

Nasal and Paranasal Sinuses Anatomical Variations in Patients with and without Chronic Rhinosinusitis

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ABSTRACT

Background: The development of computed tomography (CT) technique results in development in visualization of the anatomic structures of the lateral nasal wall. It allows the anatomic variations of this region to be identified precisely, which is important in surgical treatment of chronic rhinosinusitis.

Purpose: The aim of this study was to determine the incidence of anatomic variations of the lateral nasal wall in a group of patients with chronic rhinosinusitis and to compare these results with the control group.

Methods: One hundred patients with chronic rhinosinusitis and 50 control subjects who were referred to Loghman Hakim general hospital, Tehran, Iran, were included in this retrospective study.

Results: High septal deviation, presence of large bulla ethmoidalis and middle turbinate concha bullosa showed to be statistically correlated to increased risk of chronic rhinosinusitis. For other anatomical variations, no statistically significant differences in incidence of chronic rhinosinusitis observed.

Conclusion: Relation between anatomical variation and rhinosinusitis was confirmed only for high septal deviation, middle turbinate concha bullosa and large bulla ethmoidalis. Surgical Approach to these variations may have a role in prevention or treatment of rhinosinusitis.

Keywords: Paranasal sinuses, Anatomical variation; Rhinosinusitis.

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INTRODUCTION

Radiological evaluation of paranasal sinuses, are complementary for history and physical examination. Imaging has a significant role in diagnosis, treatment and follow up of patients. CT scan is the method of choice for imaging of paranasal sinuses (1). This technique has the ability of presenting acceptable demonstration of bone, air and soft tissue and is appropriate for detailed evaluation of nose and paranasal sinuses anatomy including osteomeatal complex (OMC) (2). Coronal images are preferred for evaluation of OMC, and to evaluate the relationship between sinuses and ethmoid roof, orbit and brain (1).

Paranasal sinuses have considerable anatomical variations which are not pathologic in most cases. On the other hand, sometimes, there is no identifiable cause for rhinosinusitis but anatomical anomalies. Recent advancements in

endoscopic sinus surgeries, led to more comprehended attention to anatomical variation in patients and these findings are valuable for making an appropriate decision for surgery and follow up of patients (3).

Relation of anatomical variations and chronic rhinosinusitis (CRS) is not well recognized. Variations in anatomy of uncinate process, maxillary sinus and importance of sphenoidal (Onodi) air cells and agger nasi are considered by some authors (1-3). There are many evidences that support the relationship of anatomical variations and paranasal sinus (PNS) diseases. The obstruction of sinuses ostia is a key factor in pathogenesis of rhinosinusitis. This is reasonable that specific anatomy of the region, which causes complete or partial obstruction of an ostium, produces the underground of chronic rhinosinusitis (2,3).

Evaluation of the relationship between anatomical variations and chronic rhinosinusitis needs comparison of anatomy of patients with CRS and healthy subjects. The aim of this study is to investigate the potential relations between nasal and paranasal sinus anatomical variations and increased risk for occurrence of chronic rhinosinusitis.

PATIENTS and METHODS

In this retrospective study, we evaluated coronal PNS CT scans performed in 100 patients whom had chronic rhinosinusitis based on criteria of rhinosinusitis. We used CT images of 50 patients who underwent imaging for a reason other than sinusitis as control. These were patients with hypophyseal macroadenoma and were candidate for endoscopic trans-sphenoid resection. The images analyzed by a team of an otolaryngologist and a radiologist. Anatomical variation of each group was recorded in a record sheet. The nasal septum observed as having deviation, bony spur, perforation and septal bullosa. Middle turbinate observed for concha bullosa, paradoxical curvature and hypertrophy. Superior turbinate examined for diagnosis of concha bullosa. Inferior turbinate observed for concha bullosa, paradoxical curvature and bony or mucosal hypertrophy. Hypoplasia of maxillary sinus, intersinus septums and presence of Haller's cell were considered in observation of maxillary sinus. Uncinate process attachment was assessed. Attachment to lamina papyracea, skull base and middle turbinate assigned as type 1, 2 and 3 respectively. Uncinate process was also observed for being pneumatized, medialized, lateralized, anteriorized or atelectatic. Bulla ethmoidalis was examined to see whether it has a normal or large size. In the later instance, bulla ethmoidalis may obstruct OMC. We observed presence or absence of agger nasi and lateral sinus in CT Scans. Frontal sinus was examined for inter-sinus septum. The presence

