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Anatomic Variants of Paranasal Sinuses and Chronic Sinusitis

Background/Objectives: There are normal anatomic variants of paranasal structures, with concha bullosa (pneumatization) of the middle turbinate and septal deviation being the most common. It is assumed that these anatomic variants contribute to chronic sinusitis by blocking normal sinus drainage. This study investigated this assumption among the chronic sinusitis patients referring to Radiology departments affiliated to Medical Sciences universities.

Patients and Methods: A case-control study was carried out on 148 patients with a clinical diagnosis of chronic sinusitis who were referred for a sinus CT scan by ENT specialists. The control group (n= 78) were chosen from the ENT clinic patients with diagnoses other than sinusitis. The association between the anatomic variants (concha bullosa of inferior and middle turbinate, agger nasi cell, haller cell, giant ethmoidal bulla, septal deviation and inverted uncinate process) and existence of chronic sinusitis was shown with odds ratio (OR) and 95% confidence interval. Logistic regression analysis was performed for adjusting the confounders.

Results: One hundred and eight (47.8 %) patients were male. The mean (\pm SD) age was 35.5 (\pm 12) years. No difference was seen in the age and gender distribution between the cases and controls. Septal deviation and concha bullosa of middle turbinate were the anatomic variants significantly associated with chronic sinusitis (respectively OR= 2.04, CI: 1.07-3.89; and OR= 2.19, CI: 1.12-4.30). Besides, we found that agger nasi cell (OR: 0.7, CI: 0.64-0.77) and inverted uncinate process (OR: 4.76, CI: 1.92-24.5) were associated with the occurrence of ethmoidal and frontal sinusitis, respectively. No confounding effect was seen on logistic regression analysis.

Conclusion: Normal anatomic variants of paranasal sinuses may be considered as predictors for the occurrence of chronic sinusitis. The positive effect of any procedure for correction of these variants should be shown through other studies.

Key words: sinusitis, conche nasale, osteomeatal unit

Introduction

Chronic sinusitis is repeated bouts of acute infection or persistent inflammation of the sinuses.¹ Sinusitis is a very common disease, and factors which cause immunosuppression or any blockage of normal sinus drainage are responsible for this condition.¹ CT scan is the imaging modality of choice in paranasal sinusitis, revealing anatomic details of the sinuses and the adjacent soft tissue.² The imaging signs suggestive of chronic sinusitis are: mucosal thickening, sinus opacity, retention cyst, and bone changes such as deformity or sclerosis that indicate osteitis and polyposis.² Untreated chronic sinusitis can result in severe complications such as orbital cellulitis, osteomyelitis, subdural empyema, frontal lobe abscess, cavernous sinus thrombosis, and death.³ Identifying the predisposing factors for chronic sinusitis are therefore very important. Particularly, paranasal anatomical variants have been investigated by several studies, and concha bullosa has been shown to be a common predisposing factor for sinusitis.⁴ Studies report the prevalence of concha bullosa and chronic sinusitis to be 35% in Italy, and 47% in Hong Kong,⁵⁻⁷ despite its reported Switzerland, 59% in 10% prevalence in the normal population.² Another

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study in Spain in 1995 reported 4 cases of concha bullosa with remitting sinusitis who were cured by endoscopic operation on the middle turbinate. ⁸ However, in some studies no relationship was found between the anatomic variants and sinus diseases.

In regard with the above-mentioned differences in the reports, and the prevalence of chronic sinusitis and its complications, we carried out this study to determine the relationship between the paranasal anatomic variants and the incidence of chronic sinusitis.

Patients and Methods

From June 2000 to September 2001, 148 consecutive patients with the clinical diagnosis and positive CT scan findings of chronic sinusitis were chosen as cases in this case - control study. These patients were referred from ENT clinics of general hospitals affiliated to medical universities in Tehran. The control group were selected from the patients of the same clinics with clinical diagnoses other than sinusitis and indication of CT scan imaging (n= 78).

The information about age, gender, mode of CT scan (coronal or axial), imaging evidences of inflammatory disease for each sinus (only for the case group), and paranasal anatomic variants (for both cases and controls) was recorded.

