



Otorhinolaryngology

“A STUDY OF ANATOMICAL VARIATIONS OF OSTEOMEATAL COMPLEX IN CHRONIC RHINOSINUSITIS PATIENTS UNDERGOING CT AND NASAL ENDOSCOPY”

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ABSTRACT **Aim-** The aim of this study is to investigate the incidence and types of anatomical variations within the osteomeatal complex among chronic rhinosinusitis (CRS) patients, utilizing CT scans and nasal endoscopy. The study seeks to correlate these variations with the severity and type of paranasal sinus inflammation, and emphasize the importance of these diagnostic modalities in pre-operative assessment and surgical planning. **Methodology-** The study employed a mixed-methods design comprising retrospective and prospective arms. It included 100 patients aged 12-60 diagnosed with chronic rhinosinusitis, focusing on those requiring surgical intervention despite prior medical management. Comprehensive assessments involved detailed medical histories, ENT examinations, diagnostic nasal endoscopy, and CT scans using the Lund-Mackay scoring system to evaluate sinus involvement severity. **Results-** The study found a diverse age distribution with a mean age of 35.83 years and nearly equal gender representation. Common symptoms included ear fullness/pain, nasal obstruction, and facial pain. Anatomical evaluations via nasal endoscopy and CT scans revealed prevalent findings such as deviated nasal septum, inferior turbinate hypertrophy, and sinus anomalies like Concha bullosa and Agger nasi cells. CT scans highlighted frequent involvement of the maxillary sinus and other structural variations crucial for CRS management. Statistical analysis indicated strong agreement between endoscopic and CT findings, supporting their complementary roles in CRS diagnosis and treatment planning. **Conclusion-** This study on 100 CRS patients highlighted common anatomical variations in the osteomeatal complex, notably nasal septal deviation, agger nasi, and concha bullosa, influencing disease severity. Maxillary sinus involvement was predominant, emphasizing obstruction's role. Nasal endoscopy and CT scans showed consistent findings, underscoring their combined utility for accurate diagnosis and treatment planning in CRS management.

KEYWORDS : DNS, Osteomeatal complex, Chronic Rhinosinusitis(CRS), Diagnostic Nasal Endoscopy, CT Paranasal sinus

INTRODUCTION

Chronic rhinosinusitis (CRS) is a prevalent health issue with significant medical costs and severe impacts on both upper and lower airway diseases, as well as general health. CRS is defined by inflammation of the nasal and paranasal sinus mucosa lasting for at least 12 consecutive weeks.

According to the American Academy of Otorhinolaryngology and Head and Neck Surgery's Rhinosinusitis Task Force (RSTF), rhinosinusitis involves an inflammatory response of the nasal cavity and paranasal sinus mucous membranes, fluids within these cavities, and sometimes the underlying bone^[1]. Symptoms lasting more than 12 weeks include nasal blockage, rhinorrhea, reduced sense of smell, facial pain or pressure, and headache, which, while not fatal, significantly affect daily life.^[2]

The Osteomeatal Complex (OMC) is crucial for the drainage and ventilation of the paranasal sinuses. It includes the maxillary sinus ostium, ethmoid infundibulum, and middle meatus. Proper OMC function ensures the health of the nasal and sinus mucosa, which relies on effective ventilation and drainage. Anatomical variations in the OMC, such as a deviated nasal septum, concha bullosa, or an enlarged ethmoid bulla, can obstruct drainage pathways, leading to secretion stagnation, infection, and mucosal inflammation.^[3]

CT scans and nasal endoscopy are essential diagnostic tools for identifying mucosal abnormalities and bony anatomic variations in patients with CRS. These tools help confirm diagnoses, guide treatment plans, and prevent complications during surgery.

This study aims to examine the incidence of anatomical variations in the osteomeatal complex among chronic sinusitis patients, identify variations associated with each type of paranasal sinus inflammation, and evaluate the importance of pre-operative CT and endoscopic assessments in these patients.

