Anatomical variations of Nose and Paranasal Sinuses in Chronic Rhinosinusitis

Research Article

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ABSTRACT

The aim of this study was to (a) detect the prevalence of anatomical variations of nose and paranasal sinuses in Chronic Rhinosinusitis (CRS) on 'Nasal Endoscopy',and'Computed Tomography', (b) correlate between the two investigation modalities and (c) study association of anatomical variations of nose and paranasal sinuses in Chronic Rhinosinusitis. This Cross sectional study was carried out at Tertiary Rural Health Institute 'NKP Salve Institute of Medical Sciences and Research Centre' Nagpur, during November 2011 to October 2013. Diagnostic Nasal Endoscopy and Computed Tomography of nose and Paranasal Sinuses of 122 patients of chronic rhinosinusitis were studied and results were statistically analysed using z-test and chi-square test. Mean age of the study population was 35.48 years (SD=16.15) with male predominance. Maxillary sinus (68.03%) was the most commonly affected sinus due to chronic sinusitis followed by anterior ethmiod sinusitis (60.66%). Deviated Nasal Septum was the most common anatomical variation, which was detected in 59(48.30%) patients on Diagnostic Nasal Endoscopy and in 62(50.81%) patients on Computed Tomography. Aggernasii cells, medialised uncinated process and concha bullosa were diagnosed both by Diagnostic Nasal Endoscopy and Computed Tomographic scan with good agreement between the two. Anatomical variations like deviated nasal septum, aggernasii cells, medialised uncinated process, large concha bullosa were statistically significantly associated with chronic rhinosinusitis. Diagnostic nasal endoscopy and CT scan are complimentary in diagnosis of anatomical variations of nose and paranasal sinuses. Some anatomical variations of osteomeatal complex play important role in pathogenesis of chronic rhinosinusitis.

Key Words: Anatomical variations, chronic rhinosinusitis, computed tomography, diagnostic nasal endoscopy

INTRODUCTION:

Chronic Rhinosinusitis (CRS) is chronic inflammation of nose and paranasal sinuses. Its pathophysiology is poorly described and seems to be multifactorial. With the arrival of Functional Endoscopic Sinus Surgery, the approach to the patient with CRS has been changed. Certain anatomical variations of lateral wall of nose are important as they contribute in blockage of osteomeatal complex, ventilation and drainage of paranasal sinuses. Preoperative evaluation of these variants is also important being a part of surgical safety.

Anterior rhinoscopy reveals little information with regard to middle meatus. Diagnostic Nasal Endoscopy and Computed tomography play a vital role in accurate assessment of osteomeatal complex and anatomical variations at this area. CT scan has the ability to delineate mucosal disease of sinuses, to detect primary obstructive pathology and to image the distal structures like posterior ethmoid and sphenoid sinuses, which can not be visualised by endoscopy. Nasal Endoscopy has the ability to detect small localised disease in the nasal cavity, which can be missed even by Computed Tomography.

Several studies have been carried out to find out the relationship between anatomical variations and chronic rhinosinusitis on CT scan. But very few studies have been found reported comparing Diagnostic Nasal Endoscopy and CT scan in diagnosing anatomical variations of nose and paranasal sinuses in chronic

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rhinosinusitis.

We conducted this study with the aim to study the prevalence of anatomical variations of nose and paranasal sinuses in Chronic Rhinosinusitis (CRS) on Nasal Endoscopy and CT Scan, correlate between the two investigation modalities and study association of anatomical variations of nose and paranasal sinuses in Chronic Rhinosinusitis.

MATERIALS AND METHODS:

This was a cross sectional study conducted at tertiary health care Institute, NKP Salve Institute of Medical Sciences, Nagpur, during November 2011 to October 2013. Patients of chronic rhinosinusitis, diagnosed as per the criteria described by Task Force on Rhinosinusitis,[1,2] of either sex with age more than 10 years were included in the study. Patients having acute rhinosinusitis, fungal rhinosinusitis, pregnant women and those who underwent nasal surgery previously were excluded from the study. Approval for the study was obtained from Institutional Ethical Committee. Written informed consent was taken before enrolment of patients into the study. The cases selected for the study were subjected to detailed history taking and clinical examination. Routine blood and urine investigations along with Bleeding Time and Clotting Time were done and then patient underwent systematic Diagnostic Nasal Endoscopy (DNE) and Computed Tomography (CT) of Nose and Paranasal sinuses.