and number of supra-orbital and supra-bullar cells determined. Fovea ethmoidalis and lamina papyracea examined for any evidences of dehiscence. In sphenoid sinus we evaluated the presence of horizontal or vertical septum and bulging of internal carotid artery and optic nerve into the sinus. Regarding to optic nerve, type 1 considered when no effect of nerve was observable in the sinus. Type 2 was slight bulging, type 3 was significant bulging and type 4 considered as dehiscence in the bony barrier between the nerve and sinus mucosa. The presence of Onodi cells were determined. We looked for the type of cribriform plate. Type 1 assigned as a plate that was in the same level with fovea ethmoidalis. Type 2 was when it lied slightly lower and type 3 was when it was significantly lower than fovea ethmoidalis.

In rhinosinusitis cases, a disease group was identified as one of the followings: Infundibular, OMC, sphenothmoidal, isolated and pansinusitis/polyposis. Exclusion criteria were history of sinunasal surgery, history of maxillofacial trauma and presence of a destructive disease in nasal cavity or paranasal sinuses. A radiologist reviewed all CT scans and recorded the characteristics of each patient's anatomy in a checklist. An analyzer who was blind about the diagnosis of the patients analyzed these data. Statistical analysis performed by X² test using SPSS ver. 17 for windows. Results of the two groups compared to find out any statistically significant differences.

RESULTS

There were 100 patients in case group (62 males/38 females) with mean age of 34.5 ± 11.2 years and 50 patients in control group (24 males and 26 females) with mean age of 43.4 ± 8.1 years.

Respiratory allergy was present in 47.5% and 38.2% of patients in case and control groups respectively. This difference was not statistically significant.

Hypersensitivity to aspirin was found in 18.6% of cases and 3.3% of controls and asthma was found in 45.7% of cases and 13.3% of controls.

Table.1 Nasal Septum Anatomical Variations in Case and Control Groups

		Bony Spur	SD	High SD	Septal Bullosa	Normal	Total
Case	Number (%)	12(12)	49 (49)	24(24)	12 (12)	3 (3)	100 (100)
Control	Number (%)	8 (16)	27 (54)	4(8)	6 (12)	5 (10)	50 (50)
Total	Number (%)	20 (13.3)	76 (50.7)	28	18 (12)	8 (5.3)	150 (100)

Table.2 Middle turbinate Anatomical Variation in Case and Control Groups.

		Middle Turbinate				
		Concha Bullosa	Paradoxical	Hypertrophy	Normal	Total
Case	Number (%)	52 (26)	10 (5)	4 (2)	134 (67)	200 (100)
Control	Number (%)	10 (10)	4(4)	0	86 (86)	100 (100)
Total	Number (%)	62 (20.7)	14(4.7)	4 (1.3)	220 (73.3)	300 (100)

