boğaz bölümüne yönlendirilmiş 72 adet hastanın paranazal sinüs tomografileri ve dosyaları retrospektif olarak değerlendirilmiştir. Hacimler sinüs volüm indeks metodu ile hesaplanmış ve anatomik varyasyon olarak septal spur, konka bülloza, onodi hücresi, haller hücresi, agger nazi hücresi ve paradoksik orta konka varlığı değerlendirilmiştir. Kontrol grubu olarak estetik amaçla açık teknik rinoplasti ameliyatı yapılmış 40 adet hastanın verileri alınmıştır ve ortaya çıkan sonuçlar istatistiksel olarak kıyaslanmıştır.
Bulgular: Hasta grubunda frontal sinüs volüm indeksi 4,57 cm^3, kontrol grubunda ise 6,02 cm^3 olarak ölçülmüş ve bu fark istatistiksel olarak anlamlıdır. Diğer paranazal sinüs hacimlerinde her iki grup arasında anlamlı bir fark bulunamamıştır. Anatomik varyasyon olarak sadece septal spur varlığı hasta grupta daha sık olarak gözlenmiş ve bu sonuç istatistiksel olarak anlamlı olarak bulunmuştur. Diğer anatomik varyasyonlar ile ilgili her iki grup arasında anlamlı bir fark tespit edilememiştir.
Sonuç: Rinojenik baş ağrısı oluşumunda sinüs hacimlerinin azlığının bir etkisi olabilir. Septal spur varlığı olası bir mukozal kontakt noktası yaratarak rinojenik baş ağrısına yol açabilir.

Anahtar kelimeler: Baş ağrısı, Paranazal sinüs, Anatomik Varyasyon, Volüm

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Introduction

Headache is one of the most common complaints in admissions to otolaryngology, neurology, internal medicine and emergency departments. Headache is an important public health problem and affects 1-2% of the general population (1). Almost all people experience a primary or secondary headache at least once in their lifetime. A primary headache is when the headache itself is the main problem and is not a symptom of another underlying disease. Secondary headaches occur due to another underlying disease or condition. Among the secondary headaches, rhinogenic headaches are a common entity and are frequently seen in routine outpatient admissions (2).

Rhinogenic headache; is a secondary headache syndrome that may be associated with some sinonasal conditions despite the absence of rhinosinusitis and other inflammatory diseases, hyperplastic mucosa, purulent discharge, nasal polyps or masses (3). Although the diagnosis, management and treatment protocol are still controversial, this headache syndrome is a branch of headache types defined by the International Headache Society (2). Some studies have suggested that rhinogenic headache may be associated with sinonasal mucosal contact points (4). On the other hand, there are some studies in the literature focusing on the relationship between anatomical sinonasal variations and rhinogenic headache (5). The volumes and aeration levels of the sinuses can also be classified in the spectrum of anatomical variations of the paranasal sinuses and may differ in most patients and cause some various clinical findings accordingly. There are many studies with various results about the etiology of rhinogenic headache. While some authors describe some cases with large and hyperaerated paranasal sinuses with a rhinogenic headache complaint; there are also some studies describing patients with low paranasal sinus volume complaining rhinogenic headache (6). Most of the time, etiologic causes and pathophysiologic mechanisms can not be clarified in patients presenting with rhinogenic headache. This situations leads to most patients are left untreated and it causes recurrent hospital admissions. Evaluation with paranasal sinus tomoFigurey should also be used in addition to the examination in patients who applied to the otolaryngology department with a preliminary diagnosis of rhinogenic headache. Anatomical variations of the paranasal sinuses, the volume and level of aeration of the paranasal sinuses can be evaluated significantly by computed tomoFigurey imaging of the paranasal sinuses. The aim of this study is to evaluate the possible relationship and effects of anatomical variations and levels of paranasal sinus volumes in patients with rhinogenic headache by evaluating the tomoFigureic sections of patients who applied to the otolaryngology department.