In the present study, DNE was done under local anaesthesia using 0^0 and 30^0 rigid nasal endoscope. Endoscopy was performed using the standard three pass technique to obtain the information regarding purulent secretions, polypoidal mucosa in middle meatus and anatomical variations.[3]

Plain CT Scan Nose and PNS was done in both coronal and axial planes, in all enrolled cases with Toshiba Spiral CT scanner. Patient's position was supine with head extension. Thickness of slice was 3 mm at Osteomeatal complex and 5 mm for rest of structures. CT Scan was done for both bony and soft tissue windows. Reporting of CT Scan was done by Senior Radiologist. The presence of anatomical variations was also documented along with radiological features of chronic rhinosinusitis.

Correlation between Diagnostic Nasal Endoscopy and CT Scan nose and PNS in diagnosing anatomical variations was determined by z-test and association of anatomical variations with chronic Rhinosinusitis was analysed statistically by using chi-square test.

RESULTS:

Total 122 patients of chronic rhinosinusitis were enrolled in the study. The age of the patients ranged between 11 years to 76 years. Mean age of the study group was 35.48 years (SD=16.15). Study comprised of 66% males and females were 34%. Thus male to female ratio was 1.9:1.

Common symptoms of the patients in the present study were Headache (77.04%), Nasal obstruction (75.40%), Nasal discharge (65.57%) followed by altered sense of smell (46.72%) , facial pain (22.95%). Most of the patients in this study presented with multiple symptoms except for few who presented with a single complaint of headache only.

As shown in Table 1, regarding the CT prevalence of sinusal opacities, 83(68.03%) cases had maxillary sinusitis, 74(60.66%) anterior ethmoid sinusitis and 39(31.97%) frontal sinusitis. Posterior ethmoid sinusitis (31.15%) or sphenoid sinusitis (18.03%) was not seen individually but was seen in association with maxillary and/or anterior ethmoid sinusitis.

Various anatomical variants of nose and paranasal sinuses in chronic rhinosinusitis patients were diagnosed on Diagnostic nasal Endoscopy and CT Scan. They were either unilateral or bilateral. We compared the effectiveness of these two modalities in detecting anatomical variations [Table 2]. Deviated Nasal Septum was most common anatomical variation, which was detected in 59(48.30%) patients on DNE [Figure 1]

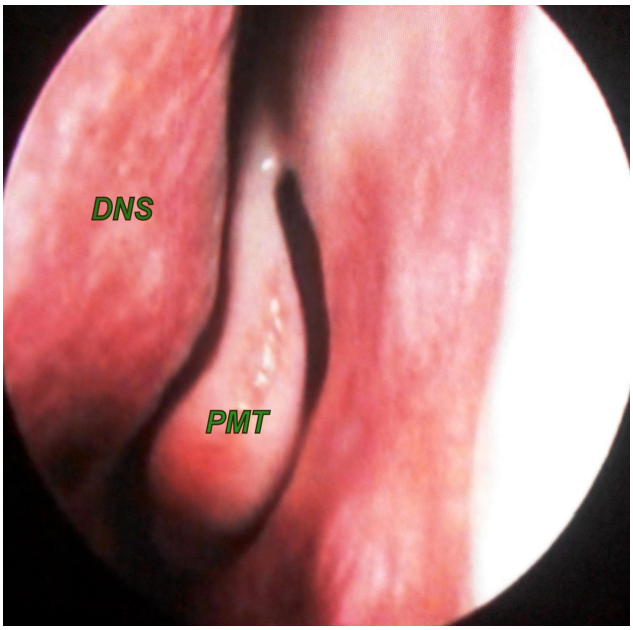

Figure 1: Deviated Nasal Septum to left with Paradoxical Middle Turbinate (PMT) on Left side on DNE

