

Original Research Article

Correlation of sinonasal anatomical variations with relevant sinus involvement in chronic rhinosinusitis: a prospective observational study

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ABSTRACT

Background: The purpose of this study was to study the association of anatomical variations as risk factors in affecting specific sinuses in cases of chronic rhinosinusitis (CRS).

Methods: It is an observational study carried out from June 2018 to May 2019. 61 patients of CRS were included in this study. The diagnosis of CRS with or without nasal polyposis was made as per diagnostic guidelines of the task force on chronic rhinosinusitis. Each of them was assessed by nasal endoscopy and computed tomography (CT) imaging for diagnosis and evaluation of anatomical risk factors.

Results: A total of 61 patients of CRS were examined. Presence of various anatomical variants in relation to CRS were studied. We studied CT paranasal sinuses of the 61 patients, since each patient has 2 of each groups of sinuses, a total 122 group of sinuses are assessed in this study. On analyzing, we found, a significant association between deviated nasal septum (DNS) and maxillary sinusitis. Agger nasi cell and frontal and ethmoid (anterior and posterior) sinusitis, concha bullosa and maxillary sinusitis and over pneumatized ethmoid bulla and anterior and posterior ethmoid sinusitis. Other anatomical variants encountered, had no significant association with diseased sinuses (p value >0.01).

Conclusions: The study showed that, there is a strong relationship between the presence of diseased sinus and some anatomical variants. It is suggested that besides anatomical variations, other clinical parameters should also be taken into account for the etiology of sinusitis.

Keywords: Chronic rhinosinusitis, Anatomical variants, DNS, Concha bullosa, Agger nasi

INTRODUCTION

Chronic rhinosinusitis (CRS) is one of the most common chronic diseases of adults. It is defined as a condition of symptomatic inflammation of the nose and paranasal sinus mucosa persisting for more than 12 weeks.

CRS affects 5-15 percent of the urban population. The last reported overall prevalence of CRS by EP3OS criteria was 10.9% (range 6.9-27.1).¹⁻² CRS remains a common cause of morbidity, social embarrassment and impaired performance at school or workplace. CRS in addition to physical discomfort causes a substantial economic burden

to a patient in terms of missed workdays due to physician or hospital visits.³⁻⁴

Ideally prevention, or at least early definitive diagnosis and timely intervention can reduce morbidity due to this disease and improves outcome as well as quality of life. As the pathophysiology of this chronic condition has attracted great amounts of attention, an increasing number of studies have focused on potential risk factors associated with CRS. Understanding the anatomical risk factors will result in better understanding of subsequent targeted management of CRS. Knowledge of role of anatomic variations will enable the clinician to make informed

choices in surgically correcting these variations and even sometimes prevent an unindicated surgery.

METHODS

This observational cross-sectional study was conducted at Department of ENT, Bhabha Atomic Research Centre and Hospital, Mumbai between June 2018 and June 2019. After power analysis, 61 patients of CRS who visited the hospital ENT department and who fulfilled the inclusion criteria were enrolled in the study after obtaining informed consent.

Inclusion criteria

Adults (above 18 year age) and having CRS at the time of enrolment.

Exclusion criteria

Children and adolescent (below 18 year age) with CRS, patients of CRS who had undergone endoscopic sinus surgery, and patients of CRS with acute exacerbation of sinusitis.

After detailed history, nasal endoscopy was done to confirm chronic sinusitis and finally high-resolution CT (HRCT) of paranasal sinuses was done for final confirmation, evaluation of the sinuses involved and record of any anatomical variations was done in each of them. The study was cleared by the institutional ethics committee.

RESULTS

This study comprised of 61 patients of CRS diagnosed by history and nasal endoscopy and further confirmed by computed tomographic scanning of paranasal sinuses (CT PNS). Presence of various anatomical variants in relation involved sinuses were studied. Pearson chi square test was used to find out the association and significance (p value <0.01).