These evaluations aid in detailed anatomical assessments, surgical planning, and reducing intraoperative and postoperative complications.^[4]

MATERIALS AND METHODS**Study Design and Participants**

The present study was conducted at the Department of Otorhinolaryngology, Gajra Raja Medical College, and Jayarogya Group of Hospitals in Gwalior, Madhya Pradesh. This study employed a mixed-methods approach, comprising both retrospective and prospective components with a total of 100 patients. The retrospective arm, covering the period from July 2021 to June 2022, involved the analysis of medical records from outpatient and inpatient departments. The prospective arm spanned from July 2022 to December 2023, during which 50 patients were enrolled and evaluated. Inclusion criteria encompassed patients aged 12 to 60 years, diagnosed with chronic rhinosinusitis, characterized by symptoms persisting for more than 12 weeks and necessitating surgical intervention despite prior medical management. Patients with acute sinusitis, paranasal sinus malignancy, chronic granulomatous diseases, fungal sinusitis, facial anomalies or trauma, previous nasal surgery, or those who were pregnant or lactating were excluded from the study.

Data Collection

Prior to data collection, informed consent is obtained from all participants, including legal guardians for minors aged 12 to 18 years. Comprehensive assessments include detailed medical history, ENT clinical examinations, routine laboratory investigations (e.g., complete blood count, liver function tests), and specialized procedures such as anterior rhinoscopy, diagnostic nasal endoscopy, and CT imaging of the paranasal sinuses. Symptom severity was quantified using The Lund and Mackay Staging System^[5] and visual analogue scale. CT scans were conducted with axial and coronal cuts at 3mm intervals, and images were assessed using the Lund-Mackay CT Scan Assessment Score to evaluate the extent and severity of sinus involvement.

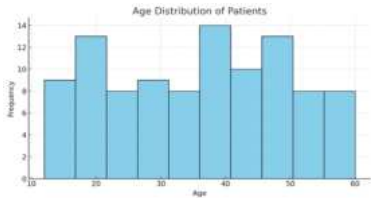
RESULTS

The study employed a hospital-based descriptive retrospective and prospective design over an 18-month period in 100 patients diagnosed with chronic rhinosinusitis, aged between 12 and 60 years.

Demographic Characteristics and Age Distribution:

The study population had a mean age of 35.83 years, with a median age of 36.50 years and a mode of 18 years, indicating a broad age distribution with a peak in younger patients. The standard deviation of

13.73 years highlighted significant variability, while the age range from 12 to 60 years underscored the diversity of the patient cohort.



Graph showing Gender Distribution of Patients

Gender Distribution:

Gender distribution among the patients was nearly equal, with 51 males and 49 females, ensuring a balanced representation for comprehensive analysis without gender bias.

Table No. 1 - Gender Distribution of Patients

Gender	Frequency
Male	51
Female	49

Symptom Prevalence:

The most prevalent symptoms included ear fullness/pain (reported by 57 patients), nasal obstruction (52 patients), and facial pain (52 patients). Other symptoms such as nasal discharge, hyposmia /anosmia, and headache were also frequently reported, highlighting the multifaceted presentation of the condition.

Table no. 2 - Symptom Prevalence

Symptom	Frequency
Nasal obstruction	52
Nasal discharge	47
Facial pain	52
Hyposmia/anosmia	46
Headache	51
Ear fullness/pain	57

Anatomical Variations in Osteomeatal Complex:

The study assessed anatomical variations in the osteomeatal complex through both endoscopic and CT scan evaluations. The majority of patients exhibited unilateral abnormalities, with five being the most common count (35%), followed by bilateral abnormalities, typically limited to one or two findings (each 32%). Specific abnormalities included DNS (deviated nasal septum), Inferior turbinate hypertrophy, medialised uncinate process, accessory ostium, and Bulla ethmoidalis, which were frequently observed on both sides.

Nasal Endoscopic Findings:

Endoscopic evaluations observed that DNS (left) had the highest percentage at 58.0%, indicating it is the most common finding. Following closely are Inferior Turbinate Hypertrophy (left) and Superior Meatus and Turbinate (right), with percentages of 55.0% and 57.0%, respectively. These findings underscored the prevalence of anatomical variations contributing to chronic rhinosinusitis symptoms.

