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A Study of Lateral Nasal Wall: Anatomical Variants,Radiological And Endoscopic Appearance And Role in Symptomatology in Chronic Rhinosinusitis

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Abstract:*It is assumed that the anatomical variations of lateral wall of nose contribute to various disease symptoms by blocking normal sinus drainage.This prospective study was conducted on hundred patients suffering from chronic rhinosinusitis, to study the various anatomical variations of lateral wall of nose by CT scan and diagnostic nasal endoscopy.A statistically significant correlation was found between concha bullosa and maxillary sinusitis (right and left concha bullosa with ipsilateral maxillary sinusitis p value was 0.033 and 0.01, respectively which are < 0.05), right and left agger nasi cell and ipsilateral frontal sinusitis (p value is. 01 and. 0006 which are <.05), right and left paradoxical middle turbinate and ipsilateral maxillary sinusitis (p value is. 000 and. 000 which are <.05).Considering the results obtained, we conclude that anatomical variations of the nose and paranasal sinusescan play an important role in the pathogenesis of chronic rhinosinusitis, and thus may increase the risk of sinus mucosal disease.*

Keywords:*Chronic rhinosinusitis, Diagnostic nasal endoscopy, Concha bullosa, Agger nasi cells, Paradoxical middle turbinate.*

I. Introduction

Chronic rhinosinusitis(CRS) is a condition that is increasing in proportions throughout the world. It has been known to negatively impact health related quality of life.[1] It's a common disease affecting over 30 million individuals globally each year with more than 200,000 people annually requiring surgical intervention.There are numerous narrow clefts in lateral wall of nose, many anatomical variations that can easily narrow these clefts and thus predispose to recurring infection.[2] Several authors have assessed the relationship between sinonasal anatomic variants and the incidence of rhinosinusitisCT scan of nose and paranasal sinuses plays a central role in the modern management of chronic rhinosinusitis due to its ability to delineate mucosal disease, to demonstrate a primary obstructive pathology and to image distal structures such as the posterior ethmoid sinus that cannot be viewed with direct endoscopy. CT scan with its excellent capability of displaying bone and soft tissue is the current diagnostic modality of choice for sinonasal disease. The coronal plane is considered to be the best orientation for evaluation of the sinonasal tract as it clearly shows the ostiomeatal complex and the relationship of the brain to the ethmoidal roof and correlates closely with the surgical orientation.Nasal endoscopy combined with CT has made the approach to sinonasal disease more specific, rational and accurate.Anatomic variations, such as deviation of the nasal septum, concha bullosa or paradoxical middle turbinate, ethmoidal bulla hypertrophic, agger nasi cell, lateral or medial bending of uncinate process (UP) and haller cell are common and emphasized in routine evaluation of computed tomography (CT) images.[5] However, their roles in pathogenesis of rhinosinusitis are still unclear. Theoretically, these variants could shift and compress osteomeatal complex components, determining an obstruction to the paranasal sinuses mucus drainage and further predispose to sinusitis. However, this concept is still controversial and the presence of any anatomical variation does not necessarily establish aetiology for rhinosinusitis.There is not much literature available regarding the anatomical variations of paranasal sinuses in the population residing in northern India. It is important for us to describe these variations among our population and establish the associations if present, between the variations and the genesis of CRS.The present study was aimed at studying the most frequently encountered anatomical variations in lateral wall of nose that may predispose to various symptoms in chronic rhinosinusitis patients.