Our study had 38 males and 23 females with male female ratio being 1.65:1. Maximum number of patients were seen in age group 41-60 followed by age group 20-40 years, and least in age group >60 years (Table 1).

Our study population had 57 patients of CRS with nasal polyposis and 4 patients of CRS sans polyposis. Since each individual has 2 sets of each paranasal sinus (right and left), so total 122 group of sinuses were studied. We found that, 47 patients had mild to moderate CRS and 14 patients had severe CRS, according to Lund and Mackay staging based on CT PNS study (Table 2).

We found that, 58 patients had maxillary sinusitis, 37 patients had frontal sinusitis, 41 patients had anterior ethmoid sinusitis, 36 patients had posterior ethmoid

sinusitis and sphenoid sinusitis was seen in 28 patients. Most patients had disease in multiple sinuses (Table 3).

Table 1: Age and gender wise distribution of the study subjects.

Age groups (in years)	Gender		Total N (%)
	Male N (%)	Female N (%)	
21-40	10 (16.66)	9 (14.75)	19 (31.1)
41-60	14 (22.95)	11 (18.03)	25 (41)
>61	14 (22.95)	3 (4.92)	17 (27.9)
Total N (%)	38 (62.3)	23 (37.7)	61 (100)
Mean±SD	54.16±16.2	43.30±14.4	50.07±16.12

Table 2: Disease severity distribution according to Lund and Mackay scoring based on CT study.

Category	Lund Mackay scoring (LMS)	No. of patients
Mild to moderate	1-10	47
Severe	>10	14

Table 3: Distribution of study subjects on the basis of different sinuses and drainage pathways involved, based on CT study.

Sinuses and drainage pathways involved in 61 patients	Number of diseased study subjects	Percentage (%)
Sinuses		
Maxillary sinus	58	95.08
Frontal sinus	37	60.65
Anterior ethmoid sinus	41	67.21
Posterior ethmoid sinus	36	59.02
Sphenoid sinus	28	45.90
Drainage pathways		
Ostiomeatal complex block	52	85.24
Frontal recess block	36	59.02
Spheno ethmoid recess block	29	47.54

Bilateral disease was found more common than unilateral disease in each group of sinuses. Most common drainage pathway found to be involved was OMC block (77) followed by FR block (60) and then SER block (47) (Table 4).

After analyzing the CT PNS, significant DNS were 44 either to left/right/bilateral side, agger nasi cells were 39, concha bullosa were 42, Over pneumatized ethmoid bulla were 16, paradoxical middle turbinate were 7, haller cell were 4, onodi cell were 8, frontal air cell were 5 and inferior turbinate hypertrophy were 13. On studying diseased sinuses and anatomical variants on CT PNS, we found that, out of 44 significant DNS only 34 were on diseased side i.e. (77.27%), out of 39 agger nasi cell, 31

were on diseased side i.e. (79.49%), out of 42 concha bullosa, 36 were on diseased side i.e. (85.71%), out of 7 paradoxical middle turbinate, 6 were on diseased side i.e. (85.71%), out of 8 onodi cells, 7 were on diseased side i.e. (87.50%), out of 13 inferior turbinate hypertrophy, 8 were on diseased side i.e. (61.54%) and all the hellers cells (4), over pneumatized ethmoid bulla (16) and frontal air cells(5) were on diseased side i.e. (100%). No pneumatized uncinata found in this study (Table 5).

On analyzing the association between different diseased sinuses and anatomical variants we found, significant association between DNS and maxillary sinusitis, agger nasi cell and frontal and ethmoid (anterior+posterior) sinusitis, concha bullosa and maxillary sinusitis. Over pneumatized ethmoid bulla and anterior and posterior ethmoid sinusitis (p value <0.01). Rest of the anatomical variants had no significant association with diseased sinuses (p value >0.01) (Table 6).

On studying the association of different sinus involvement with respective drainage pathways like OMC, FR, SER, significant association was found with all of them (p value <0.01) (Table 7).