Materials and Methods

Ethical approval was obtained for the study from the non-interventional clinical research ethics committee of Faculty of Medicine of Uşak University (Meeting date: 16.09.2021 , Application no: 168-168-11,Decision no: 11)

In this study, the images of paranasal sinus tomoFigureies and hospital files of 158 patients who applied to the otolaryngology department due to rhinogenic headache between January 2021 and December 2021 were evaluated retrospectively. These patients were referred to the otolaryngology department with a preliminary diagnosis of rhinogenic headache by the neurology department. Neurological evaluations of the patients and cranial imaging with magnetic resonance (MR) were performed by the neurology department, and no neurological disease was diagnosed to explain the headache. Patients with uncontrolled hypertension, visual disturbances, dentoalveolar complaints, and a history of previous nasal or paranasal surgery were excluded from the study.

In this study, images of paranasal sinus computed tomoFigureies (CT) and hospital files of 158 patients who applied to the otolaryngology department due to rhinogenic headache were evaluated. 86 patients were excluded from the study because of soft tissue hypertrophy, inflammatory images, and findings related to rhinosinusitis on paranasal CT images. The remaining 72 patients were included in the study. Sinus volumes and levels of aeration of the paranasal sinuses were evaluated by the sinus volume index method and frequently encountered remarkable anatomical variations were examined. Septal spur, concha bullosa, onodi cell, haller cell, agger nasi cell and paradoxical middle turbinate were chosen as the most common and remarkable anatomical variations and these variations were evaluated in tomoFigurey sections in this study. As the control group, 40 patients who underwent open technique rhinoplasty surgery for aesthetic purposes are included in the study.

Examination of Paranasal CT Images

Paranasal CT imaging was performed at 40 mA and 120 kV, at a rotation speed of 1 second, and 1 mm thick sections were taken. Paranasal CT images were examined together with the otolaryngologist and radiologist, and the measurements were recorded with an agreement of two physicians. The sinus volume index method, which was defined by Barghouth et al. (7) in their study published in 2002, was used to calculate the paranasal sinus volumes. According to this method, the largest distances of the relevant paranasal sinus in sagittal, axial and coronal sections were measured. These measured distances were calculated according to the formula SVI = ½ * A * B * C and sinus volüme indices of the right maxillary, left maxillary, frontal and sphenoid sinuses were calculated (Figure 1). Due to the complex anatomical structure of the ethmoid sinuses, sinus volume index was not calculated and the ethmoid sinuses were not evaluated in this study.

Septal spur, concha bullosa, onodi cell, haller cell, agger nasi cell, paradoxical middle turbinate were examined as remarkable anatomical variations. Paranasal sinus tomoFigurey sections were examined in all three planes, and the

existence of these variations was decided with the agreement of the radiologist and otolaryngologist.

Statistical analysis

IBM SPSS 25.0 (IBM Corp., Armonk, NY) program suitable for Windows was used for statistical analysis. The $p<0.05$ value was accepted for statistical significance. For the statistical comparison of paranasal sinuses and sinus volume indices between groups, the t test used for independent groups was used. For the analysis of anatomical variation parameters, descriptive statistical methods of SPSS program and chi-square test were used.

