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Association of Chronic Rhino Sinusitis with Concha Bullosa and Deviated Nasal Septum

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Abstract:
Introduction: The most common anatomical variations of nasal air sinuses are concha bullosa and deviated nasal septum according to many authors, but their relationship with Chronic Rhino sinusitis (CRS) is under debate. Their role in pathogenicity and chronicity of CRS warrants further detailed study.
Aims: To find out any possible association among Chronic rhino sinusitis, Concha bullosa and Deviated Nasal Septum (DNS) in Central India.
Methodology: 100 cases, in the age group of 18 to 42 years referred with clinical features of CRS not responding to medical management for 8 weeks or more to the radiologists, were subjected to CT of the paranasal sinus region as a part of routine medical treatment. The control group included 100 patients who had undergone CT scan of the paranasal sinus region for a reason other than CRS and were not having any CRS. Resulting data were calculated and statistically analyzed.
Results: 64% of the total population were having DNS and 57% had Concha bullosa. Frequency of occurrence of these variation between the CRS group and the control group was not significant (p>0.05). The Concha bullosa was significantly seen in control group rather than in cases of CRS whereas DNS was seen to be related more on the opposite side of where the concha bullosa was seen.
Conclusion: These anatomical variations can be used as a tool for early prediction of CRS and hence substantiates the need for lifestyle modification to counteract this disease at its nascent stage. A more descriptive study is warranted for further understanding of the role of these variations in etiopathogenesis of CRS.
Keywords: *Chronic rhino sinusitis; Concha bullosa; Deviated Nasal Septum.*

I. Introduction

Chronic rhino sinusitis (CRS) is one of the most common illnesses of our times and is a condition that is increasing in epidemic proportions throughout the world [1]. *Chronic sinusitis*, defined as symptoms lasting longer than 8 weeks [2]. Rhinosinusitis occurs when the lining of the sinuses gets infected or irritated, become swollen, and create extra mucus. The swollen lining may also interfere with drainage of mucus.

Certain anatomical variations of lateral wall of nose like concha bullosa, nasal septal deviation and oversized bulla [3] 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.

The presence of anatomical variations have been studied in great detail by many authors in different populations, but their relationship with CRS is under debate. Most common variations being either DNS or Concha bullosa. Its role in pathogenicity and chronicity of CRS warrants further detailed study. CT demonstrates the extent of disease, significant anatomical variations that may predispose to rhinosinusitis and the nearby vital structures so that iatrogenic damage can be avoided [4].

The deviated nasal septum (DNS) may involve the cartilage or bone or both. There are varieties of DNS like Anterior dislocation, C- Shaped deformity, S- Shaped deformity, Spur or Thickening (may be due to localized hepatoma or overriding of displaced fragments). DNS can affect any age and sex, but males are more commonly affected than females [5]. Various symptoms associated with it are nasal obstruction, headache, sinusitis, epistaxis, anosmia, external deformity, middle ear infections.

The definition of Concha bullosa (CB) is the pneumatization (or air pocket) of the middle, inferior and superior turbinates [6-8] but specially related with middle conchae. The middle turbinate bone is usually a thin plate of bone. When this plate becomes pneumatized by extension of the anterior or posterior ethmoidal air cells, the air cell created is referred to as Concha bullosa [9-10]. Varied degrees of pneumatization of the concha may be observed, possibly causing middle meatus or infundibulum obstruction, besides being related to deviation of the nasal septum to the contralateral side [10,11]. Some studies have reported a relationship between the presence of concha bullosa and rhinosinusitis [12-13], however, other researchers have shown no direct

relationship [14-15]. The relationship of concha bullosa to paranasal sinus disease continues to be debated [11,16].

