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RHINOLOGY

Paranasal sinus volumes and headache: is there a relation?

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Abstract

Purpose The aim of the study is to investigate the relation between paranasal sinus volumes and headache in patients with no other rhinologic causes.

Methods Two hundred patients with chronic headache and 99 subjects with no headache or facial pain history in the last 6 months were included in the study. Paranasal computed tomography (CT) scans of both patient and control groups were evaluated. Sixty one patients were excluded from the study due to possible rhinogenic headache CT findings such as secretions and contact points. Sinus volume index (SVI) formula created by Barghouth et al. in 2002 was used to calculate paranasal sinus volumes: SVI = ½. $A \times B \times C$. Mann–Whitney U test was used to compare an independent continuous variable and a continuous variable with non-normal distribution.

Results In the patient group, the total sinus, frontal sinus, and maxillary sinus volumes were found to be significantly lower than those of the control group ($p < 0.001$). Although the total sphenoid sinus volume was found to be lower in the patient group, there was no significant difference between the two groups ($p = 0.013$).

Conclusion Although rhinogenic findings are often related to secondary headache, the relation between paranasal sinus volume and headache is scarcely investigated in the literature. Our study showed that paranasal sinus volumes might have a role in secondary headaches. Furthermore, in contrast to the literature, our study showed a significant relation between headache and smaller paranasal sinus volumes.

Keywords Paranasal sinuses · Sinus volume · Headache · Facial pain

Introduction

Headaches are one of the most frequent reasons for visiting an emergency department (ED), accounting for more than 5 million ED visits in the United States in 2011 [1]. Almost all people experience a type of headache at least once in their lifetime. The major diagnostic pitfalls in approaching patient with severe acute headache in ED are misdiagnosis of primary headache syndromes and undiagnosed secondary causes of headache [2]. Difficulties in reaching the diagnosis can cause treatment incompetence or malpractice. Therefore,

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knowing the underlying mechanisms is essential for accurate evaluation and treatment.

Primary headache is a condition that does not have any specific causes and mostly caused by migraine, cluster or tension type headaches. Secondary headaches are caused by specific reasons, of which rhinogenic headaches are a common entity. Intranasal contact points are one of the most studied causes of rhinogenic headaches and listed by the International Headache Society (IHS) as a new entity in 2004 [3]. It is defined as a headache secondary to mucosal contact points in nasal cavities due to anatomic variations including septal spurs, concha bullosa or misplacement of middle turbinate [4]. On the other hand, there are studies present in the literature presenting results against mucosal contact point theory [5, 6]. Furthermore, acute sinusitis or acute exacerbation of chronic sinusitis is a common cause of facial pain and headache.

Another anatomic variation that is hypothesized to cause rhinogenic headache is hyperaeration of the sinuses which was first described by Urken et al. [7]. In that study, a spectrum of frontal sinus hyperaeration was described as a potential cause of headache. In 2015, Herzallah et al. [8] investigated the relation between sinus volume and chronic headache, and a significant relation was not found.

The aim of the present study was to investigate the relation between paranasal sinus volume and headache in patients with no other rhinologic causes.

Materials and methods

Subjects

In this retrospective study, patient charts and computed tomography (CT) scans of 299 subjects, 200 patients with headache and 99 subjects in control group, were evaluated.

Two-hundred patients who had been admitted to the Department of Neurology with chronic headache were included in the study. All the patients included in the study had been evaluated with both CT and magnetic resonance imaging (MRI) scans and any neurological causes were excluded. Forty-one patients who had visible secretions in CT scans that might be due to sinusitis were excluded from the study. Furthermore, 20 patients who had contact points that might cause headache were also excluded and the remaining 139 patients were included in the study.

The control group included 99 subjects with no headache or facial pain history in the last 6 months. All subjects in the control group had previous paranasal sinus CT scans for other causes.