However, as we know these drainage pathways are very close to each other so mucosal oedema or polyposis affecting one drainage pathway can also affect the other drainage pathway (like OMC and frontal recess are very close to each other).

So, it is not possible to establish the significant association between drainage pathways blockage with individual sinuses.

On studying the association between different anatomical variants with respective drainage pathways like OMC, FR, SER, no significant association was found (p value >0.01) (Table 8).

Table 4: Incidence of bilateral disease in the various sinuses and drainage pathways involved.

Sinuses involved	Number of diseased study subjects	Side of involvement	Frequency (n=61)	Percentage (%)
Maxillary sinus	58	U/L	24	41.38
		B/L	34	58.62
Frontal sinus	37	U/L	14	37.84
		B/L	23	62.16
Anterior ethmoid sinus	41	U/L	15	36.59
		B/L	26	63.41
Posterior ethmoid sinus	36	U/L	12	33.33
		B/L	24	66.67
Sphenoid sinus	28	U/L	11	39.29
		B/L	17	60.71
Drainage pathways				
Ostiomeatal complex block	52	U/L	27	51.92
		B/L	25	48.08
Frontal recess block	36	U/L	12	33.33
		B/L	24	66.67
Spheno ethmoid recess block	29	U/L	11	37.93
		B/L	18	62.07

Table 5: Incidence of the anatomical variants of nose among the study subjects.

Anatomical variants of nose	Total no of anatomical variation present in all studied sinuses (N)	Anatomical variation present on side of disease (N)	Percentage of variants occurring on diseased side (%)
Significant deviated nasal septum	44	34	77.27
Agger nasi cell	39	31	79.49
Concha bullosa	42	36	85.71
Pneumatized uncinata	0	0	0
Overpneumatized ethmoid bulla	16	16	100
Paradoxical middle turbinate	7	6	85.71
Haller's cell	4	4	100
Onodi cell	8	7	87.50
Frontal cell	5	5	100
Inferior turbinate hypertrophy	13	8	61.54

Table 6: Association between different diseased sinuses and the anatomical variations of nose found, among the study subjects.

Anatomical variants of nose on diseased side	Maxillary sinusitis (n=92)		Frontal sinusitis (n=60)		Anterior ethmoid sinusitis (n=66)		Posterior ethmoid sinusitis (n=60)		Sphenoid sinusitis (n=45)	
	No.	P value	No.	P value	No.	P value	No.	P value	No.	P value
Significant deviated nasal septum (n=34)	33	0.001	22	0.033	22	0.144	22	0.033	18	0.022
Agger nasi cell (n=31)	28	0.026	22	0.005	24	0.001	22	0.005	16	0.049
Concha bullosa (n=36)	33	0.007	19	0.607	21	0.544	18	0.907	16	0.263
Pneumatized uncinated (n=0)	0	-	0	-	0	-	0	-	0	-
Overpneumatized ethmoid bulla (n=16)	15	0.068	12	0.027	14	0.004	14	0.001	8	0.243
Paradoxical middle turbinate (n=6)	5	0.644	4	0.380	4	0.526	3	0.967	3	0.495
Haller's cell (n=4)	4	0.246	4	0.039	4	0.061	4	0.039	2	0.580
Onodi cell (n=7)	5	0.801	4	0.664	5	0.343	4	0.664	4	0.253
Frontal air cell (n=5)	5	0.192	4	0.159	4	0.235	4	0.159	2	0.883
Inferior turbinate hypertrophy (n=8)	8	0.095	6	0.131	6	0.220	6	0.131	3	0.970

Table 7: Association between sinuses and drainage pathways involved among the study subjects.