II. Material And Methods

This study was conducted on 100 adult patients attending the outdoor of the Department of ENT, Government Medical College and Rajindra Hospital, Patiala.A clinical diagnosis of chronic rhinosinusitis was made on clinical criteria reported by the Task Force on rhinosinusitis. All patients of age > 18 years underwent examination by diagnostic nasal endoscopy. The study excluded patients with alteration in paranasal anatomy due to facial trauma, tumours of sino-nasal mucosa, previous sinus surgery, acute infection, nasal polyps, nasal mass, bleeding disordersPatient work up was done taking a detailed history about symptoms and their duration. Patients included in the study were subjected to CT Scan- Nose and Paranasal Sinuses- Coronal View and axial view, with contiguous 3mm thick images in coronal plane. Diagnostic Nasal Endoscopy (DNE) was done in all cases to confirm or discard the CT findings, after anaesthetizing and decongesting the nasal mucosa instilling 4% xylocaine along with a vasoconstrictor. 0 degree and 30 degree 4mm endoscope was used. The anatomical variations findings were noted down. All the information was entered in a predesigned proforma and analyzed statistically applying chi square testand p value <0.05 was significant and p <0.001 was highly significant.

III. Results

This study was conducted on 100 adult patients. Age distribution of patients varied from 15 years to 75 years. The majority of the patients(34%) were in the age group of 26 to 35 years. The sex distribution showed a male preponderance with 66% males and 34% females. Headache was the most common symptom occurring in 84%, followed by Nasal discharge in 81%, Post nasal drip in 76%, nasal obstruction in 70%. Maximum number of patients, i.e, 86% had symptoms for 1-5 years, 5% patients had symptoms for less than 1 year and 9% patients had symptoms for more than 5 years.The most common anatomical variation seen was Agger nasi cells (Fig-3),which were present in 78 % patients. [unilateral in 26% and bilateral in 52%]. Deviated nasal septum was present in 76% patients. Inferior turbinate hypertrophy was seen in 74% patients (unilateral in 34% and bilateral in 40%).Concha bullosa (Fig -1) was seen in 66% patients (unilateral in 36% and bilateral in 30%).. Pneumatized middle turbinate(concha bullosa) was seen in 66% patients with unilateral in 36% patients and bilateral in 30% patients. Hence 96 turbinates were studied. Lamellar pattern was seen in 44.79% sides, bulbous pattern in 10.42% sides. True concha bullosa pattern was seen in 38.54%. Uncinate process variation present in 64% patients (unilateral in 34% and bilateral in 30%).Bulla ethmoidalis was present in 29% patients. Paradoxical middle turbinate(Fig.2) was present in 22% patients. Haller's cells were found in 4% patients. All were unilateral. Accessory maxillary ostia were seen in 20% patients and 16 % were unilateral and 4 % were bilateral. The uncinate was found to be typical in 64%. [Type I - in 48%, Type II in 10% and Type III in 6%]. The maximum number of attachments were seen to lamina papyracea.

CT scan nose and paranasal sinuses were done to see the extent of mucosal hypertrophy. Mucosal hypertrophy was seen most commonly in osteomeatal complex in 82% patients which was unilateral in 46% patients and bilateral in 36% patients. Maxillary sinus mucosal hypertrophy was seen in 87% patients which being unilateral in 45% and bilateral in 42% patients. Mucosal hypertrophy of anterior ethmoids was seen in 77% patients which was unilateral in 38% patients and bilateral in 39% patients. Posterior ethmoids were involved in 56% patients which being unilateral in 30% patients and bilateral in 26% patients. Mucosal hypertrophy of frontal sinus was seen in 64% patients which was unilateral in 40% patients and bilateral in 24% patients. Sphenoid sinus was involved in 20% patients which was unilateral in 9% patients and bilateral in 11% patients(Table-1).We found a statistically significant correlation between concha bullosa and maxillary sinusitis (right and left concha bullosa with ipsilateral maxillary sinusitis p value is 0.033 and 0.01, respectively which are < 0.05), right and left agger nasi cell and ipsilateral frontal sinusitis (p value is. 01 and. 0006 which are <.05) and in total p value is. 029 which is again <.05, right and left paradoxical middle turbinate and ipsilateral maxillary sinusitis (p value is. 000 and. 000 which are <.05) and in total p value is. 000 which is again <.05.(Table 2).

