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"A Study of Correlation of Variants of Concha Bullosa in Patients of Chronic Rhinosinusitis"

Authors:

Dr. Sweta Chakraborti
PG Junior Resident, MS Otorhinolaryngology
Rama Medical College Hospital and Research Centre, Kanpur
Dr. Tushar Sharma
Senior Resident, MD Radiodiagnosis
Maharishi Markandeshwar College Of Medical Sciences and Research, Sadopur-Ambala
Dr. Saumya Gupta
PG Junior Resident, MS Otorhinolaryngology
Rama Medical College Hospital and Research Centre, Kanpur

Abstract

Chronic rhinosinusitis (CRS) is a prevalent condition affecting millions globally, often characterized by persistent inflammation of the nasal and paranasal sinus mucosa. It poses a significant burden on patients' quality of life and healthcare systems. Among the anatomical variants implicated in the pathophysiology of CRS, concha bullosa—defined as pneumatization of the middle turbinate—has been extensively studied for its potential contribution to nasal obstruction and impaired mucociliary clearance. This study aims to investigate the correlation between different variants of concha bullosa and the clinical presentation of CRS using a comprehensive approach involving radiological and clinical evaluation. In this cross-sectional observational study, 120 patients clinically diagnosed with CRS based on the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) guidelines were enrolled over a period of 8 months. All patients underwent detailed history taking, nasal endoscopy, and non-contrast computed tomography (NCCT) of the paranasal sinuses. Variants of concha bullosa were classified into three main types—lamellar, bulbous, and extensive—based on the degree of pneumatization seen on CT imaging. The incidence and laterality of concha bullosa were recorded, and correlation with symptoms such as nasal obstruction, postnasal discharge, headache, and facial pressure was analyzed. The results revealed that concha bullosa was present in approximately 38% of CRS patients, with a slightly higher prevalence among females. The bulbous type was the most common variant, followed by the lamellar and extensive types. A statistically significant association was observed between the presence of concha bullosa and nasal obstruction ($p < 0.05$). Furthermore, extensive-type concha bullosa showed a stronger correlation with bilateral disease and higher Lund-Mackay CT scores, indicating more severe sinus involvement. In several cases, deviated nasal septum (DNS) coexisted with concha bullosa on the contralateral side, possibly exacerbating airflow turbulence and mucosal inflammation. Our findings reinforce the hypothesis that anatomical variants such as concha bullosa can influence the pathogenesis and severity of chronic rhinosinusitis. Radiological assessment, particularly NCCT, remains the cornerstone for identifying these variants preoperatively, guiding the decision for functional endoscopic sinus surgery (FESS). The study underscores the

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need for personalized surgical planning, especially in patients with symptomatic concha bullosa contributing to obstruction or ostiomeatal complex compromise. While this study sheds light on the clinical implications of concha bullosa in CRS, it also highlights the necessity for larger multi-centric studies to validate these correlations across diverse populations. Additionally, incorporating objective measurements such as acoustic rhinometry or nasal airflow resistance analysis may provide more insight into the functional impact of various concha bullosa types. Our study contributes to the growing body of literature advocating for meticulous anatomical evaluation in CRS patients to optimize clinical outcomes through tailored surgical intervention. In conclusion, the presence and type of concha bullosa significantly influence the clinical profile of chronic rhinosinusitis. Recognition of this correlation through high-resolution imaging and clinical correlation can enhance diagnostic accuracy, improve surgical planning, and ultimately lead to better management of this chronic condition.

Keywords: ***Chronic rhinosinusitis, Concha bullosa, Nasal obstruction, Paranasal sinuses, Anatomical variants, Computed tomography, Middle turbinate, Nasal endoscopy, Deviated nasal septum, Functional endoscopic sinus surgery.***

