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The effect of paranasal anatomic variations on chronic rhinosinusitis

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Abstract

Rhinosinusitis is the inflammation of the paranasal sinus mucosa and the most common pathophysiological event causing rhinosinusitis is the ostiomeatal complex disease. The aim of the study is to determine the prevalence of anatomical variations and mucosal pathologies in paranasal computed tomography images of patients with chronic rhinosinusitis and to reveal the relationship between anatomical variations and sinus pathologies. Anatomical variations and mucosal pathologies in coronal paranasal tomography images were evaluated in 100 patients diagnosed with chronic rhinosinusitis and 32 individuals in the control group without any sinus complaints. The rate of having at least one anatomical variation in the control group was 64.1%, while this rate was 87.5% in patients with chronic rhinosinusitis ($p<0.001$). The most common variation, Agger nasi cell, was found to be present in 34.3% of the individuals in the control group and in 53.5% in the rhinosinusitis group ($p<0.05$). In patients with rhinosinusitis, maxillary sinus was affected in 66.5%, anterior ethmoid sinus in 42.5%, frontal sinus in 32.5%, posterior ethmoid sinus in 20%, sphenoid sinus in 18.5% either in isolation or in combination. The relationship between anatomical variations and mucosal pathologies of the sinuses was evaluated. A significant correlation was found between anatomical variations such as Agger nasi cell, concha bullosa, septum deviation, ethmoid bulla and Haller cell with maxillary sinusitis, between Agger nasi cell and septum deviation with frontal sinusitis, and between Agger nasi cell, concha bullosa, septum deviation and ethmoid bulla with ethmoid sinusitis. In conclusion, it was concluded that anatomical variations are an important factor in the development of chronic sinusitis and that not only sinuses but also anatomical variations that impair drainage should be corrected during the surgical treatment of rhinosinusitis.

Keywords: paranasal sinus, tomography, variation, surgical treatment

1. Introduction

Rhinosinusitis is the inflammation of the paranasal sinus mucosa and is one of the common diseases in the population. Various causes from upper respiratory tract infections to systemic infections can be listed in its etiology, however, the most common pathophysiological event causing rhinosinusitis is the ostiomeatal complex disease. Small pathological changes in the mucosa of the ostiomeatal complex impair the drainage and ventilation of the sinuses by preventing mucociliary excretion of secretions in the paranasal sinuses (1, 2).

Direct radiography, computed tomography and magnetic resonance imaging are used to visualize the anatomical variations of the paranasal sinus. Direct radiography is insufficient for detailed imaging of lesions, differential diagnosis, and treatment planning. On the other hand, it is possible to evaluate the ostiomeatal complex pathologies that cause infection in the sinuses in detail using computed tomography. Moreover, using computed tomography, it is possible to evaluate the areas in contact with each other, the degree of mucosal inflammation, anatomical variations causing obstruction, mucocele, osteomyelitis, and complications related to sinusitis. As functional endoscopic sinus surgery has become the routine practice, computed tomography is now one of the most important diagnostic methods in revealing the mucosal pathologies and anatomical variations of the paranasal sinuses (3).

In addition to the fact that the anatomical structure of the nose differs from individual to individual, prominent anatomical variations have been detected in the population, especially in people with chronic sinusitis. It is known that such anatomical variations may cause chronic rhinosinusitis by narrowing the nasal passage and ostiomeatal complex. Agger nasi cell, concha bullosa, septum deviation, hyper-pneumatized ethmoid bulla, Haller cell, paradox middle concha and pneumatized uncinate process can be listed among the most frequently detected anatomical variations using computed tomography (4, 5).

The aim of the study is to determine the prevalence of anatomical variations and mucosal pathologies in patients with chronic rhinosinusitis using computed tomography imaging and to reveal the correlation between these anatomical variations and sinus pathologies.

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2. Materials and Methods

In the study, mucosal pathologies and anatomical variations in paranasal computed tomography scans were evaluated in 100 patients diagnosed with chronic rhinosinusitis referred to our clinic between February-October 2001, as well as 32 individuals as the control group.