Table-1 Table Showing Incidence Of Anatomical Variations On Ct Scan

Anatomical Variation	**No. of Patients (n=100)**	**No. of Patients (n=100)**	**No. of Patients (n=100)**
	Unilateral	**Bilateral**	**Total**
Agger Nasi Cell	26 %	52 %	78 %
Deviated Nasal Septum	-	-	76 %
Inferior Turbinate Hypertrophy	34 %	40 %	74 %
Concha Bullosa	36 %	30 %	66 %
Uncinate process variations	34 %	30 %	64 %
Enlarged Bulla Ethmoidalis	14 %	15 %	29 %
Paradoxical Middle Turbinate	19 %	3 %	22 %
Accessory Maxillary Ostia	16 %	4 %	20 %
Onodi cell	5 %	-	5 %

Haller's Cells	4 %	-	4 %

Table-2 Statistically Significant Correlation Between Anatomical Variations And Sinusitis

Anatomical variation	Sinusitis	p value
Concha bullosa	Maxillary sinusitis	.0004(<0.05)
Right	Right	.033 (<0.05)
Left	Left	.01 (<0.05)
Agger nasi cells	Frontal sinusitis	.029(<0.05)
Right	Right	.01 (<0.05)
Left	Left	.0006 (<0.05)
Paradoxical middle turbinate	Maxillary sinusitis	.000(<0.05)
Right	Right	.000(<0.05)
Left	Left	.000(<0.05)
DNS	Maxillary sinusitis	.04 (<0.05)
Right	Right	.015 (<0.05)
Left	Left	.006 (<0.05)