Review of CT images and volume calculations

Paranasal CT examinations had been performed at 120–400 mA and 80–160 kV, and CT slides 1 mm in thickness were obtained and approximately 120–300 images per CT were evaluated.

All CT scans were evaluated by two otolaryngologists—one resident and one rhinology fellow—and the mean values of the measurements obtained by the two physicians were used for analyses.

Barghouth et al. [9] described a simplified technique to calculate the average paranasal sinus volume in their study in 2002. In that study, sinus volume index (SVI) was found by the equation: $SVI = ½. A \times B \times C$, in which the greatest depth, length, and width of the sinus was calculated using sagittal, axial, and coronal sections, respectively. In our study, the same technique were used to calculate the volumes of maxillary, frontal, and sphenoid sinuses. The volume of the ethmoid sinuses was not calculated due to complex anatomy and vague borders of the sinuses, which might lead to incorrect results (Fig. 1).

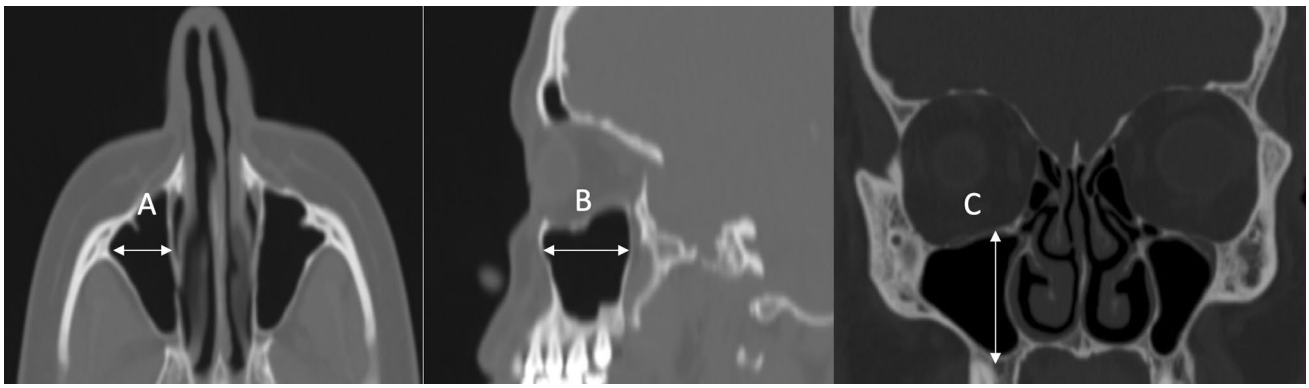

Fig. 1 Paranasal sinus computed tomography sections; *A* width of the evaluated sinus in an axial section, *B* length of the evaluated in sagittal section and *C* height of the evaluated sinus in coronal section

Statistical analysis

Statistical analysis was performed using MedCalc Statistical Software version 12.7.7 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2013).

Descriptive statistics were used to determine continuous variables (mean, standard deviation, minimum, median, and maximum). Normality of the continuous variables was tested using Shapiro–Wilk test. Mann–Whitney *U* test was used to compare an independent continuous variable and a continuous variable with non-normal distribution. The significance level was accepted as $p < 0.05$.

Results

The patient group consisted of 139 patients with a mean age of 39.8 ± 12.7 years (range 19–74 years), of which 97 were females (70%) and 42 were males (30%). The control group included 99 subjects with a mean age of 32.5 ± 14.2 years (range 18–75 years), of which 44 were females (44.4%) and 55 were males (55.6%).

The mean maxillary, frontal, and sphenoid sinuses volumes, and the total sinus volumes (sum of maxillary, frontal, and sphenoid sinuses) of the patients and controls are presented in Fig. 2.

In the patient group, the total sinus, frontal sinus, and maxillary sinus volumes were found to be significantly lower than those of the control group ($p < 0.001$). Although the total sphenoid sinus volume was found to be lower in the patient group, there was no significant difference between the two groups ($p = 0.13$) (Table 1).