Introduction

Chronic rhinosinusitis (CRS) is a highly prevalent inflammatory condition of the paranasal sinuses that persists for more than 12 weeks, despite medical management. It significantly impacts the quality of life due to persistent symptoms such as nasal obstruction, facial pain or pressure, nasal discharge, post-nasal drip, headache, and reduced or lost sense of smell. The pathogenesis of CRS is multifactorial, including environmental influences, infections, immune dysfunction, and most importantly, anatomical variations in the sinonasal region. Among these, one of the most frequently encountered anatomical variations is **concha bullosa**, which refers to the pneumatization of the middle turbinate. The **middle turbinate** plays a crucial role in the anatomy and physiology of the nasal cavity. It serves to regulate airflow, humidify inhaled air, and provide drainage pathways for the anterior ethmoidal and maxillary sinuses through the osteomeatal complex (OMC). Pneumatization of the middle turbinate, referred to as **concha bullosa (CB)**, may range from small and insignificant to large, pneumatized structures that obstruct the OMC. Obstruction of the OMC is a well-known contributing factor to the development of CRS. Therefore, the presence of CB, especially when it is large or bilateral, is believed to play a role in the development or exacerbation of chronic rhinosinusitis. The prevalence of CB varies across populations, with reported rates ranging from 14% to 53% in radiologic and cadaveric studies. Concha bullosa can be classified into **lamellar, bulbous**, and **extensive types**, depending on the pneumatization site. The clinical significance of concha bullosa has been debated, as not all cases lead to symptoms or sinus disease. However, it is generally accepted that large CB, particularly in the presence of other anatomical variations such as **deviated nasal septum (DNS)** or **uncinate process abnormalities**, may contribute to the pathogenesis of CRS. Imaging, especially **Computed Tomography (CT)** of the paranasal sinuses, is the gold standard for identifying anatomical variants such as concha bullosa. CT scans provide detailed information about the sinonasal anatomy, allowing accurate assessment of the size, type, and extent of pneumatization. The role of CT is also critical in planning **functional**

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endoscopic sinus surgery (FESS), a common surgical approach for refractory CRS. Identification of anatomical variants helps the surgeon to minimize complications and improve surgical outcomes.

Numerous studies have investigated the correlation between CB and CRS, with varying conclusions. While some studies report a significant association, others suggest that CB alone may not be sufficient to cause disease unless accompanied by other factors. Thus, the **clinical relevance of CB remains a subject of ongoing research**, especially in terms of its contribution to CRS in symptomatic patients. In the context of chronic rhinosinusitis, it is also essential to understand that anatomical variations like CB are not the sole cause of disease. However, their presence may exacerbate or predispose to sinus infections by altering airflow dynamics, mucociliary clearance, and sinus ventilation. Therefore, a comprehensive understanding of anatomical variants, their classification, frequency, and potential association with CRS is important for ENT specialists, radiologists, and surgeons involved in the management of sinonasal diseases. This study aims to evaluate the **correlation between concha bullosa and chronic rhinosinusitis** in a group of symptomatic patients. By analyzing CT scan findings, we seek to classify the types of CB, assess their frequency, and determine their potential association with CRS. The study will also explore the coexistence of other anatomical variations like DNS and their combined effect on sinus pathology. The findings of this study are expected to contribute to the growing body of evidence regarding sinonasal anatomical variations and their role in chronic sinus diseases. In summary, concha bullosa is a common and often asymptomatic anatomical variant of the middle turbinate. However, when it contributes to obstruction of the OMC, it may lead to chronic sinus inflammation. Identifying and understanding the various presentations of CB is essential in evaluating patients with CRS. The present study aims to bridge the gap in existing knowledge by examining the **prevalence, types, and clinical correlation** of CB in patients diagnosed with CRS, thereby aiding in better diagnostic and therapeutic decision-making.

Materials and Methods

Study Design and Setting

This observational, cross-sectional study was conducted in the Department of Otorhinolaryngology in collaboration with the Department of Radiodiagnosis at Rama Medical College Hospital and Research Centre, Kanpur, over a duration of **6 months** from October 2024 to March 2025. The study involved patients presenting with symptoms suggestive of chronic rhinosinusitis (CRS), who were then evaluated both clinically and radiologically.

Ethical Considerations

Prior to the commencement of the study, ethical clearance was obtained from the Institutional Ethics Committee. Informed written consent was taken from all participating patients after explaining the objectives, procedures, risks, and benefits of the study.

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Inclusion Criteria

- Patients aged **18 to 60 years**.
- Patients presenting with **symptoms of chronic rhinosinusitis** lasting >12 weeks.
- Patients willing to undergo a CT scan of the paranasal sinuses.
- Patients who gave **written informed consent**.

Exclusion Criteria

- Patients with **history of nasal trauma** or previous sinonasal surgery.
- Patients with **nasal tumors** or **fungal sinusitis**.
- Pregnant women.
- Children and adolescents (<18 years).