The anatomic types that were assessed included: septal deviation, concha bullosa of the middle and lower turbinates, the uncinat process, giant ethmoidal bullae, haller cells, giant agger nasi cells, and reverse uncinat process. The presence of each of these anatomic variants was diagnosed according to the imaging descriptions in the CT scan reference books. CT scan instrument were General Electric (GE), 9800 and spiral Siemens. Paranasal sinus CT scans are generally performed by coronal views with thin slices (5-8 mm) and in the osteomeatal complex area thinner slices (2mm) are used.

The association between chronic sinusitis and presence of anatomical variants of paranasal sinuses were measured by calculation of odds ratio (OR) with 95% confidence interval (CI). Because of a high suspicion of the confounding effect of the variants on the study results, logistic regression models were used.

Results

Descriptive information of the study participants are abstracted in table 1.

The mean age (\pm SD) was 35.6 (\pm 12) years in the cases, and 35.4 (\pm 11) in controls. No significant difference was seen between these results (two-tailed t-test, $p= 0.60$). Also, male comprised 77 (52%) of the cases, and 31 (39.7%) of controls. No significant difference was seen (chi-square test, $p=0.08$)

We found an association between presence of concha bullosa in middle turbinate and the septal deviation. The odds ratio (OR) and 95% confidence interval were 2.04 [1.07-3.89] and 2.19 [1.12-4.80], respectively.

Data analysis in subgroups showed an association between the presence of anatomic variants and the occurrence of chronic sinusitis in any of the paranasal sinuses (Table 2). This association was very strong in maxillary, frontal and sphenoidal sinusitis. Concha bullosa of turbinates, septal deviation, giant agger nasi cells and inverted uncinat process were variants which showed significant associations in different

Table 1. Descriptive statistics of background variables in participants of the study

	No. of cases (%)
Sinusitis	148 (65.5%)
Ethmoidal sinusitis	62 (27.6%)
Maxillary sinusitis	140 (61.9%)
Frontal sinusitis	41 (18.2%)
Sphenoid sinusitis	48 (21.2%)
Pansinusitis (>3 sinuses)	31 (13.7%)
Anatomic Variants	121 (53.5%)
Nasal septum	
ucosal thickness	11 (4.9%)
eviation	51 (22.6%)
Inferior turbinate	
Mucosal thickness	28 (12.4%)
Concha bullosa	6 (2.7%)
Middle turbinate	
Mucosal thickness	14 (6.2%)
Concha bullsca	53 (23.5%)
Giant bullae	25 (11.1%)
Haller cell	10 (4.4%)
Giant agger nusi cell	14 (6.2%)
Inverse uncinat process	6 (2.6%)

Table 2. Association between anatomical variants and types of sinusitis

	OR	[95% CI]*
Ethmoidal sinusitis	2.82	[2.15-3.69]
Maxillary sinusitis	350	[143-2110]
Frontal sinusitis	777.77	[95.78-6313]
Sphenoidal sinusitis	610	[125-3213]

* Odds ratio and 95% confidence interval

types of sinusitis (Table 3).

None of the above mentioned variants had been accepted in logistic regression models.

Discussion

The current study revealed that among all the observed paranasal variants, concha bullosa of middle turbinate and septal deviation were associated with the occurrence of chronic sinusitis.

Also, there was a significant association between presence of anatomic variants and occurrence of chronic sinusitis for each paranasal sinus. Except for ethmoidal sinusitis, this association was very strong.

In a study by Scribno, 1997 Italy, 59% of their patients with chronic sinusitis had concha bullosa and 5% of them had large ethmoidal bulla. The remarkable difference between the prevalence of these variants among their patients as compared with the normal population lead to the conclusion that these anatomic changes probably increase the risk of sinus inflammatory diseases by bringing the mucosal lining of the osteomeatal unit in contact with the mucosal lining of the paranasal sinuses.⁶ Also in a Swiss study, S-Nadas reported that 35% of 151 patients with chronic sinusitis had middle turbinate concha bullosa, and after resecting the anterior third of the pneumatized turbinate, 80% of the patients showed

improvement in their symptoms.⁵ Also another study by Lam on 100 patients with signs and symptoms of chronic sinusitis, spiral CT scan of the paranasal sinuses yielded 47 cases of concha bullosa and a significant relationship between this finding and chronic sinusitis was observed.⁷ Moreover, Masegur reported 4 cases of concha bullosa with chronic sinusitis who underwent endoscopic operation on the middle turbinate, and all the 4 patients were relieved of their symptoms