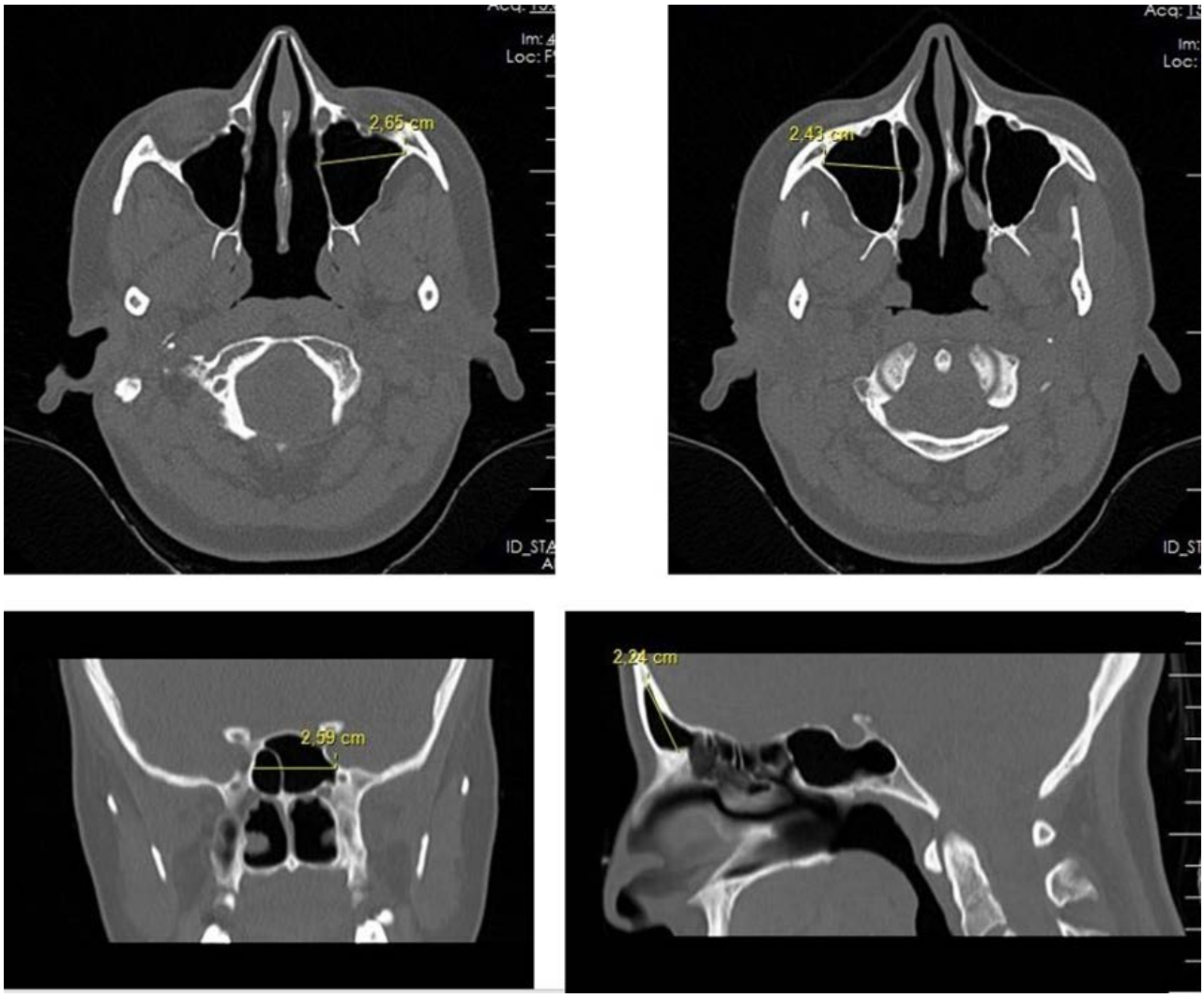

Figure 1: An example of measuring of largest lengths of the paranasal sinuses for calculating sinus volume indices in the coronal, axial, sagittal planes according to Barghouth G, et al method

Results

There were a total of 72 patients in the patient group in the study, and the mean age of the patients was 37.90 ± 6.27 years, 49 of them were female (68.05%) and 23 of them (31.94%) were male. In the control group, there were a total of 40 patients and the mean age of the patients was 27.46 ± 7.86, 26 of them were female (65%) and 14 of them was male (35%).

The distribution of the mean, p and t values of the paranasal sinus volume indices in both groups are given in Table 1 with details.

Paranasal sinus volume indices were compared between both groups using an independent sample t test. The frontal sinus volume index was calculated as a lower value in the patient group than in the control group, and this was statistically significant. No statistically significant difference was observed between the two groups among other sinus volume indices. Although there was no statistically significant difference was observed, the volumes of other paranasal sinuses were also measured to be lower level than the control group.