Concha bullosa is a very common anatomical deviation. While it does not necessarily predispose to sinus problems, persons with enlarged turbinates and concha bullosa may have a blockage which prevents their sinuses from draining properly resulting in frequent sinus infections. This condition may require surgical intervention. 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 persists as long as the anatomical abnormality is present, causing chronicity [17]. Some studies have also linked concha bullosa with a deviated septum [11]. It is worth noting that a concha bullosa and a deviated septum may interfere with transnasal surgery and is thus a relevant finding on imaging of the region for other reasons [18]. There are many racial and genetic factors responsible for these anatomical variations, and there is a variation of these in different populations and races [19].

The main aim of this study was to find the relationship among Chronic Rhinosinusitis, Concha bullosa and DNS with the help of CT scans of M.P. population mainly from Indore region (Central India) and their clinical significance and to find out whether a probable relationship exists between them or not. Also, to identify and to compare the percentage calculation of CB and DNS in different population, race and region. This knowledge will be useful for future endoscopic surgeons in order to understand the pathogenesis of sinusitis and therefore avoid iatrogenic injury due to these common anatomical variations.

II. Material And Methods

2.1. CASES: 100 CT PNS cases were collected from the Radiologist, which were mainly referred from Tertiary care centres of MP region (Central India) with clinical features of CRS not responding to medical management for 8 weeks or more, and who were subjected to CT of the paranasal sinus region as a part of routine medical treatment.

2.1.1. Sinusitis symptom assessment: Clinical features of CRS include either of facial pressure or pain, nasal discharge, nasal congestion, fatigue, headache, postnasal drip, and/or loss of sense of smell.

2.1.2. Inclusion Criteria: Adult patients (both males and females)18 to 42 years of age irrespective of socio-economic status and with clinical diagnosis of CRS who were advised CT scan as a part of routine management protocol with CT scan finding of 4 mm or more mucosal thickening in any of the paranasal sinus as diagnosed by the radiologist.

2.1.3. Exclusion Criteria: Patients with history of previous sinus surgery, benign tumors of sino-nasal mucosa or facial trauma or facial disturbances, Also patients having Mucosal polyps (massive or recurrent) or other expansive lesions or Craniofacial anomalies, Patients with odontogenic sinusitis, acute rhinosinusitis or acute infections, with sinus malignancies, who were not willing to undergo necessary investigation were excluded. Patients with fungal rhinosinusitis (mycetoma), altered ciliary motility like immotile cilia syndrome, kartageners syndrome, down syndrome and cystic fibrosis and patients who had undergone endoscopic sinus surgery were also excluded from this study.

2.2. Controls: 100 patients from the age group 18 to 42 years who had undergone CT scan of the paranasal sinus region for a reason other than CRS like trauma, evaluation of headache and were not having any CRS.

2.3. Method: All the CT scans were obtained with 64 Slice Multidetector CT machine. After obtaining the scout projection, the area of scanning was defined to include the region from roof of frontal sinus up to the hard palate. The sections were taken with slice thickness of 5 mm. Coronal sections were performed with the patients in prone position with extended neck and the plane that is perpendicular to hard palate. In CT scans of both the groups, presence of Concha bullosa and DNS were documented. After consulting with Rhinologist anatomical variations were documented as either being present or absent to elucidate a probable correlation between them and chronic inflammation.

All the data were tabulated and statistically analyzed by using SPSS version 21 and microsoft excel softwares. Numerical data was expressed as mean whereas categorical data was expressed as number and percent. Unpaired t- test was used to compare each 2 independent groups of numerical data and Chi square test was used to compare each 2 independent groups of categorical data. P value was considered to be significant if it was <0.05.