There are other studies indicating the role and association of concha bullosa in chronic sinusitis.⁹⁻¹¹ However, a few studies like Tati's in 2001 and Unlv in 1994 found no relationship between the anatomic abnormalities and chronic sinusitis.^{12, 13}

Taking into account the normal anatomy of the paranasal sinuses and the osteomeatal unit (i.e. middle meatus, frontal recess and infundibulum), any anatomical abnormality that impedes sinus drainage can potentially cause (chronic) sinus inflammation. Among the anatomic variants, concha bullosa (especially the larger ones), and giant ethmoidal bulla occur in the vicinity of maxillary sinus infundibulum, and agger nasi cells are close to the frontal sinus recess. Therefore, they can compress these outlets.¹ It can be postulated that concha bullosa compresses semilunaris hiatus that is in continuity with maxillary sinus infundibulum, and the mucosal linings of these parts come into contact this sets the stage for mucosal inflammation, which persist as long as the anatomical abnormality is present, causing chronicity.

In our study, the odds of presence of concha bullosa was 2.04 times as common among the individuals with chronic sinusitis as in the controls (95% CI: [1.07-3.89]).

Table3. Association of different variants and types of sinusitis*

Anatomical variants	ethmoidal	Maxillary	Frontal	sphenoidal
Concha bullosa of middle turbinate	2.89 [1.56-5.35]	—	2.85 [1.42-5.7]	5.62 [2.81-11.10]
Concha bullosa of inferior turbinate	3.24 [1.33-6.87]	2.22 [0.95-5.16]	5.90 [2.67-13.05]	5.19 [2.39-11.26]
Septal deviation	—	2.39 [1.24-4.63]	2.83 [1.40-5.71]	2.91 [1.49-5.69]
Giant Agger nasi cell	0.70 [0.64-0.77]	—	—	—
Inverted uncinate process	—	—	4.76 [1.92-24.5]	—

* Numbers in the table represents odds ratio [95% confidence interval].

Also, the odds of the presence of septal deviation in patients with chronic sinusitis was 2.19 times more than the odds in the controls (95% CI: [1.12-4.30]). This finding shows that the deviation of nasal septum may interfere with normal drainage of sinuses and cause chronic inflammation, with the above-mentioned mechanisms.

In our study, the giant ethmoidal bulla was slightly more common among the patients with chronic sinusitis (12.2% vs. 9% in normal participants) but the difference was not significant. No association was found between these anatomical variants and chronic sinusitis which can be explained as follows:

The size of the ethmoidal bullae must be really large to compress the osteomeatal unit from the superior portion of the maxillary infundibulum. In the current study the moderately large ethmoidal bullae were grouped together with true large bullae, and this may have caused the difference.

An interesting finding in our study was the preventive effect of presence of giant agger nasi cells on occurrence of ethmoidal sinusitis (OR= 0.70; 95% CI: [0.64-0.77]). Another noticeable finding was the association of inverted uncinate process with frontal sinusitis (OR=4.76; 95% CI: [1.92-24.5]).

We did not notice any association between agger nasi cells and chronic frontal sinusitis. We assume that was because in our patients, the size of this anatomic variant was not large enough to exert mass effect on the frontal recess. It is noteworthy that in other studies as well, there has been no report on association between this variant and chronic sinus inflammation.

For other structural changes, like haller cells, normally we do not expect serious pressure effect or a higher prevalence of chronic sinusitis, since they occur away from the osteomeatal unit.

Performing the logistic regression analysis showed that no known confounding effect had existed in the study results. Therefore, we can conclude that no important relationship exists among different anatomical variants of paranasal sinuses. However, the way we had selected our control group, may have brought

some degrees of selection bias into our study. It would be better to select the control group from clinics other than ENT clinics. This form of bias may shift the study results toward the null hypothesis (i.e. no difference between the study groups).

Conclusion

Chronic inflammatory diseases of the sinuses can entail severe complications. Identifying the predisposing factors for these complications and eliminating them can prevent the inflammation from becoming chronic. Concha bullosa of the middle turbinate is one of those predisposing factors that can be successfully treated by sinus endoscopic operation. Hence, its diagnosis has important clinical implications in our country as well as every other region.

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