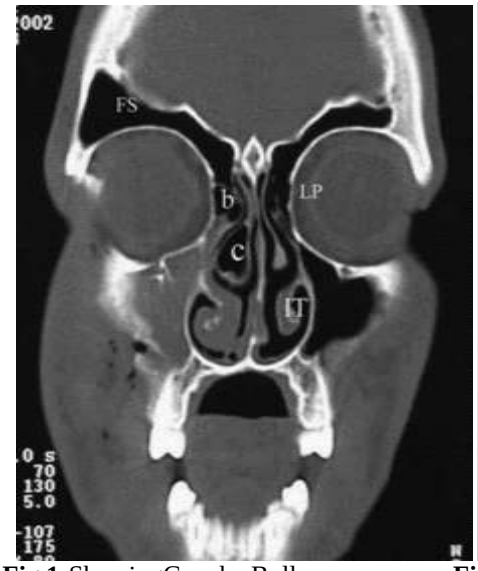

Fig.1: ShowingConcha Bullosa

Fig.2: Showing paradoxical middle turbinate

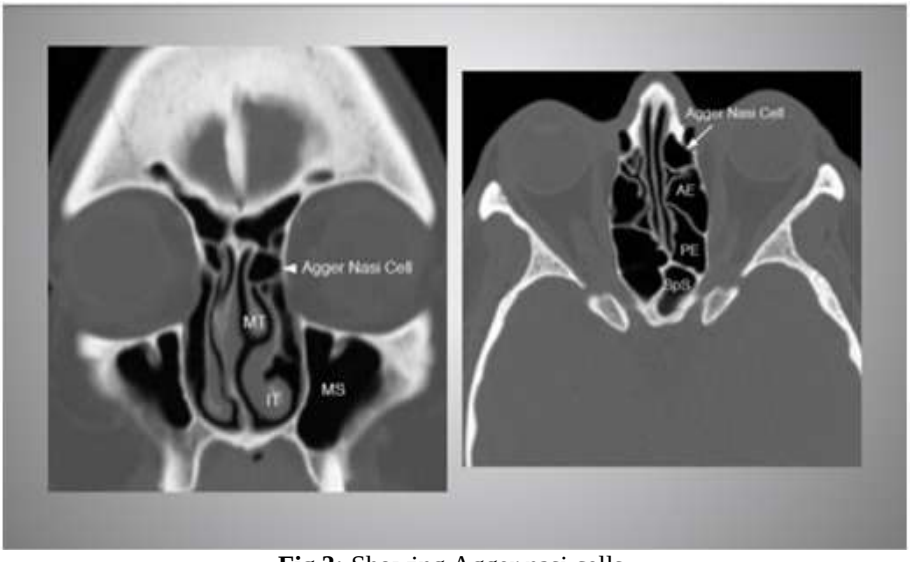

Fig.3: Showing Agger nasi cells

IV. Discussion

The variations in lateral wall of nose perpetuates the sinus disease. This in turn requires the surgeons to have detailed knowledge of the anatomy of the lateral nasal wall, paranasal sinuses and surrounding vital structures and of the large number of anatomical variants in the region.Disruption of the mucociliary clearance due to anatomic variations and mucosal disease of the osteomeatal complex is considered to be the prime factor

for the continuation of symptoms and chronicity of rhinosinusitis. Functional endoscopic sinus surgery (FESS) addresses these anatomical variations and mucosal diseases and restores the normal physiology of the paranasal sinuses. For FESS to be effective, accurate localization of the disease is very important. Although nasal endoscopy is very helpful, the convoluted anatomic framework of the ethmoids precludes the direct non-invasive endoscopic evaluation of deeper osteomeatal complex, posterior ethmoids and sphenoid sinus disease[7]. CT scan has proved to be indispensable in identifying the magnitude and extent of the disease in sinonasal areas.

In our study we found that the headache was most common symptom which could be sinogenic origin or contact headache (84%). This was followed by nasal discharge (81%) which could be explained by the fact that variants can cause narrowing of middle meatus leading to inspissations of secretions and thereby causing discharge. The symptoms of post nasal drip and nasal obstruction were present in 76% and 70% patients respectively.

Wani et al[4] et al in their study found headache and facial pain as the main symptom in 90% cases, nasal discharge in 86.6%, nasal obstruction in 85.33% and hyposmia in 20%cases.In a study by Sheetal et al[8], the most common symptom of presentation was headache in 90% followed by nasal discharge in 80%. Madani et al[9] in their study found the following symptoms, nasal obstruction (24.3%), headache (21.9%), nasal congestion (18.5%) and post nasal discharge (16.6%). Kolvekar et al[10] in their study found, nasal obstruction (42.66%), headache and facial pain (34.66%),running nose (29.33%), nasal bleeding (4%). El-Shazly et al[11] found refractory frontal headache in 92.8% of patients, thus our study correlates to Wani et al [4] , Sheetal et al[8] and El-shazly et al[11] .

Agar nasi cell was the most common anatomical variation in our study. Agger nasi cells were found to be present in 78% patients. It was unilateral in 26% and bilateral in 52%. The prevalence of agger nasi cells varies widely possibly due to the factors like different definition assigned to this anatomical variation and may be the small size of agger nasi cell makes its detection difficult in some studies. Our results are close to those reported by Leunig et al[12](80%).

Out of 200 sides, superior insertion of uncinate process could be identified definitely in 94 sides. We found Type I uncinate process in 70 (74.4%) of 94 sides, Type II uncinate process seen in 14 (14.8%) of 94 sides, Type III uncinate process seen in 10 (10.6 %) of 94 sides.Landsberg et al[13] studied 144 CT scans for superior attachment of uncinate Process out of possible 288 sides, they were able to identify superior attachment in 173 sides (60%) and most common type of uncinate attachment was to lamina papyracea in 52% sides. Turgut et al[14] studied CT scan of 243 patients (486 sides), they were able to identify superior attachment in 361 (74%) of 486 sides. They found insertion of uncinate process to lamina papyracea was the most common type found in 226 (63%) of the 361 sides followed by insertion into skull base in 52 (14%) of the 361 sides. Our study is similar to those by Turgut et al[14] in showing that the most common superior attachment of uncinate process was to lamina papyracea.