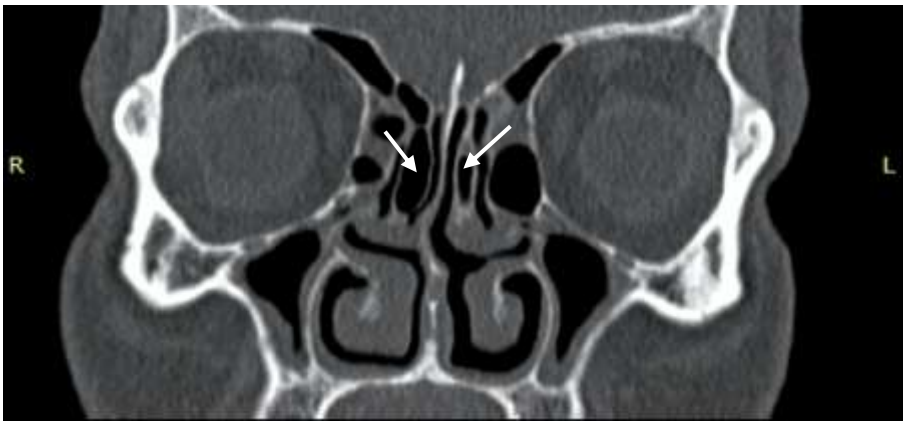


Figure 1: Coronal CT showing pneumatized bulbous portion of middle turbinate— Bilateral Concha Bullosa (arrows) with right sided nasal septal deviation.

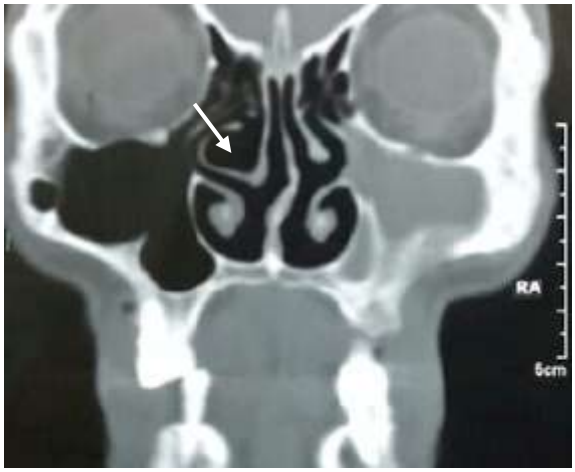


Figure 2: Coronal CT showing right sided concha bullosa (arrow) with left sided nasal septal deviation.