Routine otolaryngological examinations were performed for the patients who had clinical complaints such as nasal discharge, postnasal drip, headache, facial pain, and pressure sensation. Patients with nasal or postnasal purulent discharge and/or erythematous changes in the nasal mucosa, and those with air-fluid level or opacity presence in direct radiography were diagnosed with acute sinusitis and administered antibiotic treatment for three weeks. In the follow-up, paranasal computed tomography was performed for patients who have on-going symptoms and findings after the medical treatment.

Patients with maxillofacial trauma, inverted papilloma, paranasal sinus malignancy, immunodeficiency, history of paranasal sinus surgery and patients under 18 years of age were excluded from the study. The control group consisted of 32 patients who did not have sinonasal complaints but had undergone paranasal tomography due to ophthalmologic or neurological complaints or whose tomography sections passed through the paranasal sinuses with no detected pathology in the sinuses.

Paranasal sinus tomography was performed using a General Electric CT Sytec Plus device with 3mm section thickness, 130 mA and 120 kV examination protocol. The images were evaluated by expert radiologists and otolaryngologists separately for each hemicranium and the findings were recorded in the study form. Anatomical variations including Agger nasi cell, concha bullosa, septum nasi deviation, hyper-pneumatized ethmoid bulla, Haller cell, paradox middle concha, and pneumatized uncinate process, as well as sinus pathologies were examined for the rhinosinusitis and control groups. Anatomical variations were evaluated as present or absent regardless of their shape or size. All changes in the sinuses ranging from minimal mucosal thickening to opacifications filling the entire sinus were considered pathological.

In the study, the distribution of mucosal pathologies to the sinuses, the frequency of the presence of at least one anatomical variation in the rhinosinusitis and control groups, the frequency of the presence of each anatomical variation in both groups, the correlation between the anatomical variations and rhinosinusitis in the experiment group, and the effect of the presence of multiple anatomical variations in the same hemicranium on the sinuses were evaluated.

The statistical analyses were performed using the Chi-square test and Fisher's exact test.

3. Results

Of the 100 individuals in the rhinosinusitis group, 65 (65%) were male and 35 (35%) were female. The ages of the patients in this group ranged between 18-81 years, with a mean of 37.4 years. Of the 32 individuals in the control group, 18 (56.2%) were male and 14 (43.8%) were female. The ages of the patients in this group ranged between 19-73, with a mean of 38.5 years.

In the rhinosinusitis group, 172 out of 200 hemicrania (86%) had mucosal pathology in at least one sinus, while no mucosal pathology was observed in any sinus in 28 (14%) hemicrania. It was observed that the most frequently affected sinus was the maxillary sinus in 133 (66.5%) hemicrania, and the least affected sinus was the sphenoid sinus in 37 (18.5%) hemicrania (Table 1).

Table 1. Mucosal pathology distribution over the sinuses

Sinuses (n=200)	Affected sinuses	
	Number	%
Maxillary sinus	133	66.5
Anterior ethmoid sinus	85	52.5
Frontal sinus	65	32.5
Posterior ethmoid sinus	40	20.0
Sphenoid sinus	37	18.5

In the rhinosinusitis group, the number of hemicrania with at least one variation was 175 (87.5%), while this number was 41 (64.1%) in the control group. The number of hemicrania with no anatomical variation present was 25 (12.5%) in the rhinosinusitis group and 23 (35.9%) in the control group. The probability of having at least one anatomical variation in the rhinosinusitis group was 3.9 times higher than in the control group ($p<0.001$).

One of the anatomical variations, agger nasi cell, was distributed differently between the two groups and the difference was statistically significant ($p<0.05$). The differences in the distribution of concha bullosa, septum nasi deviation, ethmoid bulla, Haller cell, paradox middle concha and pneumatized uncinate process between the two groups was not statistically significant ($p>0.05$) (Table 2).