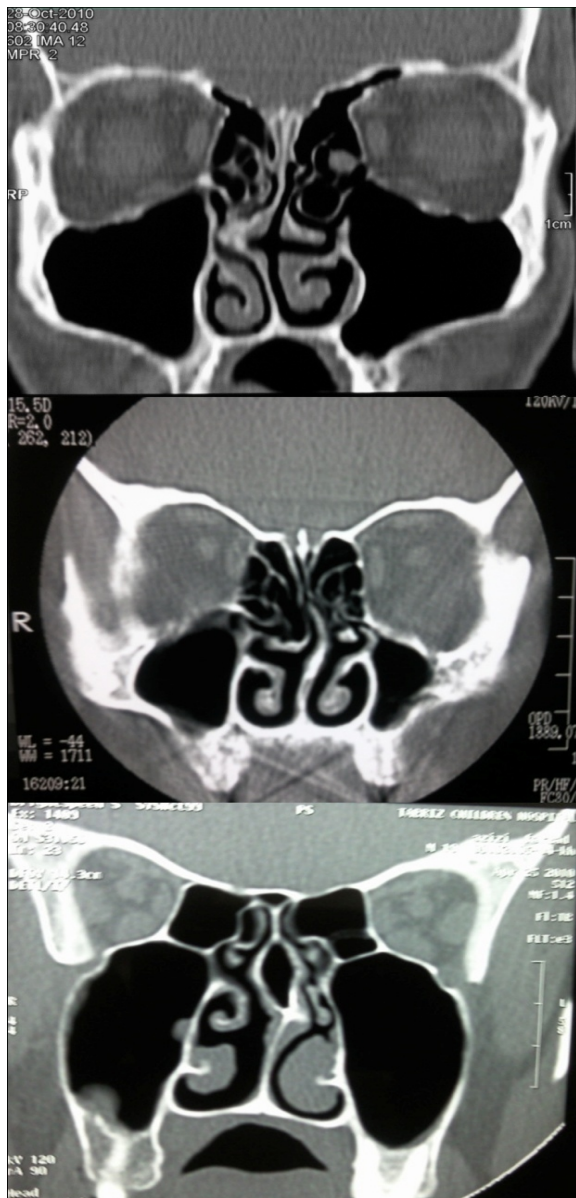


Figure 1. Nasalseptum. Top: bony spur, Middle: high septal deviation, Bottom: septal bullosa

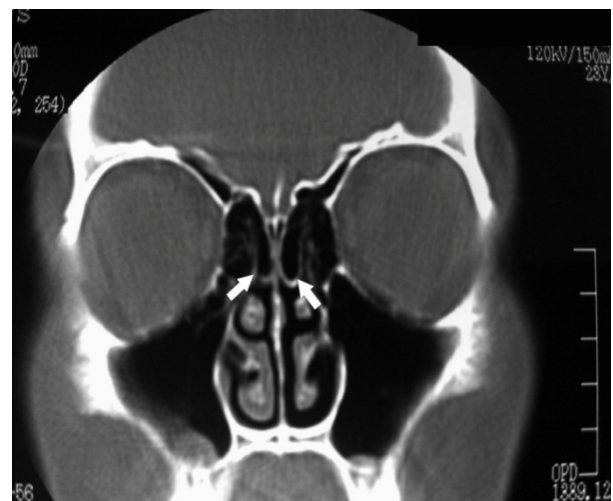


Figure 2. Bilateral superior turbinate concha bullosa (arrows).

These differences were statistically significant ($p < 0.005$). In patients with chronic rhinosinusitis, 18% had infundibular disease, 37% OMC pattern, 6% sphenothmoidal pattern, 7% isolated sinusitis and 14% pansinusitis/ polyposis. In this group, mean Lund-Mackay Score was 5.27 ± 2.46 . All sinunasal anatomic elements except nasal septum were paired, so the sample size was doubled while we were studying them. We found many anatomical variations in nasal septum (Figure 1). More than half of patients in both groups had degrees of septal deviation (SD). However deviation in higher portions of septum was significantly more common in case group ($p < 0.005$) (Table 1).

Table 3. Maxillary Sinus Hypoplasia Grade in Case and Control Groups.

		Maxillary Sinus Hypoplasia Grade				Total
		No	1	2	3	
Case	Number (%)	172 (86)	10 (5)	14 (7)	4 (3)	200 (100)
Control	Number (%)	96 (96)	4 (4)	0	0	100
Total	Number (%)	268 (89.3)	14 (4.7)	14 (4.7)	4 (1.3)	300

Table 4. Optic Nerve Type in Case and Control Groups.

		Optic Nerve Type				Total
		1	2	3	4	
Case	Number (%)	126 (63)	32 (16)	20(10)	22(11)	200 (100)
Control	Number (%)	72(72)	16(16)	4(4)	8(8)	100 (100)
Total	Number (%)	198 (66)	48 (16)	24(8)	30 (10)	300 (100)

Table 5. Cribriform Plate Type in Case and Control Groups.