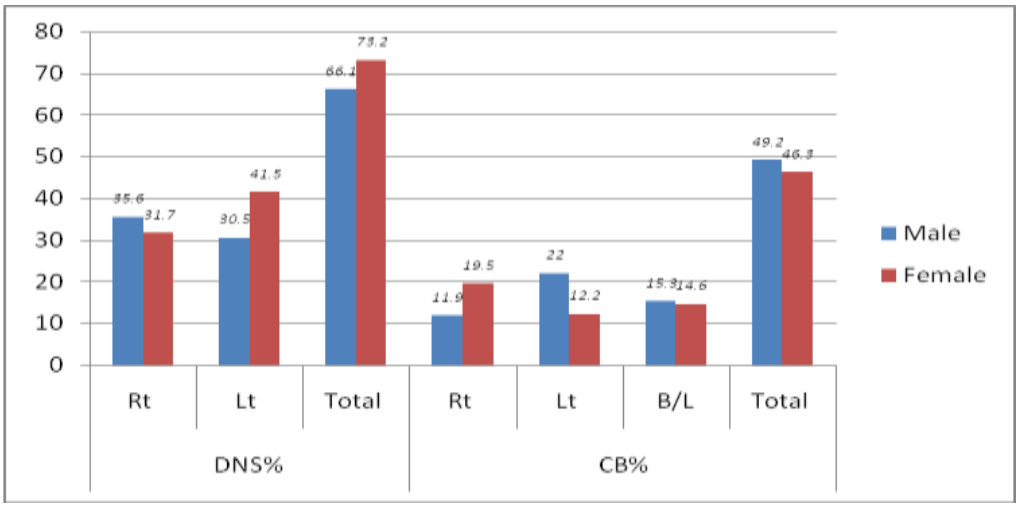
III. Observations and Results

We took 100 CRS cases in which 41 were females and 59 were males. As seen in Table No. 1 and Graph No 1, Out of 41 female cases, 13 (31.7%) was having DNS on Rt side and 17 (41.5%) on Lt side; 8 (19.5%) cases was having CB on Rt side, 5 (12.2%) on Lt side and 6 (14.6%) had CB bilaterally. Out of 59 male cases, 21 (35.6%) was having DNS on Rt side and 18 (30.5%) on Lt side; 7 (11.9%) cases was having CB on Rt side, 13 (22%) on Lt side and 9 (15.3%) had CB bilaterally. 34% of the total cases taken was having right side DNS and 35% was having left side DNS. But concha bullosa, was bilateral in 15% of cases, 15% on right side and 18% on left side of sino-nasal cavity. There were no significant differences in laterality. It was also seen that the Concha bullosa was significantly seen in control group rather than in cases of Chronic Rhinosinusitis whereas DNS was seen to be related more on the opposite side of where the concha bullosa was seen.

Table No.1: Distribution of Anatomical Variations among Cases according to laterality

Total (100 cases)	**DNS**						**CB**							
	Rt		**Lt**		**Total**		**Rt**		**Lt**		**B/L**		**Total**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Female (41)	13	31.7	17	41.5	30	73.2	8	19.5	5	12.2	6	14.6	19	46.3
Male (59)	21	35.6	18	30.5	39	66.1	7	11.9	13	22	9	15.3	29	49.2
Total	34	34	35	35	69	69	15	15	18	18	15	15	48	48

R= right L= left B/L= bilateral



Graph No. 1: Showing % distribution of DNS and CB in males and females

As seen in Table No. 2, DNS was more common in female patients of CRS (73.2%), where as CB was more common in male cases (49.2%). No significant difference (p> 0.05) was found in the distribution of anatomical variations among males and females. Of the total population participated 64% were having Deviated nasal septum and 57% had Concha bullosa. It was found that there is no significant relationship occurs between the anatomical variations taken up in the study with CRS. Although the difference in the occurrence of Concha bullosa is more in controls than in cases (p=0.01), it does not point towards its association with Chronic Rhinosinusitis.

Table No.2: Distribution of DNS and CB in sino-nasal cavity and its Relationship with CRS

Parameter	Cases %			Controls %			Total %	p value	Significance
	Male	Female	Total	Male	Female	Total			
DNS	66.1	73.2	69	60.3	55.6	59	64%	0.1421	Ns
CB	49.2	46.3	48	65.8	66.7	66	57%	0.01	**

Ns= Not Significant ** Significant

IV. Discussion

The anatomic variants are a potential threat for surgical safety occur frequently and need to be specifically sought as part of preoperative evaluation [14,20-21], the most common being concha bullosa and septal deviation according to different authors' study. In our study, we reviewed the CT scans for DNS or CB of 100 patients suffering from CRS, and correlated them with the presence of radiologic evidence of sinus mucosal disease. Finally, we correlated the incidence of DNS and CB with the presence of unilateral or bilateral sinusitis, and the results were compared with other literature data.

Nasal septum is fundamental in the development of the nose and paranasal sinuses. It is the epiphyseal platform for the development of the facial skeleton [22]. The reported prevalence of DNS varies widely. It was the most common anatomical variant seen in the study. DNS is present in 20-31% of the general population, and severe septal deviation has been noted as a contributing factor for sinusitis [23-24]. However, some studies have not demonstrated a causal relationship between DNS and sinusitis [11,25]. Deviation, although if severe and if associated with nasal spurs causes a decrease in the critical area of the osteomeatal unit predisposing to obstruction and related complications [26]. Similar finding were observed by Perez et al [27]. A detailed study with DNS and its severity is thus warranted to further evaluate its role in causation of CRS. Infact in various studies the finding of nasal septal deviation ranged from 14.1% to 80% as shown in Table no. 3.