In the evaluation of anatomical variations, it was found that Agger nasi cell presence correlated significantly with frontal, maxillary, and anterior ethmoid sinusitis ($p<0.01$), and the presence of concha bullosa correlated significantly with maxillary and anterior ethmoid sinusitis ($p<0.001$). Similarly, septum deviation was found to be significantly correlating with frontal, maxillary, and anterior ethmoid sinusitis ($p<0.001$), and hyper-pneumatized ethmoid bulla was found to be significantly correlating with anterior ethmoid and maxillary sinusitis ($p<0.001$). Moreover, it was statistically significant that Haller cell correlated with maxillary sinusitis ($p<0.001$), while no significant correlation was found between paradox middle concha or pneumatized uncinate process with sinusitis ($p>0.05$).

Table 2. Distribution of anatomical variations in rhinosinusitis and control groups

Variations	Rhinosinusitis group (n=200)		Control group (n=64)		p
	Number	%	Number	%	
Agger nasi cell	107	53.5	22	34.3	<0.05
Concha bullosa	89	44.5	28	43.7	>0.05
Septum deviation*	43	43.0	10	31.2	>0.05
Hyper-pneumatized ethmoid bulla	39	19.5	11	17.1	>0.05
Haller cell	20	10.0	2	3.1	>0.05
Paradox concha	11	5.5	5	7.8	>0.05
Pneumatized uncinate process	6	3.0	-	-	-

*n=100

It was determined that 32 sinuses were affected in 25 hemicrania without any anatomical variation, while 17 sinuses were found to be affected in 10 hemicrania with four anatomical variations each ($p<0.05$). These findings suggest that the risk of rhinosinusitis increases 1.67-fold in hemicrania with one anatomical variation compared to no anatomical variations, while hemicrania having three anatomical variations have an increased rhinosinusitis risk of 1.89-fold ($p<0.05$) (Table 3).

Table 3. Total number of variations and affected sinuses in the same hemicrania in the rhinosinusitis group

Total number of variations in the same hemicranium	Hemicranium number in the rhinosinusitis group	Total number of affected sinuses	Odds ratio	p-value
None	25	32	-	
1	87	159	1,67	<0.05
2	46	89	1,83	<0.05
3	32	63	1,89	<0.05
4	10	17	1,50	<0.05

4. Discussion

Rhinosinusitis is a commonly observed disorder in the population and has a significant socioeconomical impact. Sinusitis caused by impaired ventilation and mucociliary transport of the paranasal sinuses results in headache, nasal congestion, feeling of fullness on the face, and nasal or postnasal purulent discharge (6-8).

Today, endoscopy and computed tomography are used together and complement each other in the evaluation of paranasal sinus diseases and the detection of pathological conditions and anatomical variations in the ostiomeatal complex (5,9,10,11). Diagnosing the anatomical variations in the ostiomeatal complex, identifying their prevalence, determining whether they contribute to the development of chronic or recurrent sinusitis, and deciding whether to surgically correct these anatomical variations is important for treatment (3,12). Some anatomical variations in the region of the ostiomeatal complex predispose to infection in the middle meatus, leading to secondary infection of adjacent large sinuses (9,13,14,15).

In coronal paranasal tomography of patients with rhinosinusitis, agger nasi cell was detected in 33.7% of the patients in the study by Kaygusuz et al. (2000); in 52.2% by Ünlü et al. (1992); in 98.5% by Bolger et al. (1991); while Kennedy (1988) reported this variation to be present in all the cases studied (9,17,18,19). In our study, agger nasi cell was detected in 53.5% of the patients in the rhinosinusitis group and in 34.3% patients in the control group. The difference between the two groups was statistically significant ($p<0.05$). Stammberger and Wolf (1998) suggested that agger nasi cells pneumatized in varying degrees may cause frontal sinusitis because of frontal recess obstruction (5). In our study, agger nasi cell was found to be correlating with frontal, anterior ethmoid, and maxillary sinusitis ($p<0.001$).