Table no. 3 - Prevalence of Endoscopy Finding

Finding	Frequency	Percentage (%)
DNS (right)	53	53.0
DNS (left)	58	58.0
Inferior Turbinate Hypertrophy (right)	51	51.0
Inferior Turbinate Hypertrophy (left)	55	55.0
Middle Turbinate Hypertrophy (right)	47	47.0
Middle Turbinate Hypertrophy (left)	47	47.0
Medialised Uncinate process (right)	48	48.0
Medialised Uncinate process (left)	57	57.0
Accessory ostium (right)	54	54.0
Accessory ostium (left)	54	54.0
Bulla ethmoidalis (right)	51	51.0
Bulla ethmoidalis (left)	51	51.0
Superior meatus and turbinate (right)	57	57.0
Superior meatus and turbinate (left)	53	53.0
Spheno ethmoidal recess (right)	50	50.0
Spheno ethmoidal recess (left)	50	50.0

CT Scan Findings:

Based on the CT findings presented:

Concha Bullosa: It was observed in 50% of patients on both the right (54 cases) and left (50 cases) sides, indicating a frequent anatomical variation characterized by pneumatization of the middle turbinate.

Paradoxical Middle Turbinate: This anomaly was noted in 48% of patients bilaterally, where the middle turbinate projects inferomedially rather than laterally.

Agger Nasi Cells: These are frontal ethmoid air cells located anteriorly to the frontal recess, and were prevalent in 56% of patients on the right side (56 cases) and 49% on the left side (49 cases).

Haller Cells: Found in 54% of patients on the right side (50 cases) and 49% on the left side (49 cases), Haller cells represent infraorbital ethmoid air cells located between the orbital floor and the maxillary sinus.

Onodi Cells: Observed in 9% of patients bilaterally (9 cases each), Onodi cells are posterior ethmoid air cells that extend laterally to the sphenoid sinus.

Table no. 4 Prevalence of CT Findings

Finding	Frequency	Percentage (%)
Concha Bullosa (right)	54	50.0
Concha Bullosa (left)	50	50.0
Paradoxical middle turbinate (right)	48	48.0
Paradoxical middle turbinate (left)	48	48.0
Agger nasi cell (right)	56	56.0
Agger nasi cell (left)	49	49.0
Haller cells (right)	50	54.0
Haller cells (left)	49	49.0
Onodi cells (right)	9	9.0
Onodi cells (left)	9	9.0
Maxillary sinus (right)	56	56.0
Maxillary sinus (left)	55	55.0
Anterior ethmoidal cells (right)	52	52.0
Anterior ethmoidal cells (left)	54	54.0
Frontal sinus (right)	49	49.0
Frontal sinus (left)	54	54.0

Pattern of Sinus Involvement (Disease Extent) in CRS

In chronic rhinosinusitis (CRS), anatomical variations in sinus involvement are significant: Maxillary sinus anomalies were prevalent in 56% on the right side (56 cases) and 55% on the left side (55 cases), indicating structural abnormalities in these cavities. Anterior ethmoidal cells were found in 52% on the right side (52 cases) and 54% on the left side (54 cases), representing ethmoid air cells located anteriorly to the ethmoid bulla. Frontal sinus variations were observed in 49% on the right side (49 cases) and 54% on the left side (54 cases), indicating deviations in anatomical structures within the frontal sinus. These findings underscore the variability and importance of anatomical evaluations in understanding CRS pathophysiology.

These findings underscore the importance of CT scans in identifying and understanding anatomical variations associated with chronic rhinosinusitis, providing crucial insights for accurate diagnosis and management planning.

Correlation Between Endoscopic and CT Findings:

Statistical analysis, including chi-square tests and correlation coefficients, demonstrated high consistency between endoscopic and CT findings (p-values > 0.05). This supported the reliability and validity of using both modalities to diagnose and evaluate chronic rhinosinusitis and associated anatomical variations.

DISCUSSION

The discussion of the study on Chronic Rhinosinusitis (CRS) highlights several significant findings and implications concerning its epidemiology, clinical presentation, anatomical variations, and diagnostic methods.