Table 1: Means of paranasal sinus volume indices in patient and control groups

Paranasal sinus	Patient Group (n=31)	Control Group (n=28)	p value	t value
Right maxillary sinus volume index	13,28 cm^3	14,40 cm^3	0,271	-1,52
Left maxillary sinus volume index	12,91 cm^3	14,45 cm^3	0,374	-1,97
Sphenoid sinus volume index	7,29 cm^3	8,54 cm^3	0,967	-2,55
Frontal sinus volume index	4,57 cm^3	6,02 cm^3	0,005	-3,48

The comparison of the right maxillary sinus volume index between the patient and control groups is presented in Figure 1, the comparison of the left maxillary sinus volume index is presented in Figure 2, the comparison of the sphenoid sinus volume index is presented in Figure 3 and the comparison of the frontal sinus volume index is presented in Figure 4. The presence of septal spur, concha bullosa, onodi cell, haller cell, agger nasi cell and paradoxical middle turbinate parameters as a remarkable anatomical variations were also investigated. The distribution of these anatomical variations within the patient and control groups is summarized in Table 2 and the comparisons between the groups are shown in Figure 5.

The distribution of anatomical variations within the subject groups was statistically analyzed by multivariate analysis. Only the septal spur variation was observed more common in the patient group than in the control group, and this was statistically significant. No statistical difference was observed between the two groups of subjects regarding the distribution of other variations.

Table 2: Distribution of remarkable anatomical variations in patient and control groups

		Remarkable Anatomical Variations					
		Septal Spur	Concha Bullosa	Onodi Cell	Haller Cell	Agger Nasi Cell	Paradoxical Middle Turbinate
Type of Group	Patient	10	7	3	2	3	3
	Control	3	9	1	2	2	4

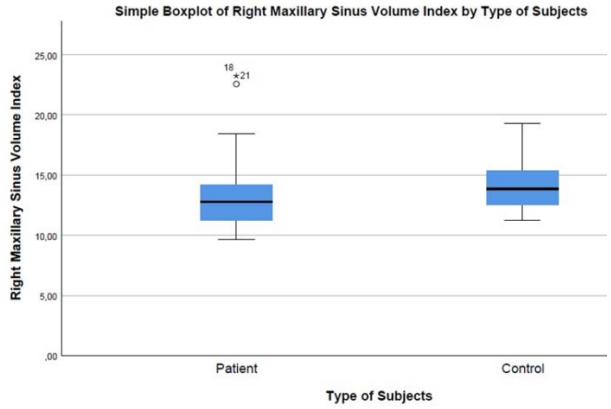

Figure 1. Box plot Figure showing the difference in right maxillary sinus volume index between patient and control groups.

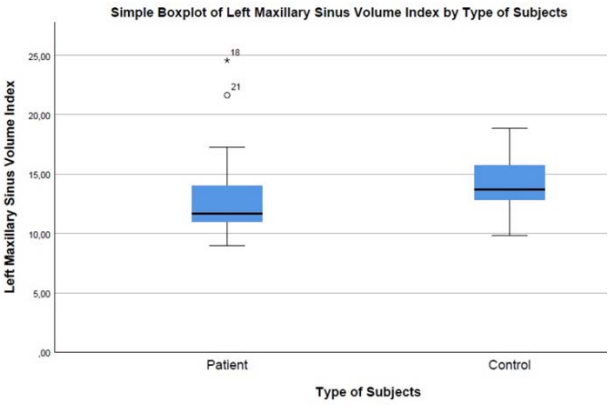

Figure 2. Box plot showing the difference in left maxillary sinus volume index between patient and control groups

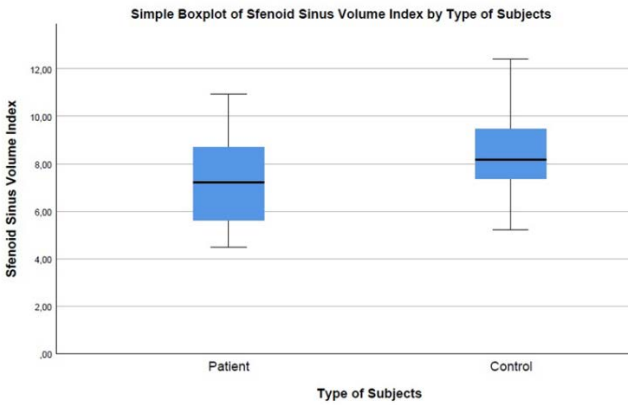

Figure 3. Box plot showing the difference in sphenoid sinus volume index between patient and control groups