Depending on the degree of pneumatization of the middle concha, if the concha is in contact with the lateral nasal wall, it may cause mucosal edema, polyp, retention cyst, mucocele, and pyocele (5). Yousem et al (2). (1991) reported that the size of the concha bullosa is more important than its presence only (20). When researchers evaluated all conchae with air density as bullous, they found that the prevalence increased up to 53%. Bolger et al. (1991) found the concha bullosa variation to be present in 50% in the control group and 53.6% in the rhinosinusitis group (3,9,13). In our study, all conchae with air density were considered bullous. Concha bullosa was detected in 44.5% of the patients in the rhinosinusitis group and in 43.7% in the control group. The difference between the two groups was not significant ($p>0.05$). Calhoun et al. (1991) reported that concha bullosa is associated with anterior ethmoid sinusitis, but not with ostiomeatal complex disease (13). In our study, a significant correlation was found between concha bullosa variation with maxillary and anterior ethmoid mucosal pathologies ($p<0.001$).

The most studied variation in association with chronic sinusitis is septum deviation. Severely deviated septum narrows the nasal cavity and middle meatus, preventing

proper ventilation and increasing susceptibility to sinus infection (1,3). Calhoun et al. (1991) detected septum deviation in 40% of patients with chronic rhinosinusitis and in 19.5% of patients without a sinus infection and reported that the deviation was associated with anterior ethmoid, posterior ethmoid, and ostiomeatal complex disease (13). In our study, septum nasi deviation was found in 43% of the patients in the rhinosinusitis group and in 31.2% of the control group. The difference between the groups was not significant ($p>0.05$). However, there was a significant correlation between maxillary, frontal, and anterior ethmoid mucosal pathologies on the deviated side of the septum in the rhinosinusitis group ($p<0.001$).

When the ethmoid bulla is excessively pneumatized to completely fill the middle concha cavity, it may cause contact headache without causing an infection. Cysts, polyps, and pus can be seen in the ethmoid bulla itself (16). In patients with rhinosinusitis, Kaygusuz et al. (2000) found hyper-pneumatized ethmoid bulla in 18.1%, while Ünlü et al. (1992) in 26.1% of the patients (17,18). In our study, we found hyper-pneumatized ethmoid bulla with a rate of 19.5% in the rhinosinusitis group and 17.1% in the control group. Although the difference between the groups was not significant ($p>0.05$), the correlation between hyper-pneumatized ethmoid bulla with maxillary and anterior ethmoid sinusitis was significant in the rhinosinusitis group ($p<0.001$).

Depending on their size, Haller cells are considered among the causes of recurrent maxillary sinusitis when infected (16). Milczuk et al. (1993) found ipsilateral rhinosinusitis in 66.7% of cases with Haller cells (21). In our study, maxillary sinusitis was present in 14 of 20 hemicrania with Haller cell in the rhinosinusitis group, and this relationship was statistically significant ($p<0.01$).

It is still debated which image is compatible with rhinosinusitis in the evaluation of paranasal sinuses using computed tomography. While Som (1985) considered all images in which the mucosa can be seen on tomography to be pathological, Havas et al. (1988) reported that the mucosa seen in tomography is not always pathological, but it would be appropriate to evaluate the image together with the clinical representation of the patient. Zinreich et al. (1987) evaluated 100 patients with chronic sinusitis and found that 72% of the ethmoid cells, 65% of the maxillary sinus, 34% of the frontal sinus, 40% of the posterior ethmoids and 29% of the sphenoid sinus were affected (3,16,22). In our study, it was determined that the most affected sinus in the rhinosinusitis group was the maxillary sinus (66.5%), and the least affected sinus was the sphenoid sinus.

Narrow recesses and ostia that provide ventilation and drainage of the sinuses become narrower in the presence of anatomical variations. Subsequent edema and mechanical obstruction affect the mucociliary system, impairing the ventilation and drainage of the sinuses. In our study, mucosal pathology was 1.6 times more common in hemicrania with one anatomical variation compared to no variation presence, while the rate is increased to 1.9-fold in hemicrania with three anatomical variations.

In conclusion, we suggest that the anatomical variations are an important factor in the development of chronic sinusitis and that not only sinuses but also anatomical variations impairing drainage should be corrected in the surgical treatment of rhinosinusitis.

Conflict of interest

None the declare.

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