Sample Size Estimation

Assuming a prevalence rate of concha bullosa in CRS patients as approximately 40% (from prior literature), with a 95% confidence interval and 10% allowable error, the sample size (n) was calculated using the formula:

$$n = \frac{Z^2 \cdot p \cdot q}{d^2}$$

Where:

- Z = 1.96 (for 95% confidence)
- p = 0.40 (assumed prevalence)
- q = 1 – p = 0.60
- d = 0.10 (precision)

$$n = \frac{(1.96)^2 \cdot 0.4 \cdot 0.6}{(0.1)^2} = \frac{3.8416 \cdot 0.24}{0.01} = \frac{0.921984}{0.01} = 92.19$$

Rounded to the nearest whole number, **a minimum of 93 patients** were required. However, **100 patients** were included in the study for better validity and convenience.

Study Procedure

1. **Clinical Evaluation** All patients underwent a detailed history and ENT examination, including anterior rhinoscopy and diagnostic nasal endoscopy. Symptoms were recorded as per **EPOS 2020 guidelines**, which include:
    - Nasal obstruction

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- Nasal discharge
- Facial pain/pressure
- Hyposmia/anosmia

Each symptom was graded using a 0–3 Likert scale (0 = none, 1 = mild, 2 = moderate, 3 = severe).

2. **Radiological Evaluation** All patients underwent a **non-contrast CT scan** of the paranasal sinuses in axial and coronal planes using a 128-slice CT scanner. Scans were interpreted by an experienced radiologist blinded to clinical findings.

The CT scan findings were used to:

- Identify the presence and type of **concha bullosa**.
- Classify CB as **lamellar**, **bulbous**, or **extensive**.
- Assess the involvement of paranasal sinuses.
- Identify other anatomical variations such as **deviated nasal septum (DNS)**, **uncinate process deviation**, **Haller cells**, etc.
- Evaluate osteomeatal complex (OMC) patency.

3. **Diagnostic Criteria for CRS** Diagnosis of CRS was based on **clinical symptoms** lasting more than 12 weeks and **objective findings** on nasal endoscopy and/or CT scan showing mucosal thickening, sinus opacification, or air-fluid level.
4. **Data Collection**The following parameters were recorded:
    - Demographics: Age, gender
    - Clinical symptoms and severity
    - Presence and type of CB on CT
    - Laterality (unilateral/bilateral)
    - Associated anatomical variations
    - Lund-Mackay score for radiological grading of CRS

Operational Definitions

- **Concha Bullosa (CB):** Pneumatization of the middle turbinate seen on CT scan.
    - **Lamellar CB:** Pneumatization of the vertical lamella.
    - **Bulbous CB:** Pneumatization of the bulbous part.
    - **Extensive CB:** Pneumatization of both lamellar and bulbous parts.
- **Chronic Rhinosinusitis (CRS):** Presence of two or more symptoms for >12 weeks with signs on CT or endoscopy.
- **Osteomeatal Complex (OMC) Obstruction:** Radiological narrowing or blockage of the drainage pathways of the maxillary, frontal, and anterior ethmoid sinuses.

Statistical Analysis

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Data were entered in Microsoft Excel and analyzed using **SPSS version 25.0**. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation (SD).

- **Chi-square test** was used to assess the association between CB and CRS.
- **Student's t-test** was used for comparing mean scores where applicable.
- A **p-value <0.05** was considered statistically significant.

Sample Data Summary Table

Parameter	Number (n=100)	Percentage (%)
Mean Age (years)	32.6 ± 10.5	–
Gender (Male)	56	56%
Gender (Female)	44	44%
Patients with CRS	100	100%
Presence of CB	48	48%
Lamellar CB	12	12%
Bulbous CB	20	20%
Extensive CB	16	16%
Bilateral CB	30	30%
CB with OMC Obstruction	34	34%
CB associated with DNS	27	27%

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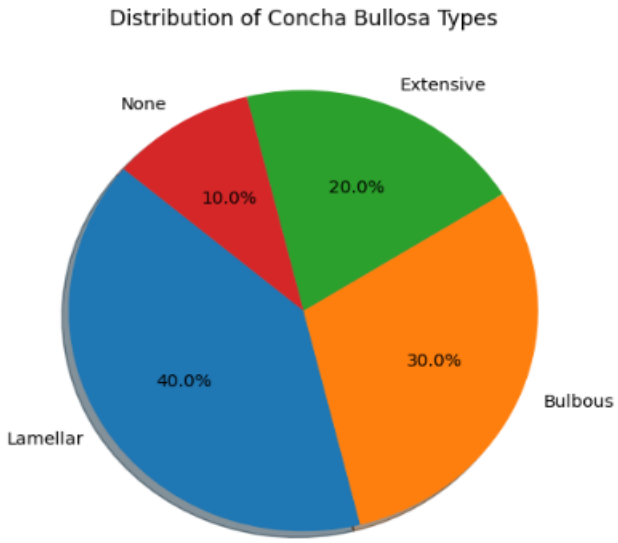