We found pneumatized middle turbinate (concha bullosa) in 66 (66%) patients. Out of these, unilateral concha bullosa was seen in 36 (36%) patients and bilateral in 30(30%) patients. Of the 96 turbinates studied, lamellar pattern was seen in 44.79 % sides, bulbous pattern in 10.42% sides and true pattern was the most common seen in 38.54% sides. Concha bullosa may be a contributing factor in the pathogenesis of sinus inflammatory disease by blocking the entrance of middle meatus. The reported prevalence of choncha bullosa could vary according to differing opinions regarding significant degrees of pneumatisation. Our results correlate well with those, reported by Cagiciet al[15] and Azila et al[6] ,i.e.,69% and 62.5% respectively. Less prevelance of concha bullosa in Wani et al[4](30%) can be explained by the factors like diverse study population, different criteria for pneumatisation and analytical methods.

Paradoxical middle turbinate was seen in 22% patients, being unilateral in 19% patients and bilateral in 3% patients. Normally, the convexity of the middle turbinate bone is directed medially, toward the nasal septum. When paradoxically curved, the convexity is directed laterally, toward the lateral sinus wall. Although no studies relate this variation to sinus disease, it is a presumed etiologic factor because of the deformity and obstruction or alteration of nasal passage air flow dynamics, especially when associated with other variations.

In our study, Haller's cells were seen in 4% patients. All of them were unilateral. Literature shows a wide range of variation in their occurrence**.** The prevalence of haller cells in current study is comparable to study done by Gupta et al [16] and Stoney et al [17] ,i.e.3.2% and 7% respectively. Also called the infraorbital ethmoidal cells, these are anterior ethmoidal cells pneumatizing the floor of the orbit or the roof of the maxillary sinus. In view of their location, precisely above the region of the maxillary sinus ostium and infundibulum, they can cause narrowing of maxillary sinus ostium or infundibulum, thus predisposing to recurrent maxillary sinusitis.

In our study, inferior turbinate hypertrophy was seen in 74% cases. Though not a part of osteomeatal complex, it's hypertrophy grossly obstructs the nasal airway and is associated with inflammatory disease in other parts of the nose. Inferior turbinate hypertrophy was reported as 35.9% (Madani et al[9])This is less than as

reported by our study. Caughey et al[18] observed that narrow nasal cavities were associated with maxillary sinus disease.

We found accessory ostia of maxillary sinus in 20% patients. The bony nasal wall is often deficient behind and below the uncinate process. These defects, the nasal fontanelles, are sites of accessory ostia for the maxillary sinus. Mamatha et al[3] reported their presence in 22.5% patients which is correlating with our study.

In our study, CT scan detected mucosal hypertrophy, was seen involving the osteomeatal complex in maximum number of patients i.e. 82%. It is similar to a study by Dua et al[19] at 88%. Fadda et al[5] observed it to be 75.7%.

Maxillary sinus mucosal hypertrophy was also observed in 84% patients. Bolger et al [20] found in 77.7%, Maru et al[21] in 70.4%, Dua et al[19] in 50%, Wani et al[4] in 70% and Fadda et al[5] in 67.1% cases. This is less than that found in our study.

The comparison of results of present study with some of the other studies in terms of incidence of involvement of various paranasal sinuses on CTscan is shown in table-3

Table-3 Studies Showing Involvement Of Paranasal Sinuses On Ct Scan

Author and year of study	Maxillary sinus	Anterior ethmoids	Posterior ethmoids	Frontal sinus	Sphenoid sinus
Bolger et al (1991)	77.7%	84.3%	38.6%	36.6%	25.4%
Maru et al (2001)	70.4%	73.7%	52.4%	48.3%	40.8%
Dua et al(2005)	50%	88%	66%	32%	18%
Wani et al(2009)	70%	87.3%	38%	15%	8.66%
Fadda et al (2012)	67.1%	54.3%	10%	22.1%	10%
Present Study (2015)	84%	74%	56%	48%	20%