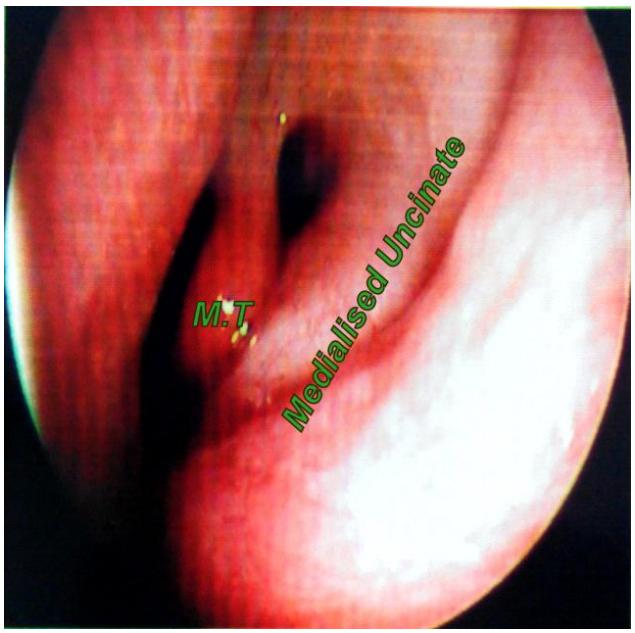

Figure 2: Medialised uncinate process on Left side on DNE

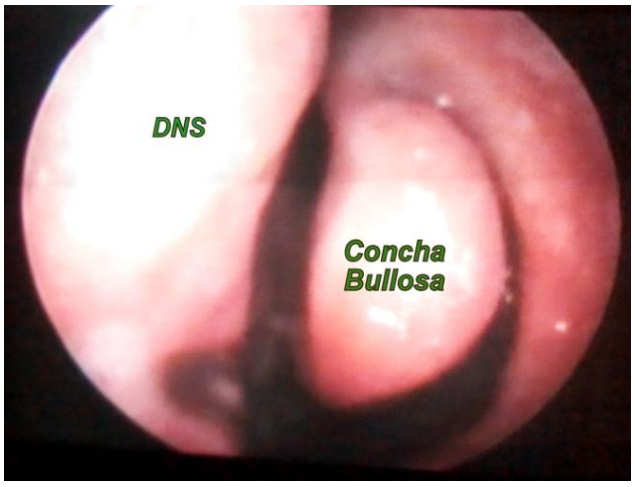

Figure 3: Concha bullosa on Left side on DNE

Figure 4: Aggernasii cells on Right side on DNE

and in 62(50.81%) patients on CT Scan. Other anatomical variations that of uncinate process [Figure 2], concha bullosa [Figure 3], aggernasii cells [Figure 4], bulla ethmoidalis, paradoxical middle turbinate were detected by both DNE and CT scan in cases of Chronicrhino-sinusitis in decreasing order. Level of agreement between DNE and CT scan in diagnosing all these anatomical variations in Chronic Rhinosinusitis was analysed by z-test of proportion. We have found the difference to be non significant between DNE & CT; and hence both are equally good [Table 2].

Accessary ostium in 34(27.87%) patients could be seen only on DNE and not on CT Scan. While Haller cells and Onodi cells were detected only by CT Scan in 20(16.39%) and 5(4.09%) patients respectively [Table 2].

Association of anatomical variations with Chronic Rhinosinusitis has been observed using chi-square test [Table 3]. There was statistically significant correlation between right septal deviation and right maxillary sinusitis ($p < 0.01$). We also found correlation between right and left Aggernasii cells and frontal sinusitis of respective side. There was statistically significant association between medialised uncinated process and anterior ethmoid sinusitis and maxillary sinusitis of corresponding side. Medialised uncinated process on right side was also associated with right frontal sinusitis. There was statistically significant association between right and left large bulla ethmoidalis and anterior ethmoid sinusitis of respective side, right large ethmoid bulla and right maxillary sinusitis, right and left concha bullosa and homolateral maxillary sinusitis. There was no other statistically significant correlation between any other anatomic variations and ipsilateral or contralateral sinusitis of any paranasal sinus.

