Section: ENT

Original Research Article

CT–ENDOSCOPY AGREEMENT IN OSTEOMEATAL COMPLEX EVALUATION: INSIGHTS FROM A PROSPECTIVE CHRONIC RHINOSINUSITIS COHORT

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ABSTRACT

Background: Chronic rhinosinusitis (CRS) remains a prevalent health concern worldwide, often attributed to anatomical abnormalities of the osteomeatal complex (OMC) that impair mucociliary clearance. Computed tomography (CT) and nasal endoscopy are key diagnostic modalities for identifying OMC variations contributing to disease persistence. This study aimed to evaluate OMC abnormalities using CT in CRS patients and to assess correlation with endoscopic findings.
Materials and Methods: This prospective observational study was conducted in the Department of ENT from July 2024 to June 2025. A total of 100 patients with clinically diagnosed CRS were included. Patients underwent diagnostic nasal endoscopy followed by CT paranasal sinus (PNS) evaluation. Demographic data, OMC variations, and mucosal changes were documented. Statistical analysis included chi-square test, kappa correlation, and p-value <0.05 as significant.
Results: The mean age was 36.8 ± 11.2 years, with male predominance (58%). CT identified deviated nasal septum (DNS) in 64%, concha bullosa in 32%, paradoxical middle turbinate in 18%, and Haller cells in 14%. Endoscopy detected DNS in 61%, concha bullosa in 29%, and paradoxical turbinate in 15%. CT showed higher sensitivity for anatomical variants, while endoscopy excelled in mucosal changes. Agreement between CT and endoscopy for OMC variations was substantial ($\kappa = 0.74$, $p < 0.001$).
Conclusion: CT is indispensable for detecting subtle OMC abnormalities, while endoscopy complements by providing real-time mucosal evaluation. Their combined use enhances diagnostic accuracy and guides surgical planning in CRS patients.

Keywords: Chronic rhinosinusitis, osteomeatal complex, computed tomography, nasal endoscopy, anatomical variations.

INTRODUCTION

Chronic rhinosinusitis (CRS) is a common inflammatory disorder of the paranasal sinuses, affecting quality of life and healthcare expenditure globally. Characterized by nasal obstruction, rhinorrhea, facial pain or pressure, and reduction in olfaction, CRS has a multifactorial etiology with both infectious and non-infectious contributors.[1] Among these, anatomical variations in the osteomeatal complex (OMC) have been consistently recognized as pivotal in altering sinus drainage and predisposing patients to persistent mucosal disease.

The OMC represents the final common drainage pathway of the frontal, anterior ethmoid, and maxillary sinuses. Even minor anatomical deviations can narrow this corridor, impairing mucociliary clearance and promoting bacterial colonization.[2] Variations such as deviated nasal septum, concha bullosa, paradoxical middle turbinate, agger nasi cells, and Haller cells are often implicated in CRS pathophysiology.[3]

Accurate diagnosis of OMC abnormalities is critical for guiding both medical and surgical management. Computed tomography (CT) of the paranasal sinuses is considered the gold standard imaging modality for anatomical assessment, offering detailed multiplanar visualization.[4] It enables precise delineation of bony landmarks and variations that could complicate functional endoscopic sinus surgery (FESS). However, CT provides static imaging and may not fully reflect dynamic mucosal changes.[5]

Diagnostic nasal endoscopy, in contrast, allows direct in vivo visualization of the nasal cavity and mucosa. It is invaluable in assessing inflammatory changes, identifying polyps, and guiding biopsy when necessary. Yet, its limited penetration beyond the OMC reduces sensitivity for deep bony variations.[6]

The combined application of CT and nasal endoscopy offers complementary advantages. Correlation between these modalities enhances diagnostic confidence, reduces intraoperative surprises, and improves surgical outcomes.[7] Several studies have highlighted the need for such correlation, though variations exist across populations in terms of prevalence of OMC abnormalities and their clinical significance.[8]

Considering the rising prevalence of CRS and the critical role of preoperative evaluation, this study was designed to systematically assess osteomeatal complex abnormalities on CT and correlate them with diagnostic nasal endoscopy findings in affected patients. Additionally, it sought to determine the degree of diagnostic concordance and highlight the comparative strengths of each modality in detecting key anatomical variations.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective observational study conducted in the Department of ENT Dr. Patnam Mahender Reddy Institute of Medical Sciences, between July 2024 and June 2025. The study was designed to evaluate osteomeatal complex (OMC) abnormalities in patients with chronic rhinosinusitis (CRS) using computed tomography (CT) and to correlate the findings with diagnostic nasal endoscopy (DNE).