		CP Type			Total
		1	2	3	
Case	Number (%)	26 (13)	124 (62)	50 (25)	200 (100)
Control	Number (%)	18 (18)	62 (62)	20 (20)	100 (100)
Total	Number (%)	44 (14.7)	186 (62)	70 (23.3)	300 (100)

Table 6. Uncinate Process Attachment in Case and Control Groups.

		Uncinate Process Attachment			Total
		Lamina Papyracea	Skull Base	Grand Lamella	
Case	Number (%)	76 (38)	94 (47)	30 (15)	200 (100)
Control	Number (%)	34 (34)	54 (54)	12 (12)	100 (100)
Total	Number (%)	110 (36.7)	148 (49.3)	42 (14)	300 (100)

Among patients with both high SD and rhinosinusitis, 17 patients (70.8%) had OMC or infandibular pattern. Superior turbinate was normal in most cases. We found 4 concha bullosa of superior turbinate in case group (2%) (Figure2). There were 50 middle turbinate concha bullosa in case group (25%), while 12% of middle turbinate's in control group had concha bullosa. This difference was statistically significant ($p < 0.005$). (Table 3, Figure 3). In cases with a middle turbinate concha bullosa, 41 ones (78.8%) had a OMC pattern. Hypertrophy of inferior turbinate was found in 46% (14% bony and 32% mucosal) of turbinate's in case group and 32% (8% bony and 24% mucosal) in control group. The difference was not significant. Ten percent of maxillary sinuses in case group and 6% in control group had intra-sinus septations. The difference was not significant. We also did not find a significant difference in number of patients with maxillary sinus hypoplasia in case and control groups (Table 4). Haller

cells (Figure 4) were present in 15% of maxillary sinuses in case group and 12% in control group (not significant). Septation of frontal sinus was found in 12% of sinuses in cases and 10% in controls. Septation of sphenoid sinuses was more common and found in 50% of sinuses in cases and 52% of controls. None of these differences were significant. We found 14 Onodi cells in case group (14%) and 12 in control group (12%). The anatomic variation of optic nerve in our patients is shown in table 5.

The bony barrier between internal carotid artery and sphenoid sinus was dehiscence in 9% of sinuses in cases and 10% in controls (9.3% in total). Type of cribriform plate in our patients is shown in table 6. This plate was dehiscence in 14% of sides in case group and 12% in controls. Dehiscence in fovea ethmoidalis was found in 7% of sides in cases and was not present in controls. We also found 18 dehiscence lamina papyracea correlation was not statistically significant ($p = 1.213$).