DISCUSSION:

Stenosis of the osteomeatal complex, from either the anatomical configuration or hypertrophied mucosa, can cause obstruction and stagnation of secretions, which become infected or perpetuate infection. The middle meatus and lateral nasal wall are subject to wide normal variations that must be distinguished from pathologic changes and may be the underlying cause of recurrent sinus disease.

In the present study, most common sinus affected due to infection/ inflammation was maxillary sinus (68.03%). This finding corresponds with the studies done by Clement et al,[4] (73%) and Lloyd et

Table 1: CT Scan prevalence of sinus opacities in patients of Chronic Rhinosinusitis (n=122).

Sinusitis	Unilateral N (%)			Bilateral N (%)	Total N (%)
	Right N (%)	Left N (%)	Total N (%)		
Maxillary	28 (22.95)	16 (13.11)	44 (36.07)	39 (31.97)	83 (68.03)
Anterior Ethmoid	17 (13.93)	08 (6.56)	25 (20.49)	49 (40.16)	74 (60.66)
Posterior Ethmoid	11 (9.02)	8 (6.56)	19 (15.57)	19 (15.57)	38 (31.15)
Frontal	16 (13.11)	9 (7.38)	25 (20.49)	14 (11.48)	39 (31.97)
Sphenoid	7 (5.74)	9 (7.38)	16 (13.11)	6 (4.91)	22 (18.03)

Table 2: Comparative findings on CT Scan and DNE in relation to anatomical variants in Chronic Rhinosinusitis (n=122)

Anatomical Variations	Diagnostic nasal endoscopy N (%)			Computed tomography findings N (%)			z value U/L	p value	z value B/L	p value
DNS	59 (48.30%)			62 (50.81%)						
	U/L	B/L	Total	U/L	B/L	Total				
Paradoxical Middle Turbinate	07 (5.73)	03 (2.45)	10 (8.2)	08 (6.55)	03 (2.45)	11 (9.01)	0.6736	0.5006	0	1
Concha bullosa	20 (16.39)	08 (6.55)	28 (22.95)	25 (20.49)	09 (7.37)	34 (27.87)	0.5807	0.5615	0.9811	0.3265
MedialisedUncinate Process	22 (18.03)	09 (7.37)	31 (25.41)	24 (19.67)	10 (8.19)	34 (27.87)	0.2305	0.8177	1.0867	0.2772
Lateralised Uncinate Process	15 (12.29)	08 (6.55)	23 (18.85)	16 (13.11)	11 (9.01)	27 (22.13)	0.1354	0.8923	0.5041	0.6142
Pneumatised Uncinate Process	05 (4.09)	00	05 (4.09%)	08 (6.55)	00	08 (6.56)	-	-	-	-
Large Ethmoid Bulla	08 (6.55)	13 (10.65)	21 (17.21)	08 (6.55)	17 (13.93)	25 (20.49)	0	1	0.5485	0.5833
Accessory Ostium	29 (23.77)	05 (4.09)	34 (27.87)	00	00	00	-	-	-	-
AggerNasii Cells	02 (1.63)	22 (18.03)	24 (19.67)	02 (1.63)	32 (26.22)	34 (27.87)	0	1	1.0831	0.2788
Haller Cells	00	00	00	20 (16.39)	00	20 (16.39)	-	-	-	-
Onodi Cells	00	00	00	05 (4.09)	00	05 (4.09)	-	-	-	-

al,[5] (83%), whereas, anterior ethmoid sinus was most commonly affected sinus in the studies done by Bolger et al,[6] (78.2%), Calhoun et al,[7] (84.3%) and Kennedy et al,[8] (78%).

The reported prevalence of Deviated Nasal Septum (DNS) varies widely. In the present study of 122 patients, 59(48.30%) patients had septal deviation on nasal endoscopy and 62(50.81%) patients on CT scan. It was the most common anatomical variant seen in the study. In the study conducted by Shahizon AM et al,[9], 25% of cases had septal deviation on nasal endoscopy and in 40% patients on CT scan. Fikret Kasapoglu et al,[10] reported DNS in 41.9% cases on CT scan and Jareoncharsri P et al,[11] detected it in 72.3% cases on DNE as a most common finding. Severe septal deviation has been noted as a contributing factor for sinusitis. We found a statistically significant correlation between right septal deviation and right

Table 3: Association of Anatomic Variants with Chronic Rhinosinusitis on CT Scan (n=122).