Diseased sinuses	OMC block (77)		FR block (60)		SER block (47)	
	No.	P value	No.	P value	No.	P value
Maxillary sinusitis (n= 92)	74	48.210* (0.000)	57	24.435* (0.000)	46	20.803* (0.000)
Frontal sinusitis (n=60)	53	32.254* (0.000)	49	23.413* (0.000)	38	7.397* (0.007)
Anterior ethmoid sinusitis (n=67)	59	39.724* (0.000)	53	53.247* (0.000)	44	46.246* (0.000)
Posterior ethmoid sinusitis (n=60)	55	38.518* (0.000)	50	55.100* (0.000)	41	44.296* (0.000)
Sphenoid sinusitis (n=45)	38	13.934* (0.000)	38	35.475* (0.000)	44	105.698* (0.000)

As in this table, all p values are 0.000 (<0.01), and all shows significant association, so there is no difference between strength of association of different factors, so a value called as asymptomatic significance i.e.* value used here. As the p value decreases asymptomatic significance increases which shows more association between two factors

Table 8: Association between different drainage pathways and the anatomical variations of nose found, among the study subjects.

Anatomical variants of nose on diseased side	OMC block (n=77)		FR block (n=60)		SER block (n=47)	
	No.	P value	No.	P value	No.	P value
Significant deviated nasal septum (n=34)	26	0.057	20	0.185	18	0.042
Agger nasi cell (n=31)	25	0.019	21	0.017	17	0.031
Concha bullosa (n=36)	28	0.030	17	0.780	18	0.092
Pneumatized uncinata (n=0)	0	-	0	-	0	-
Overpneumatized ethmoid bulla (n=16)	13	0.107	12	0.027	9	0.118
Paradoxical middle turbinate (n=6)	5	0.292	2	0.426	3	0.554
Haller's cell (n=4)	3	0.616	3	0.294	2	0.632
Onodi cell (n=7)	4	0.736	3	0.730	4	0.297
Frontal air cell (n=5)	4	0.424	2	0.675	2	0.945
Inferior turbinate hypertrophy (n=8)	8	0.025	5	0.436	3	0.951

DISCUSSION

Patients diagnosed with CRS were studied to determine the association of disease and anatomical variations seen on CT PNS.

Of these 38 were male and 23 females indicating a slight male predominance. This is similar to other Indian studies conducted by Wani et al, Sheetal et al, Rashi et al, Ahmet et al and Gupta et al whereas other studies have shown a female preponderance of sinusitis.⁵⁻⁹ Female preponderance was also reported by US National Center for health statistics.^{9,10} The difference may be due to racial, social or other factors.

We found that maximum number of patients of CRS, were of age group 41-60 followed by age group 20-40 years, and least in age group >60 years. Similar findings have been reported by Wani et al (average age was 35.6 years) and Fadda et al (mean age was 45.5 years).^{5,11} While other like Rashi et al, Shivakumar Senniappan, Komathi Raja et al found maximum number of patients were of age group 21-30 years.^{7,12}

In our study we had 57 patients with CRSwNP and 4 patients CRSsNP. According to EPOS 2012 CRSsNP comprises more than two-thirds of cases whereas CRSwNP represents 20-25% of cases.¹³ Epidemiologic studies done by Tan et al also revealed that incidence of CRSsNP is much higher than CRSwNP.¹⁴ The higher incidence of patients of CRSwNP in our study may be because we have enrolled patients of CRS reporting to the ENT department while the study by Bruce et al was based on data from a primary health care centre and others are from community based questionnaires.

In our study bilateral disease and multiple sinuses involvement was commoner than unilateral disease and isolated sinus disease. Maxillary sinuses (95.08%) are the commonest sinuses to be involved, followed by anterior ethmoid sinuses (67.21%), frontal sinuses (60.65%), posterior ethmoid sinuses (59.02%) and sphenoid sinuses (45.90%). These results are similar with the study conducted by Fadda et al, Senniappan and Raja et al in 2018 which showed maxillary sinus is the most common sinus involved followed by anterior ethmoid, frontal, posterior ethmoid and sphenoid sinus.^{11,12} Other researchers have reported slightly variable results, Kim et al.¹⁵ have also shown that maxillary sinus was the most commonly involved sinus but they found frontal sinus is least commonly involved sinus. Whereas similar studies conducted by Maru et al, Zinreich et al and Bolger et al found that anterior ethmoid sinus involvement was the most common followed by the maxillary sinuses.¹⁶⁻¹⁸