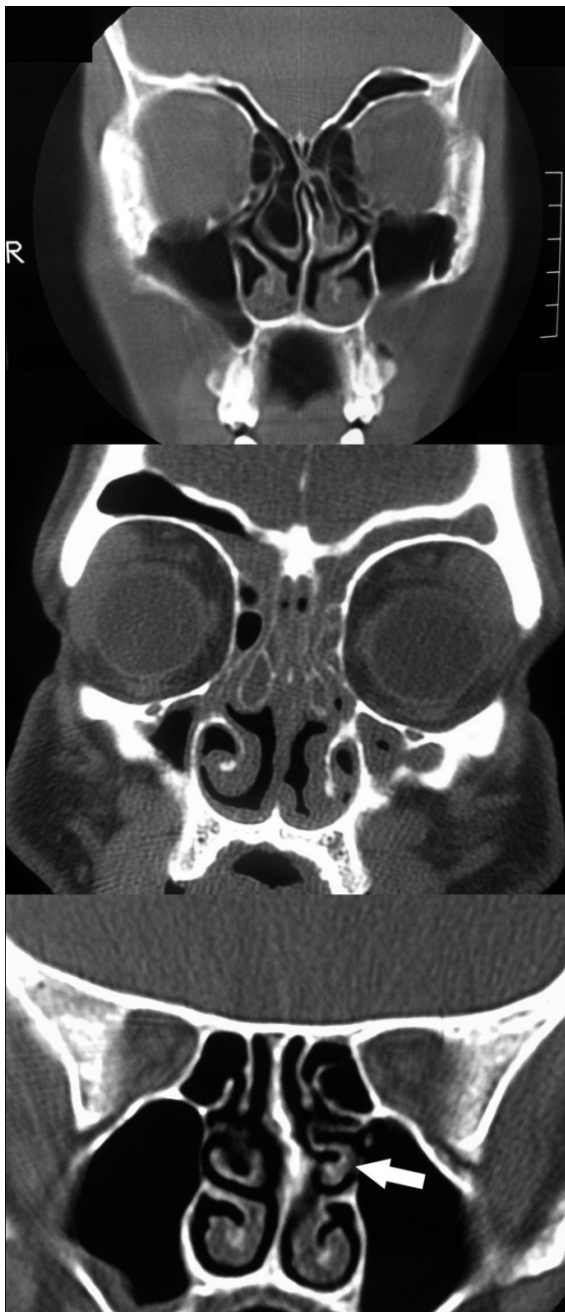


Figure 3. Middle turbinate. Top: Right side concha bullosa, Middle: Bilateral concha bullosa in a patient with OMC Pattern Rhinosinusitis, Bottom: Paradoxical curvature (Arrow).

Supra bullar ethmoid cells were present in 19% of ethmoid cases and 14% in controls. We looked for the attachment of uncinata process and found that most common attachment is to skull base (Table 6). We found 3 atelectatic uncinata processes in our cases (Figure 4). All of these patients had



Figure 4. Atelectasis of left uncinata process (arrow) and left side maxillary sinusitis. Uncinata process of right side (arrow head) is normal. There is also a three chambered middle turbinate concha bullosa in left side.

maxillary sinusitis due to infundibular obstruction. Bulla ethmoidalis was detected due to its size and possible obstruction of OMC. In the case group, in 38 ethmoid labyrinths (19%) there was a large bulla ethmoidalis that could potentially obstruct OMC while such an anatomy was found only in 4% of ethmoids in control group. This difference was statistically significant ($p < 0.005$). Among Cases with a large bulla, 30 patients (76.9%) had OMC or infundibular pattern and 8 patients (21.1%) had pansinusitis/polyposis. Agger nasi cells were very common among our patients and could be found in 85% of sides in cases and 86% in controls but the correlation was not statistically significant ($p = 0.912$).

Discussion

In the present study we evaluated the correlation between anatomical variation of paranasal sinuses and occurrence of chronic rhino-sinusitis. There was a significant difference between case and control groups in prevalence of asthma and aspirin hypersensitivity. These correlations (especially with polyposis) were well demonstrated in previous studies (1,4) Different kinds of septal deviation, including cartilaginous deviation, bony deviation, bony spur and high septal deviation were found in more than 90 percent of patients;

but, high septal deviation was the only variation that had a significant relation with chronic rhinosinusitis. This finding was in correlation with other similar studies (5, 6). It seems that deviation in higher portions of nasal septum affects the drainage of osteomeatal complex (OMC) more than other parts. In most of cases, which had a high septal deviation, the pattern of rhinosinusitis was OMC or infandibular. This is important because a diffuse mucosal involvement that is observed in pansinusitis and diffuse polyposis is not assumed to have a specific relation with anatomical variations. Our finding is in favor of a cause and effect relation between high septal deviation and some patterns of rhinosinusitis. Nonetheless, confirmation of this kind of relation needs more studies and probably clinical trials that focus on this anatomical site.

There was no significant relation between superior turbinate variations and chronic rhinosinusitis. On the other hand, superior turbinate concha bollusa is a recognized cause of occurrence of rhinogenic contact point headache (6) and this study showed that we should expect this variation in 2% of cases.