Discussion

Headaches due to mucosal contact points in the nasal or paranasal sinus cavities without any evidence of sinonasal inflammation, hyperplastic mucosa, purulent discharge, sinonasal polyps or masses are described as rhinogenic headaches. It is an entity associated with headache or facial pain syndromes. Patients and some primary care physicians inaccurately use the phrase "sinus headache" to relate some headaches to sinonasal pathologies; however, it is a misdiagnosis that can lead to improper treatment [10]. If the symptoms are thought to be secondary to sinonasal abnormalities, "rhinogenic headache" would be a more accurate description [11]. In one study, 42% of the patients diagnosed as migraine according to the IHS guidelines were previously misdiagnosed as sinus headache by internal medicine doctors [12]. The topic of contact point-induced headache has been widely discussed in the literature, remains controversial and has been debated within the fields of otolaryngology and neurology [11].

Volumes of the paranasal sinuses are another topic of interest when studying rhinogenic headache. The role of

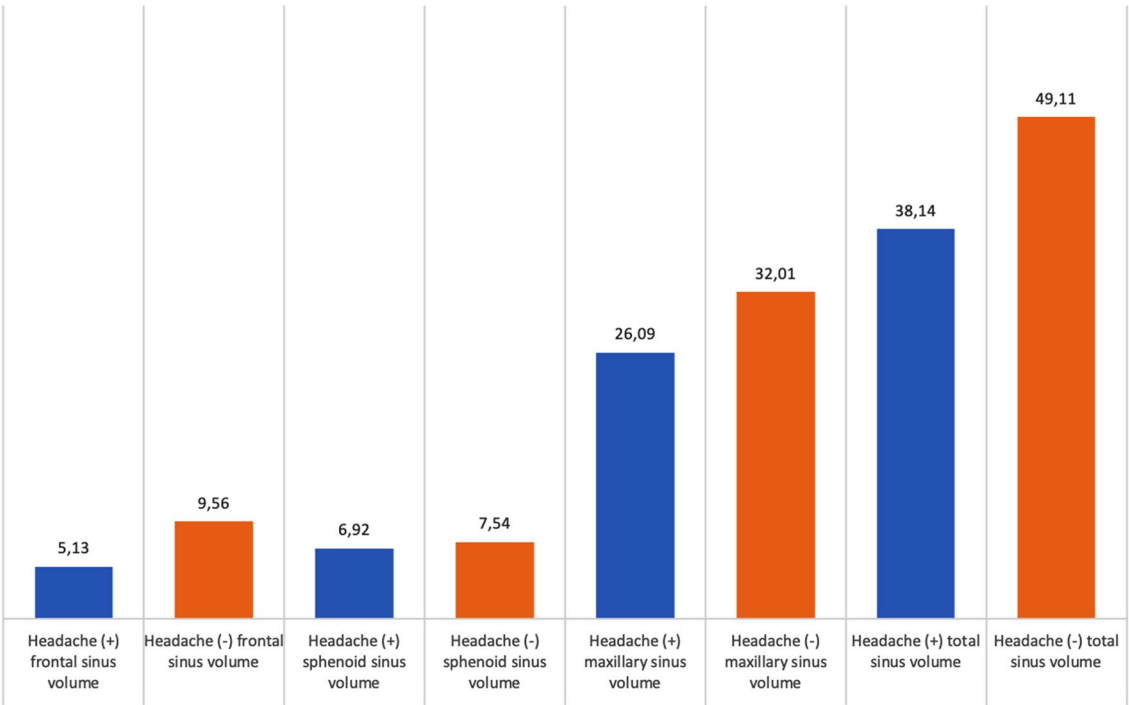

Fig. 2 Average paranasal sinus volumes of patient group and control group

Table 1 Calculated sinus volumes and inter-group comparison of the parameters

	Headache (−) $N=99$		Headache (+) $N=139$		
	Mean ± SD (cm^3)	Median (min–max)	Mean ± SD (cm^3)	Median (min–max)	p*
Total frontal volume	9.56 ± 7.1	8.4 (0–41.1)	5.13 ± 4.65	3.6 (0–25.5)	**< 0.001**
Total sphenoid volume	7.54 ± 3.8	6.9 (0.6–19.2)	6.92 ± 3.99	6.1 (0.0–21.8)	**0.013**
Total maxillary volume	32.01 ± 12.45	30.6 (4.5–67.6)	26.09 ± 13.1	24.4 (7.6–121.1)	**< 0.001**
Total sinus volume	49.11 ± 17.7	46.2 (15.9–98.9)	38.14 ± 16.8	34.3 (10.5–127.9)	**< 0.001**

Bold values are calculated sinus volumes and Inter-group Comparison of the Parameters

N number

p*: level of significance < 0.05

paranasal sinus volumes on this group of patients is still unclear. The aim of the present study was to investigate if paranasal sinus volumes had a role in rhinogenic headache. Patients with long-standing headache and those without headache but with paranasal sinus computed tomography (PNS-CT) investigation for other reasons were evaluated. The mean maxillary, frontal, and total sinus volumes were significantly lower in the headache group when compared to the control group. Although the mean sphenoid sinus volume was lower than that of the control group, the difference between the two groups did not reach statistical significance. These findings are in contrast with some case reports in the literature which suppose that some rhinogenic headaches are related to enlarged frontal sinuses (frontal pneumosinus dilatans) [13, 14]. These papers evaluated only frontal sinus volumes without considering the volumes of maxillary and sphenoid sinuses [13, 14]. To the best of our knowledge, in the literature, there is only one publication in which the volumes of all paranasal sinuses were evaluated in patients with headache symptoms. The authors found no significant difference in maxillary, sphenoid, frontal, and total sinus volumes between a group suffering from chronic headache and a control group without any headache symptoms [8].