The most common anatomical variant we found was deviated nasal septum i.e. 44 out of which 34 on diseased side and the second most common anatomical variant found was concha bullosa i.e. 42 out of which 36 were on diseased side, and the least common was haller cell. We did

not encounter a pneumatized uncinat process. Different researchers have reported different anatomical variants as being more common. According to Rashi et al, Ahmet et al and Fadda et al most common anatomical variant found was deviated nasal septum.^{7,8,11} and Sivasli et al found concha bullosa to be the most common anatomical variant while Azila et al and Maru et al found that the most common anatomical variant was agger nasi cells and the least common was pneumatized uncinat processes.¹⁹⁻²²

In our study, a significant association was found between DNS and maxillary sinusitis, agger nasi cell and frontal, anterior ethmoid and posterior ethmoid sinusitis, concha bullosa and maxillary sinusitis. Over pneumatized ethmoid bulla and anterior and posterior ethmoid sinusitis (significant, p value <0.01). Rest of the other anatomical variants had no significant association found with diseased sinuses (p value >0.01). Fadda et al have also reported statistically significant association of septal deviation, concha bullosa and haller cell with maxillary sinusitis, overpneumatized ethmoidal bulla with anterior ethmoid sinusitis, agger nasi cell with frontal sinusitis (p<0.05).¹¹ Similar results have been reported by Mendiratta et al i.e. a statistically significant correlation (p value <0.05) between septal deviation, concha bullosa and paradoxical middle turbinate with maxillary sinusitis, between medial deviation of uncinat process and anterior ethmoid sinusitis.²³ However, a recent study by Senniappan and Raja et al in 2018 showed slightly different results.¹² They have found that Septal deviation is more likely to cause posterior ethmoid sinusitis (p<0.01) than maxillary sinusitis. However, they too have reported that concha bullosa is significantly associated with maxillary and anterior ethmoid sinusitis and agger nasi cell with frontal sinusitis (but not with anterior and posterior ethmoid sinusitis as in our study). Some reporters' viz. Kaygusuz et al, Kim et al, Lerdlum et al and Stallman et al have reported no statistically significant association between the sinonasal anatomical variations and CRS.^{8,14,24,25} They have claimed that local, systemic, environmental factors or intrinsic mucosal disease were more significant in the pathogenesis of rhino sinusitis than anatomical variations. According to Holbrook et al and a review article by Nouraei et al anatomic variations were often not valued as causal factor for CRS.^{26,27}

On studying drainage pathways block, we found the incidence of OMC block was 85.24%, FR block was 59.02% and SER block was 47.54%, Earwaker found, OMC block was 51% and Fadda et al found it to be 75%.^{11,28} The higher incidence of OMC block in our study may be explained due to a predominance of subjects with polyposis compared to those without polyposis. We also found that, blockage of drainage pathways (OMC/FR/SER block) significantly related with disease in the corresponding maxillary, anterior and posterior ethmoid, frontal and sphenoid sinuses respectively. We did not find any similar study which had made such a correlation or had studied the FR and SER. Larger and more studies may be needed for further comment on this.

CONCLUSION

We have found that DNS, concha bullosa, agger nasi and over pneumatized ethmoid bulla are the anatomical variations that are significantly associated with sinus disease while other variations did not have any role in CRS. We understand that beside these anatomical factors, other factors (like systemic, environmental, genetic etc.) should also be studied to establish the association between CRS and other factors, for the better understanding of etiology and management of the patient. Other drawbacks of our study were a small number of 61 patients and a predominance of CRS with polyposis. A larger, longitudinal, randomized study having significant number of cases with and without polyposis would help to determine etiology of this disease better.

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