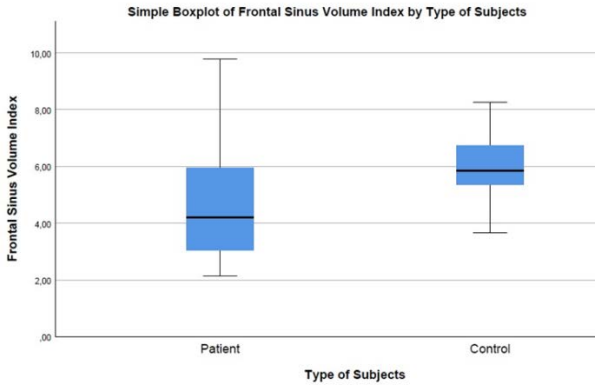

Figure 4. Box plot showing the difference in frontal sinus volume index between patient and control groups

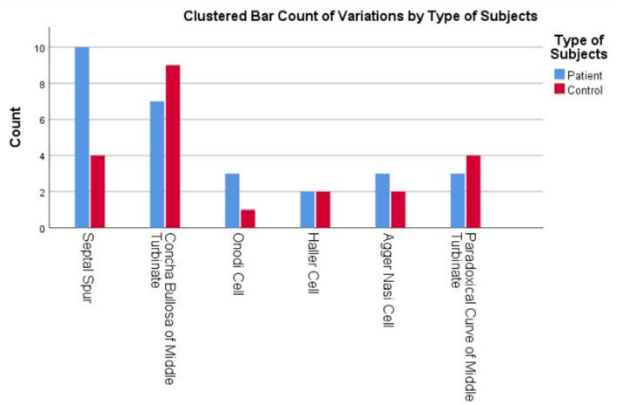

Figure 5. Comparison Figure of anatomical variations between groups.

Discussion

Sinus headache is a definition frequently used in clinical practice by many physicians, especially family physicians, emergency physicians and internists (8). Although it is named as a sinus headache believed to occur as a result of abnormalities in the sinonasal region, this type of headache was defined as rhinogenic headache by the International Headache Society (9). However, there is not any consensus on both diagnosis and treatment of this disease, and most clinicians can not manage such patients appropriately and inappropriate treatments can be observed in routine clinical practice (10). In patients with a preliminary diagnosis of rhinogenic headache, evaluation with paranasal sinus tomoFigurey has a major role in both diagnosis and treatment.

In this type of headache, there are no obvious signs of rhinosinusitis with the absence of sinonasal inflammation, hyperplastic mucosa, purulent discharge, sinonasal polyp or mass, and headache is concentrated in the paranasal sinuses. Any underlying cause can not be found and it can be considered as rhinogenic headache. Although the etiology of rhinogenic headache is often attributed to mucosal contact points in the literature, its etiology has not been fully enlighted (11). In addition to mucosal contact points, the volume and aeration levels of the paranasal sinuses are another issues that are emphasized in the etiology of this disease (12). There are some studies focusing the large and hyperaerated paranasal sinuses with rhinogenic headache, on the other hand there are also some studies resulting the relationship with immature and low-volume paranasal sinuses with rhinogenic headache. As a result of these studies, a clear consensus has not been reached about this issue. In series of rhinogenic headache with low volume paranasal sinuses , headache was often attributed to secondary causes or possible mucosal contact points. In the series of rhinogenic headache with high volume paranasal sinuses, it was thought that headache might be caused by the compression of the large paranasal sinuses on the dura and frontal lobe (13). In our study, paranasal sinus volumes were calculated with the sinus volume index method as defined by Barghouth G. et al. This method is accurate, fast, easy and inexpensive method for calculating the paranasal sinus volumes although there are other methods in which additional software and reconstruction techniques should be needed (7). In our study, a statistically significant decrease was found only in frontal sinus volumes in patients with rhinogenic headache. Although the results of other paranasal sinus volume comparisons are not statistically significant, the volume of sinuses are lower in the patient group than in the control group. These findings suggest that low paranasal sinus volumes may be a factor for rhinogenic headache. Aydemir L et al. also described a relationship of low volumes of total sinus, frontal sinus, and maxillary sinus in patients with rhinogenic headache (12). In this study, similar to that article, low frontal sinus volumes were detected in the patient group. It can be thought that low paranasal sinus volumes may be related to the etiology of rhinogenic headache. Deterioration of mucociliary activity, easily occlusion of the ostium and the formation of a possible mucosal contact point due to underdeveloped sinuses may be the potential reasons for causing rhinogenic headache in the patients with low paranasal sinus volumes. In some case series, it has been shown that hyperaerated frontal sinuses are associated with rhinogenic headache. Etiologically, it has been stated that insufficiency of mucociliary activity in large sinuses and vacuum effect of this aeration may result the headache (14). After surgery of cases with frontal bossing or pneumatocele due to excessive volume of paranasal sinus, it was observed that headache was subjectively decreased, but it still persists. Subjectively, the decrease in headache can also be attributed to the placebo effect due to surgery in patients (15).