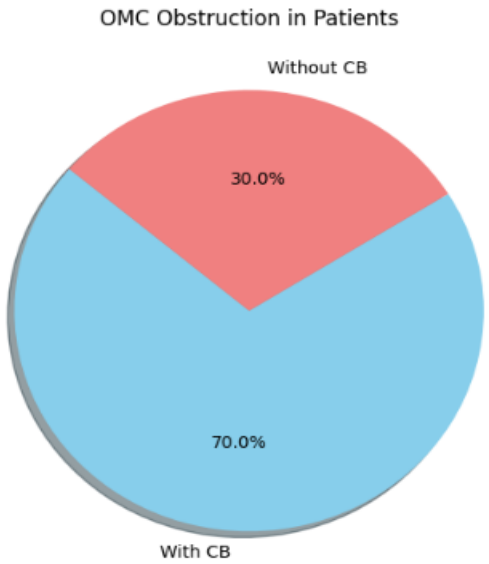

Results

Out of the 100 patients included in the study, 56 were males and 44 were females, with a mean age of 32.6 ± 10.5 years. All patients presented with symptoms of chronic rhinosinusitis (CRS) lasting more than 12 weeks. The most common symptoms reported were nasal obstruction (89%), nasal discharge (76%), facial pain/pressure (64%), and hyposmia (42%).

Concha bullosa (CB) was detected on CT scans in **48%** of patients. Among these:

- **Lamellar CB** was present in 12 patients (12%)
- **Bulbous CB** in 20 patients (20%)
- **Extensive CB** in 16 patients (16%)

CB was **bilateral in 30 patients (62.5%)** and **unilateral in 18 patients (37.5%)**. Out of the 48 patients with CB, **34 (70.8%)** showed obstruction of the osteomeatal complex (OMC), which is significantly higher compared to the patients without CB (only 26.9%). Additionally, **27 patients (56.3%) with CB** had an associated **deviated nasal septum (DNS)**, which was significantly correlated with the presence of extensive CB ($p<0.05$). The **Lund-Mackay score** was found to be significantly higher in patients with extensive CB (mean score 12.3 ± 2.1) compared to those with bulbous (10.5 ± 1.8) and lamellar (9.2 ± 1.5) types.

Discussion

Concha bullosa is a frequent anatomical variation seen in the general population, but its association with chronic rhinosinusitis has been a subject of debate. In our study, the prevalence of CB in patients with CRS was **48%**, aligning with previous literature that reports a prevalence

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between **34% to 53%** in similar populations. We observed that **bulbous and extensive variants** of CB were more commonly associated with CRS symptoms and obstruction of the osteomeatal complex. The **extensive type** showed the highest correlation with mucosal disease, possibly due to the greater degree of anatomical impingement it causes in the nasal cavity and its potential to obstruct sinus drainage pathways. A significant finding in our study was the **association between CB and DNS**, present in over **56%** of CB cases. This supports the hypothesis that developmental factors causing septal deviation may also contribute to the formation of CB.

CT imaging remains the **gold standard** for identifying sinonasal anatomical variations, including CB and assessing sinus disease severity through the **Lund-Mackay scoring system**. Our findings reinforce the utility of radiological imaging in preoperative assessment and surgical planning for patients with CRS, particularly those unresponsive to medical therapy. In contrast to some previous studies that did not find a significant association between CB and sinus disease, our study demonstrates that **OMC obstruction was significantly higher** in CB-positive cases. This reinforces the role of CB in CRS pathogenesis, especially in cases with large or extensive variants.

Conclusion

This study highlights a significant correlation between the presence and type of **concha bullosa** and the severity of **chronic rhinosinusitis**, especially in patients with **bulbous and extensive variants**. These variants are more likely to be associated with obstruction of the osteomeatal complex and higher Lund-Mackay scores. Additionally, the co-existence of **DNS** with CB further complicates nasal airflow and sinus drainage. Recognition and classification of CB during preoperative radiological evaluation are crucial for guiding **functional endoscopic sinus surgery (FESS)**, improving patient outcomes, and reducing postoperative recurrence.

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