My study shows 69% cases and 59% controls to be having DNS with a p-value of 0.14, hence not significant. There is no probable association between CRS and DNS as per my study and it correlates well with other studies. Perhaps, this was due to severity of deviation which was not prominent enough to cause obstruction. Deosthale *et al.* [28] found a statistically significant correlation between right septal deviation and right maxillary sinusitis (p <0.01) as also found by Fadda GL et al [29] in between left septal deviation and left maxillary sinusitis (p < 0.01). Kim *et al.* [30], Lerdlum *et al.* [31], and Stallman *et al.* [11] claimed that local, systemic, environmental factors or intrinsic mucosal disease were more significant than anatomic variations in the pathogenesis of rhinosinusitis. Stallman et al. [11] reported a significant relationship between the presence of concha bullosa and deviation of the nasal septal on the contralateral side (p < 0.0001).

According to Blaugrund [32], nontraumatic septal deviation is observed in some 20% of the population, especially at the level of the chondrovomerine articulation. The proportion increased to 44% in the series studied by Earwaker [33]. That author also observed dislocation of the chondrovomerine junction in 5.5% of the cases, and the presence of a bony spur on the septum in 7.2%. Perez *et al.* [27] observed an even higher frequency of septal deviation (58%) and the presence of septal spurs (13.6%), while chondrovomerine deformation was 4.5%. The %age of DNS as found by Kasapoglu F *et al.* [34] was 41.9% and 15.9% by Khalil HS *et al.* [35].

The term concha bullosa was coined by Zuckerlandl in 1862 to describe pneumatization of the middle turbinate, and its incidence was reported to range from 9% to 20% based on initial anatomical dissections [36].
Concha bullosa (middle turbinate pneumatization extending caudally at least 50% of the vertical height of the middle turbinate) [37] has been implicated as a possible aetiological factor in the causation of recurrent chronic sinusitis specially ethmoid sinusitis according to Deosthale *et al.* [28]. It is due to its negative influence on paranasal sinus ventilation and mucociliary clearance in the middle meatus region as quoted by Tonai [38].
The reported prevalence of Concha bullosa could vary according to differing opinions regarding significant degrees of pneumaization. It is hence difficult to decide when it should be said that concha bullosa is small and non significant or large and significant. Hence, we chose to report aeration of any degree.

Table No.3: Comparison of various studies and documentation of relative frequencies of Concha bullosa and DNS in CRS cases of their respective study populations

Author	Year of Study	Concha bullosa%	DNS%
Bolger WE et al. [39]	1991	15	53.6
Earwaker [33]	1993	55	44
Zinreich J [40]	1993	36	21
April et al. [41]	1993	24	13
Lusk et al. [42]	1996	10	10.4
Arslan H et al. [43]	1999	30	36
Perez P et al. [27]	2000	73	80
Asruddin et al. [44]	2000	28	38
Maru and Gupta [45]	2001	42.6	55.7
Dutra and Marchiori [46]	2002	4.2	14.1
Stallmann JS et al. [11]	2004	44	60
Dua K et al. [47]	2005	16	44
Abdel-Aziz and Ashraf [37]	2006	48.5	28.5
Baradaranfar and Labibi [48]	2007	12.5	45
Shahizon AM et al. [49]	2008	45	40
Riello and Boasquevisque [50]	2008	42.5	28.5
Wani AA et al. [51]	2009	30	25.33
Mamtha H et al. [52]	2010	16	65
Alkire and Bhattacharya [53]	2010	41.7	27.8
Azila A [54]	2011	40.8	56
Fadda GL et al. [29]	2012	49.3	58.5
Shrikrishna BH et al. [55]	2013	38	28
Madani SA et al. [56]	2013	17.4	56.7
Adeel M et al. [57]	2013	18.2	26
Biswas J et al. [58]	2013	36	78
Aramani A et al. [26]	2014	53.7	74.1
Al-Abri R et al. [59]	2014	49	80
Deosthale NV et al. [28]	2014	27.87	50.81
Kaygusuz A et al [60]	2014	41.5	72.3
Murthy DD et al. [61]	2016	45.5	73.2
Sarkar et al. [62]	2016	32.9	74.8
Mendiratta V et al [63]	2016	47.5	72.5
My study	2016	57	64