Thus, our study is comparable to the studies by Maru et al[21],Mamatha et al[3] ,Fadda et al[5] and Madani et al[9] in showing that the maxillary sinus is the most common sinus to be involved.Endoscopic findings :- In our study we found agger nasi in 78 %, DNS in 76 %, ITH in 74 %, choncha bullosa in 66 % enlarged ethmoid bulla in 29 %, paradoxical middle turbinate in 22 %, accessory ostia in 20 %.Nasal endoscopy combined with CT has made the approach to sinonasal disease more specific, rational and accurate.We found a statistical significant correlation between concha bullosa and maxillary sinusitis (right and left choncha bullosa with ipsilateral maxillary sinusitis p value is. 033 and. 01, respectively which are < 0.05).Caughey et al[18] observed statistical correlation between concha bullosa and maxillary sinus disease. It could be explained by the fact that choncha bullosa (pneumatised middle turbinate) can influence negatively on paranasal sinus ventilation and mucociliary clearance in middle meatus. We also found a statistically significant relation between right and left agger nasi cell and ipsilateral frontal sinusitis (p value is. 01 and. 0006 which are <.05) and in total p value is. 029 which is again <.05. Frontal sinus pathology could be because of prominent agger nasi cell can block the frontal recess region. We found a statistical significant relation between paradoxical middle turbinate and ipsilateral maxillary sinusitis (p value <.01 in both right and left side).In our study another statistical significant correlation was found between DNS and ipsilateral maxillary sinusitis having p value. 04 and. 015 for right and left which are <. 05.

. Fadda et al**[5]** observed in their study, statistical correlation between concha bullosa and maxillary sinusitis, between medial deviation of uncinate process and anterior ethmoid sinusitis, between agger nasi cells and frontal sinusitis and between septal deviation and maxillary sinusitis. A few studies (Dutra[22], Lusk[23], Milczuk[24]) have described the anatomical variants prevalence on computed tomography examinations in patients with chronic or recurrent sinusitis. Scribano et al[25] have observed that the maxillary sinus opacification was significantly more frequent in cases where the concha bullosa determined osteomeatal complex obliteration when compared with cases of concha bullosa without osteomeatal complex obliteration.

Sarna et al[26] observed that severe septal deviation was a contributing factor for sinusitis. However, some studies (Stallman[27],Scribano[25])have not demonstrated a causal relationship between nasal septal deviation and sinusitis. The incidence of agger nasi cells has been reported to vary from 3% to almost 100% and its presence has been firmly associated with frontal sinusitis (Zinreich et al[7]). We found a statistical significant relation between paradoxical middle turbinate and ipsilateral maxillary sinusitis (p value <.01 in both right and left side). Azilaet al[6] concluded that the major consequence of paradoxical middle turbinate variations is narrowing of the middle meatus which can lead to obstruction of infundibular drainage. However the degree of convexity of the middle turbinate is the most important factor to cause the obstruction which will lead to rhinosinusitis. Paradoxical middle turbinate is known to abut against lateral wall and the middle meatus as compared to a normal shaped middle turbinate. It has formed the basis for contact point theory resulting into disturbance with mucocilliary clearance which further leads to development of CRS. In our study most of the paradoxical middle turbinates are more curved inside. So this may be the reason that our results are highly significant.

V. Conclusions

Considering the results obtained, we believe that some anatomical variations of the nose and paranasal sinuses can play an important role in the pathogenesis of chronic rhinosinusitis, and thus may increase the risk of sinusmucosal disease. The significance of anatomical variations is that they impair normal drainage pathway, hinder endoscopic access to distal areas and increase the risk of endoscopic mishaps. Hence, the importance of CT scan and nasal endoscopy is emphasized in patients with persistent symptoms to identify the anatomicalvariations that may contribute to the development of chronic sinus mucosal disease.

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