Firstly, the prevalence of CRS among the Indian population, estimated at 15%, aligns with global trends but underscores its substantial impact on public health and healthcare resources due to the need for ongoing medical care and the associated economic burden. This study's demographic analysis revealed a mean age of 35.83 years, indicating a predominantly young adult cohort affected by CRS, with significant

variability across age groups emphasizing the need for age-specific diagnostic and treatment approaches. In the study of Pokharel M et al.,^[5] 36.8% patients were male and 63.2% were female, with age of patients ranging from 17 to 55 years (mean age 31.87 years).

Symptomatology assessment demonstrated that in our study, ear fullness/pain is the most frequently reported symptom (57 patients), followed by nasal obstruction and facial pain (52 patients each). These symptoms not only impair quality of life but also reflect the multifaceted nature of CRS, necessitating comprehensive management strategies tailored to individual patient profiles.

Anatomical variations of the osteomeatal complex, evaluated through Nasal Endoscopy and CT PNS scans, revealed common findings such as septal deviation, medialised uncinate process, inferior turbinate hypertrophy, Agger nasi, Haller cells, Concha Bullosa and Paradoxical Middle turbinate. Nasal endoscopy findings reveal that nasal septal deviation is the most common anatomical variation, present in 58% of patients. This is followed by medialized uncinate process in 57%, inferior turbinate hypertrophy in 55%, Bulla ethmoidalis in 51%, middle turbinate hypertrophy in 47%. Dua et al.,^[6] and Asruddin et al.,^[7] found prevalence of 44% and 38% of deviated nasal septum in their respective studies.

Paranasal sinus anatomical variations observed on CT scan (Table 4) in the present study revealed that the most common variation was Agger nasi, present in 56% of patients. The second most common variation was Haller cells, seen in 54% of patients, followed by concha bullosa in 50%, and paradoxical middle turbinate in 48% of patients. Onodi cells were observed in 9% of patients. Dua et al.^[6] reported the prevalence of Agger nasi cells in 40% of the patients. The prevalence of Haller's cells in the study by Maru et al.^[8] was found to be 36%. Scribano et al.^[9] reported prevalence of Concha Bullosa in 67% of the patients in their study.

These variations contribute to obstruction of sinus drainage pathways, exacerbating inflammation and symptom severity. The high prevalence of these anatomical abnormalities underscores the critical role of detailed anatomical evaluation in CRS diagnosis and treatment planning.

Comparative analysis between nasal endoscopy and CT findings demonstrated a high level of consistency, supporting the complementary use of both modalities in clinical practice for accurate diagnosis and treatment guidance. The study's findings align with previous research highlighting the efficacy of CT scans in visualizing anatomical variations that may not be fully captured by nasal endoscopy alone.

Correlation analyses between anatomical findings, symptom severity, and disease extent further validated the significance of anatomical variations in CRS pathophysiology and clinical presentation.

The study contributes valuable insights into the epidemiology, clinical characteristics, and diagnostic considerations of CRS in the Indian population. The findings emphasize the necessity of a multidimensional approach integrating clinical evaluation, anatomical assessment, and imaging modalities for comprehensive management of CRS, aiming to improve outcomes and reduce the societal burden of chronic rhinosinusitis.

CONCLUSION

The study provides a comprehensive analysis of anatomical variations within the osteomeatal complex and their implications for chronic rhinosinusitis (CRS) severity and management in a cohort of 100 patients aged 12-60 years. The findings highlight several key points: firstly, a combination of anatomical variations is commonly observed among CRS patients unresponsive to medical therapy, underscoring the complex interplay of structural abnormalities in disease pathogenesis. Nasal septal deviation emerged as the most prevalent anatomical anomaly, reflecting its significant role in obstructing sinus drainage pathways. Additionally, agger nasi (56%) and concha bullosa (54%) were identified as frequent variations, implicating them in CRS pathology due to their impact on sinus ventilation and mucociliary clearance. The study reaffirmed the predominance of maxillary sinus involvement, reinforcing the critical role of osteomeatal complex obstruction in CRS pathophysiology. Importantly, no substantial discrepancies were found between nasal endoscopy and CT findings, affirming their complementary nature in providing comprehensive

diagnostic insights. The study advocates for the integrated use of both the modalities to ensure accurate diagnosis and optimize treatment planning, thereby minimizing surgical risks and enhancing therapeutic outcomes in CRS management.

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