Another important factor investigated in the etiology of rhinogenic headache is anatomical variations. In this study, the most common and remarkable paranasal sinus and nasal cavity variations were examined. According to this study, only the presence of septal spur was observed more frequently in the patient group than in the control group and this result is statistically significiant. Other anatomical variations such as concha bullosa, haller cell, agger nasi cell, onodi cell and paradoxical middle turbinate were observed in similar numbers in both the patient group and the control group. Septal spur is usually associated with septal deviation and may cause stenosis and mucosal contact point in the nasal cavity, and it is thought that it may cause rhinogenic headache depending on these mucosal contact points (16). It is hypothesized that rhinogenic headache may be occurred by the polymodal receptors of the afferent nerves of the maxillary and ophthalmic branches of the trigeminal nerve at the mucosal contact points and by the substance P secreted from the contact points (17). Also; It has been shown that the severity and frequency of headaches are reduced when the mucosal contact points in the nasal cavity are surgically corrected (18). It is thought that agger nasi cell, concha bullosa, onodi cell, haller cell and paradoxical middle turbinate may also create a possible mucosal contact point and cause rhinogenic headache (19). However, the fact that similar anatomical variations can be observed in patients without any

symptoms leads to this issue has not been fully enlighted with details. In order to better explain the relationship between anatomical variation and rhinogenic headache, prospective studies with more subjects are required.

According to this study, it can be concluded that paranasal sinus volumes and anatomical variations may be associated with rhinogenic headache. In this study, low volume frontal sinus and septal spur was found to be statistically significant as anatomical variation may be related to rhinogic headache etiology. However, the retrospective nature of the study and the small number of patients are major limitations of this study. Therefore, multidisciplinary, prospective studies involving more subjects are needed to examine these relationships in more detail. In addition, grading the severity of rhinogenic headache and examining this change according to the results of the patients who underwent surgery will contribute to obtaining new information on this issue.

Conclusion

Rhinogenic headache is a symptom that is observed quite frequently in clinical practice and a clear consensus has not been reached in its diagnosis and treatment. The etiological causes of rhinogenic headache have not been fully defined with details. There are studies in the literature suggesting that the variations in the paranasal sinus and the volumes of the sinuses may be effective in the development of this headache. In our study; only a low frontal sinus volumes was detected in patients with rhinogenic headache. In terms of anatomical variations, only the presence of septal spur was found to be associated with rhinogenic headache. It was thought that the presence of septal spurs could create a possible mucosal contact point, and that low frontal sinus volumes could easily disrupt mucociliary activity and cause headache with the effect of vacuum. In order to reveal the relationship between rhinogenic headache and these parameters more clearly, it is appropriate to conduct prospective, multidisciplinary studies involving large patient groups and examining the severity of headache.

Ethical Approval: *Ethical approval was obtained for the study from the non-interventional clinical research ethics committee of Faculty of Medicine of Uşak University (Meeting date: 16.09.2021, Application no: 168-168-11,Decision no: 11)*

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Design : A.D., F.K.B., N.A.
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Writing manuscript: A.D.
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