Concha bollusa of middle turbinate had a significant relation with chronic rhinosinusitis. This relation was also noticed in other studies (5, 7). In our experience, this relation occurs when a large or lateralized concha bollusa obstructs sinus ostia. In the majority of cases, a simultaneous variation such as large bulla ethmoidalis or high septal deviation was also present that led to more significant effect of middle turbinate concha bollusa. Most patients had OMC pattern of rhinosinusitis. Other variations of middle turbinate including hypertrophy and paradoxical curvature did not show a significant relation with chronic rhinosinusitis.

We did not found any relation between inferior turbinate variations and chronic rhinosinusitis. We also did not find any other studies in which such a relation was reported.

Looking for a Haller's cell is important before surgical manipulation of patients. The presence of these cells may increase the risk of orbital complications during functional endoscopic sinus surgery, especially for a careless surgeon. We did not find any correlation between presence of these cells and chronic rhinosinusitis. This relation was mentioned in other previous reports (6-8) Maxillary sinus hypoplasia and septations are also variations that should be considered during surgery but were not related with sinusitis.

We detected a large bulla ethmoidalis that was radiologically obstructed OMC in 36% of ethmoid labyrinths. This variation was significantly related to rhinosinusitis. Most of these patients had a OMC pattern. Careful observation of imaging for detection of such a variation and a surgical manipulation to remove any obstruction caused by that seems to be critical for appropriate treatment of these patients.

According to some reports, the type of uncinata process attachment may affect the pattern of rhinosinusitis and number of involved sinuses (1, 2 and 9). We did not find any relation between the attachment site of uncinata process and occurrence of rhinosinusitis. Atelectasis of uncinata process was present only in 3 cases and they all had maxillary sinusitis of the ipsilateral side. Although this number is not sufficient for confirmation of a strong relation, considering the anatomy of this region, such a relation seems to be rational.

Agger nasi cells were present in 85.5% of patients. The prevalence of agger nasi cells are reported to be from 10 to 90 percent in different studies (7, 9). Our study did not show any relation between presence of agger nasi cells and rhinosinusitis. It is clear that these cells are important in treatment of frontal sinusitis (11).

In our patients, septation of frontal sinuses was not related with frontal sinusitis. We did not find any relation between presence of suprabullar and supraorbital cells and rhinosinusitis. This finding suggests that these cells must be considered as a normal anatomy. They are important in planning a dissection and must be addressed during

endoscopic surgery. But they will not necessarily lead to a disease.

Dehiscence in the bony lamella of fovea ethmoidalis was found in 7% of patients. It was more common in cases than controls. We believe that this dehiscence is secondary to rhinosinusitis. One must always look for the evidence of this site in pre-operative imaging and care about this area during surgery. Dehiscence of fovea ethmoidalis will make the patient more vulnerable to iatrogenic intracranial complications. Dehiscence of lamina papyracea was also more common among cases and probably is secondary to rhinosinusitis and raises the risk of intra orbital complications.

We found Onodi cells in 10.5% of patients, which is similar to other reports (7, 8, 12). The presence of Onodi cells will not alter the susceptibility of rhinosinusitis but may increase the risk of remnant disease and optic nerve injury following FESS. This is why careful observation of the region of Onodi cells is necessary when the surgeon assesses the preoperative CT scans. Septation of sphenoid sinus and dehiscence of internal carotid artery and optic nerve in sphenoid sinus were found in 7.5 and 9.5 percent of patients respectively and were not of course related to rhinosinusitis but they should be considered carefully before any surgical manipulation. The most common type of cribriform plate in our study was type I. This variation was not correlated with rhinosinusitis. Careful recognition of cribriform plate type is critical to avoid intracranial injury during FESS.

The most common pattern of rhino sinusitis in this study was OMC pattern which was found in 41.4% of cases followed by infandibular (27.1%), pan sinusitis/polyposis (8.6%), sphenothmoidal (5.7%) and isolated pattern (5.7%). Mean Lund Mackay score in cases was 5.2 ± 2.4 .

CONCLUSION

Nose and paranasal sinus structures have a diverse anatomical variation. Relation between these variation and rhinosinusitis was confirmed only for high septal deviation, middle turbinate concha bollusa and large bulla ethmoidalis. The role of these variations in decision making for treatment is not ignorable.

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