Study Population

Patients presenting to the outpatient department with symptoms suggestive of CRS were screened. CRS was defined according to the European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS 2020) criteria, requiring the presence of two or more symptoms (nasal obstruction, nasal discharge, facial pain/pressure, and/or reduction of smell) lasting for more than 12 weeks, with objective evidence on endoscopy or imaging.

Inclusion Criteria

- Adults aged 18–60 years
- Diagnosed with CRS based on EPOS 2020 guidelines
- Patients providing informed written consent

Exclusion Criteria

- History of previous sinonasal surgery or trauma
- Presence of sinonasal tumors or extensive nasal polyposis
- Patients with systemic granulomatous diseases (e.g., sarcoidosis, Wegener's granulomatosis)
- Pregnant or lactating women
- Patients unwilling to participate

Sample Size

Sample size was calculated assuming a prevalence of OMC variations in CRS patients of approximately 60%, with a margin of error of 10% and 95% confidence level. The minimum required sample was 92. To enhance statistical robustness, a total of 100 consecutive eligible patients were recruited.

Clinical Evaluation and Diagnostic Nasal Endoscopy

A detailed history and clinical examination were performed in all patients. DNE was carried out using a 4 mm 0° and 30° rigid nasal endoscope (Karl Storz, Germany) under topical anesthesia with 4% lignocaine and decongestant pledgets. The nasal cavity and OMC were systematically examined for septal deviation, turbinate variations, mucosal edema, polyps, and anatomical variants such as concha bullosa, agger nasi cells, and Haller cells. Findings were documented in a structured proforma.

Computed Tomography of Paranasal Sinuses

All patients underwent non-contrast CT of the paranasal sinuses using a 64-slice scanner (GE Healthcare, USA). Scans were acquired in axial and coronal planes with 2–3 mm slice thickness and reformatted in sagittal sections when required. Images were analyzed for OMC anatomical variations including deviated nasal septum, concha bullosa, paradoxical middle turbinate, agger nasi, Haller, and Onodi cells. Mucosal changes were graded using the Lund–Mackay scoring system.

Data Collection and Blinding

Endoscopic and CT assessments were independently performed and recorded by two ENT specialists blinded to each other's findings. Disagreements were resolved through consensus. Demographic and clinical details were collected prospectively.

Statistical Analysis

Data were analyzed using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables as frequencies and percentages. Chi-square test was used to assess associations between categorical variables. Concordance between CT and DNE findings was determined using Cohen's kappa coefficient (κ). Statistical significance was set at $p < 0.05$, with 95% confidence intervals (CI) calculated where appropriate.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Ethics

Committee. Written informed consent was obtained from all participants before enrollment, and patient confidentiality was strictly maintained throughout the study.

RESULTS

Males constituted 51.02% vs. 67.44%, and females 48.98% vs. 32.56% in Group A and Group B, respectively ($p = 0.139$). Respiratory failure was the most common indication (30.61% vs. 37.21%). Combined respiratory failure and shock occurred in 34.69% vs. 39.53%. Low Glasgow Coma Scale (GCS) was more frequent in Group A (28.57% vs. 16.28%). Shock alone was noted in 6.12% vs. 2.33%. Raised intracranial tension (ICT) and upper airway obstruction were reported only in Group B (0% vs. 2.33% each) ($p = 0.403$). [Table 1]

Table 1: Demographic Characteristics (n = 100)

Variable	Category	Frequency	Percentage (%)
Age (years)	Mean ± SD	36.8 ± 11.2	–
Gender	Male	58	58.0
	Female	42	42.0
Residence	Urban	39	39.0
	Rural	61	61.0