Differential diagnosis is essential in patients with headache, as primary headache and secondary headache due to paranasal pathologies have similarity in symptomatology. Septal deviation, septal spur, and concha bullosa are the most relevant common paranasal sinus abnormalities and anatomic variations which cause secondary headaches [15]. While there are studies which suggest that nasal and paranasal anatomic variations such as septal spur, septal deviation, concha bullosa, and nasal mucosal contact points may cause headache [16, 17], some other studies found no association between them [8]. Anatomic variations were not studied in the present study.

In the present study, 139 patients with chronic headache were evaluated and no evidence for primary or secondary headaches was found. All of them had a follow-up period of a minimum of 6 months. PNS-CT scans revealed no rhinosinusitis or paranasal mucosal inflammation. All other pathologies which could cause headache were excluded. Results of our study revealed statistically significant lower volumes in patients with chronic headache. These results lead us to think that the differences in paranasal sinus aeration and volumes may be a reason in otherwise unexplained headaches. This is in contradiction with the reports published by Herzallah et al. [8]. No significant difference was found in the mean sphenoid sinus volume between the two groups. On the other hand, mean maxillary and frontal sinus volume, and total sinus volume were lower when compared with that of the control group. These results raise the question whether the ratio between maxillary, ethmoid, frontal, and sphenoid sinus volumes plays a role in rhinogenic headache pathophysiology.

The localization of headache and the severity of the symptoms were not assessed in the present study. These issues along with the limited number of patients were the obvious weak points of this study.

Conclusion

Although rhinogenic findings are often related to secondary headache, the relation between paranasal sinus volume and headache is scarcely investigated in the literature. Our study showed that paranasal sinus volumes might have a role in secondary headaches. Because of the limitations of the present study, further studies with larger groups are needed to be performed on this topic.

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Compliance with ethical standards

Conflict of interest There is no conflict of interest among the authors.

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