Anatomic Variations	Sinusitis	p value*
Deviated Nasal Septum: Right	Maxillary Sinusitis: Right	<0.01
AggarNasii cells: Right	Frontal Sinusitis : Right	<0.01
AggarNasii cells: Left	Frontal Sinusitis : Left	<0.05
Medialised Uncinate Process: Right	Anterior Ethmoid Sinusitis: Right	<0.01
Medialised Uncinate Process: Left	Anterior Ethmoid Sinusitis: Left	<0.05
Medialised Uncinate Process: Right	Maxillary Sinusitis: Right	<0.05
Medialised Uncinate Process: Left	Maxillary Sinusitis: Left	<0.01
Medialised Uncinate Process: Right	Frontal Sinusitis : Right	<0.01
Medialised Uncinate Process: Left	Frontal Sinusitis : Left	>0.05
Paradoxical Middle Turbinate: Right	Anterior Ethmoid Sinusitis: Right	>0.05
Paradoxical Middle Turbinate: Left	Anterior Ethmoid Sinusitis: Left	>0.05
Paradoxical Middle Turbinate: Right	Frontal Sinusitis : Right	>0.05
Paradoxical Middle Turbinate: Left	Frontal Sinusitis : Left	>0.05
Pneumatised Uncinate process: Right	Anterior Ethmoid Sinusitis: Right	>0.05
Pneumatised Uncinate process: Left	Anterior Ethmoid Sinusitis: Left	>0.05
Haller's cell: Right	Maxillary Sinusitis: Right	>0.05
Haller's cell: Left	Maxillary Sinusitis: Left	>0.05
Bulla Ethmoidalis Large: Right	Anterior Ethmoid Sinusitis: Right	<0.01
Bulla Ethmoidalis Large: Left	Anterior Ethmoid Sinusitis: Left	<0.01
Bulla Ethmoidalis Large: Right	Maxillary Sinusitis: Right	>0.05
Bulla Ethmoidalis Large: Left	Maxillary Sinusitis: Left	<0.05
Concha Bullosa: Right	Maxillary Sinusitis: Right	<0.05
Concha Bullosa: Left	Maxillary Sinusitis: Left	>0.05

* p value <0.05 is statistically significant.

maxillary sinusitis (p <0.01) as also found by Fadda GL et al,[12] between left septal deviation and left maxillary sinusitis.

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 and is reported as a possible cause for closed osteomeatal complex and mucosal pathologies. In the study conducted by Saxena R et al,[13] prevalence of paradoxical middle turbinate was 75% on DNE and 53.33% on CT Scan (p<0.01). Adeel M et a,l[14] Mazza D et al,[15] and Perez P et al,[16] observed paradoxical middle turbinate in 14.3%, 11% and 10% patients respectively on CT scan and is comparable with our finding. We found no association between paradoxical middle turbinate and rhinosinusitis.

The term concha bullosa, pneumatization of the middle turbinate, increases the probability of obstruction of the middle meatus and lead to recurrent ethmoid sinusitis.

Bolger et al,[6] reported three types of the middle turbinate pneumatization: the vertical lamella pneumatisation (46.2%), the inferior bulbous portion (31.2%) and entire middle turbinate pneumatisation (15.7%) ("True" concha bullosa). In the present study, true Concha Bullosa was observed in 28(22.95%) patients on DNE and 34(27.87%) patients on CT Scan. The advantage of CT scan is that it detects both lamellar as well as concha pneumatisation with more accuracy. In the various studies conducted by Adeel M et al,[14], Perez P et al[16] and Tonai I et al,[17], prevalence of Concha Bullosa was 18.2%, 24.5% and 28% respectively on CT Scan. In the study by Sheetal D etal[18], Concha bullosa was seen on CT scan in 35% and 42% of the patients on the right and left sides respectively and on DNE, it was seen in 33% and 40% of the patients on the right and left sides respectively. There was 59.7% correlation between the Endoscopic findings and CT Scan findings.We found significant association between right concha bullosa and right maxillary sinusitis (p<0.05). Fadda GL et al,[12] and Ozcan KM et al[19], Lom WW et al,[20] also found significant relationship between concha bullosa and sinusitis.