According to data from the different studies, as depicted in the Table no.3, the range of positive CT findings for concha bullosa varies from 14% to 80%. Different authors have studied the prevalence of CB by considering the specific degree of pneumatization or any degree of pneumatization. However, if any degree of pneumatisation is considered, the incidence increases [64]. None of the studies show any relationship between Concha bullosa and CRS. My study shows similar results with concha bullosa present in 48% of the cases, 66% of controls and overall 57% but no association specifically with CRS. There was no significant difference in laterality. The p value was highly significant being 0.01, but it did not point towards the relationship of CB with CRS. Instead it was concluded that CB was present as commonly in the normal population as in the cases of CRS. This discrepancy may be due to genetic differences among different races and perhaps the definition for pneumatization may vary among different investigators. Sheetal D et al [65], found CB on CT scan to be 35% and 42% of the patients on the right and left side respectively. Scribano E *et al.* [25] found CB in 67 out of 73

patients. Also the %age of CB as found by Goldman [66] was 80%, 15% by Zinreich *et al.* [64] and Weinberger et al [67], 28% by Tonai and Bala [38], 37% by Krzeski A *et al.* [68], 48.1% by Ozean KM *et al.* [69].
Bolger et al. [39] 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). Dutra and Marchiori [46], Lusk et al [42] and April et al [41] studies have included only pediatric patients.

There are different opinions in the literature concerning concomitance with mucosal pathologies. Fadda [29] found a correlation between bilateral concha bullosa and bilateral maxillary sinusitis ($p < 0.01$). Ozcan KM et al [69], Lam WW et al [15], Goldman [66] also found significant relationship between concha bullosa and sinusitis while other studies found no direct relationship [11,14,39,70]. In Abdel Aziz study [35] concha bullosa was significantly more in females (68.6%) compared to males ($p < 0.01$), but in our study CB is more common in male cases and female controls. In a study conducted by Ameri AA et al. [17] septal deviation and concha bullosa of middle turbinate were the anatomic variants that were significantly associated with chronic sinusitis. Their study concluded that the normal anatomic variants of paranasal sinuses may be considered as predictors for the occurrence of chronic sinusitis.

V. Conclusion

It was found that, of the total population participated 64% were having Deviated nasal septum and 57% had Concha bullosa. When the frequency of occurrence of these variations were compared between the CRS group and the control group it was found out that the difference is not significant. Hence, it was concluded that no relationship exists between the presence of Anatomical variations taken up in the study and pathogenesis and chronicity of CRS. But the Concha bullosa was significantly seen in control group rather than in cases of Chronic Rhinosinusitis whereas DNS was seen to be related more on the opposite side of where the concha bullosa was seen. It could be possible that the size of the variations was not big enough to cause obstructive pathology. Though it must be kept in mind that the present study only documented the Anatomical variations as being present or absent. Also, the size of variations, the degree of pneumatization and the presence or absence of other variations may have a cumulative effect on the pathogenesis of CRS.

This study and other studies like this may also be of immense value to ENT surgeons and radiologists in preventing the damage to these variations during a surgery for sinusitis. A more descriptive study is warranted for further understanding of the role of these variations in etiopathogenesis of CRS. With this study we can also conclude that CT scan is a good modality for visualizing the paranasal sinuses and their variations.
Since this study was carried out at a tertiary care center in Central India, it can be used as a reference for future studies in this region. Finally, we believe that some anatomical variations of the paranasal sinus can play an important role in the pathogenesis of chronic rhinosinusitis, and thus may increase the risk of sinus mucosal disease.

Knowledge of the presence of most common anatomical variations of the sinuses has a clinical significance as it minimizes the potential for surgical complications. There is an ethnical difference in the prevalence of anatomical variations. Further studies of anatomical variations with clinical disease correlations are needed.

5.1. Scope for further research: Similar study can be conducted in other regions and a comparison can be drawn for better understanding.

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