The superior aspect of the uncinate tip may deviate laterally, medially, or anteriorly out of the meatus, appearing as a second middle turbinate bone. The exact prevalence of these variations and their relation to sinus disease has not been determined. In a

study conducted by Saxena R et al,[13], medialised uncinate process was seen in 38(63.33%) cases on DNE, while 33(55%) patients had it on CT Scan. Medial deflection of Uncinate Process was previously described in 3-19% of cases.[21] While in the study conducted by Fadda GL et al,[12] medialised uncinated process was detected in 22.08% patients and lateralised uncinate process in 21.4% on CT scan, which are in resonance with our study. In our study, we determined the association between medialised uncinate process with anterior ethmoid sinusitis, frontal sinusitis and maxillary sinusitis of the same side.

The rate of uncinate process pneumatization in previous studies has been reported to be from 1-9%.[6, 22] In our study and that of Fadda GL et al,[12], uncinate process pneumatisation was observed on CT scan in 6.55% and 2.8% of patients respectively.

The ethmoidal bulla can be so extensively pneumatized that it can obstruct infundibulum/ middle meatus completely. The exact prevalence of an enlarged ethmoidal bulla is not known. Patel AK et al[23] reported prevalence of large ethmoid bulla in 34 (36.95%) patients on DNE, while in 30(32.60%) patients on CT Scan which is slightly more as compared to our study. Fadda GL et al,[12] Krzeski A et al,[24] and Scribano E et al[25] reported large ethmoid bulla in 32.8%, 26.75% and 3.5% patients respectively. In our study, there was a significant correlation between large ethmoidal bulla and maxillary and anterior ethmoidsinusitis, which has not been found reported in the literature.

Aggernasi cells are the most anterior extramural ethmoid cells, located anterosuperior to the insertion of middle turbinate along the lateral nasal wall. Reported prevalence of aggernasii cell varies widely among investigators. In anatomic dissection, Krzeski[24] reported it in 59%, Van Alyea,[26] in 89% and Bolger et al[6] observed it in 98.5% of cases. Fadda et al[12] detected aggernasii cells on CT Scan in 24.3% cases, while we detected it in 27.86% cases. We noticed statistically significant association between aggernasii cells and frontal sinusitis on the same side.

In the present study, prevalence of Haller cell, anethmoidal air cell located beneath the floor of the orbit, was 16.39%, which is comparable with the studies done by Fadda et al,[12] (22.8%) but differ from the studies done by Bolger et al[6] (45%), and Kennedy et al,[8] (10%). There was no association between Haller cell and maxillary sinusitis in our study in contrast to the studies done by Fadda et al,[12] and Van Alyea,[26] who reported its significant relationship between the two.

Although sphenoethmoid (Onodi) cell is an anatomic variant which is not associated with sinusitis, its presence poses an increased incidence of surgical complications for risk of injury to optic nerves or carotid arteries.In the present study, these cells were present in 4.09% patients, which is consistent with findings of Nouraei et al,[22] (4.7%) and Fadda et al,[12] (8.5%).

Accessory maxillary ostium was seen only in DNE. But to detect it on CT scan, 1 mm sections need to be taken, which cannot be done in our CT scan machine. Presence of an accessory ostium is a sign of long standing disease process which is confirmed with DNE. In the study conducted by Sheetal D et al,[18] accessory maxillary ostium was present in 13% and 11% patients on the right and left sides respectively.

CONCLUSION:

The results of this cross sectional study highlights that Diagnostic nasal endoscopy and CT scan are complimentary in diagnosis of anatomical variations of nose and paranasal sinuses. Some anatomical variations like deviated nasal septum, concha bullosa, aggernasi cells and medialised uncinated process play important role in pathogenesis of chronic rhinosinusitis. Careful evaluation of anatomical variations by CT scan is necessary in patients of chronic rhinosinusitis especially those undergoing endoscopic surgery.

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