Table 2: CT Findings of Osteomeatal Complex Variations (n = 100)

Variation	Frequency	Percentage (%)
Deviated Nasal Septum	64	64.0
Concha Bullosa	32	32.0
Paradoxical Middle Turbinate	18	18.0
Agger Nasi Cells	21	21.0
Haller Cells	14	14.0
Onodi Cells	9	9.0
Mucosal Thickening (any sinus)	72	72.0

Table 3: Endoscopic Findings (n = 100)

Variation	Frequency	Percentage (%)
Deviated Nasal Septum	61	61.0
Concha Bullosa	29	29.0
Paradoxical Middle Turbinate	15	15.0
Agger Nasi Cells	17	17.0
Haller Cells	11	11.0
Mucosal Edema/Polyps	68	68.0

Table 4: Comparative Agreement between CT and Endoscopy (n = 100)

Parameter	CT Positive (%)	Endoscopy Positive (%)	Agreement (%)	Kappa (κ)	p-value
Deviated Nasal Septum	64.0	61.0	90.0	0.82	<0.001
Concha Bullosa	32.0	29.0	88.0	0.76	<0.001
Paradoxical Middle Turbinate	18.0	15.0	85.0	0.71	0.002
Agger Nasi Cells	21.0	17.0	82.0	0.68	0.004
Haller Cells	14.0	11.0	80.0	0.66	0.006

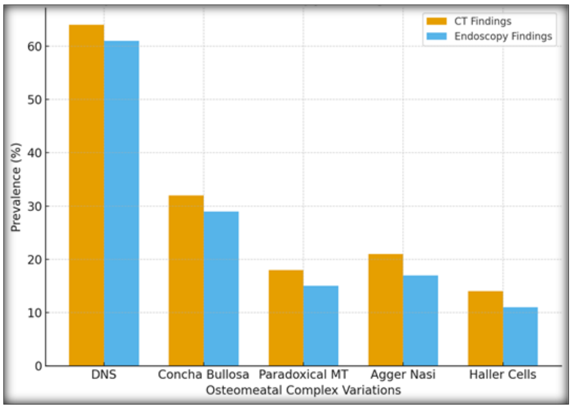

Figure 1

A total of 100 patients with chronic rhinosinusitis were included, with a mean age of 36.8 ± 11.2 years.

The cohort showed a male predominance (58%), and the majority of participants were from rural areas (61%).

On CT evaluation, the most common anatomical abnormality was deviated nasal septum (DNS), seen in 64% of cases, followed by concha bullosa in 32% and paradoxical middle turbinate in 18%. Additional variants included agger nasi cells (21%), Haller cells (14%), and Onodi cells (9%). Mucosal thickening of at least one sinus was observed in 72% of scans.

Endoscopic findings showed a similar distribution, with DNS detected in 61%, concha bullosa in 29%, and paradoxical middle turbinate in 15%. Agger nasi cells and Haller cells were identified in 17% and 11% of cases, respectively, while mucosal edema or polyps were noted in 68%.

Comparative analysis revealed substantial concordance between CT and endoscopy for key

OMC variations. DNS demonstrated the highest agreement at 90% with a kappa value of 0.82 ($p < 0.001$). Concha bullosa showed 88% agreement ($\kappa = 0.76$, $p < 0.001$), while paradoxical middle turbinate had 85% agreement ($\kappa = 0.71$, $p = 0.002$). Agger nasi and Haller cells demonstrated agreement levels of 82% ($\kappa = 0.68$, $p = 0.004$) and 80% ($\kappa = 0.66$, $p = 0.006$), respectively.

The bar chart illustrates that CT consistently identified slightly higher proportions of OMC variations compared to endoscopy, particularly for deeper structures such as Haller cells. Endoscopy, however, was superior in assessing mucosal pathology, with a nearly comparable prevalence of inflammatory changes (68% vs 72%).

Overall, the results confirm that CT is more sensitive for detecting subtle bony variations, while endoscopy provides better real-time mucosal evaluation. The substantial kappa values highlight the complementary nature of both modalities in CRS assessment.

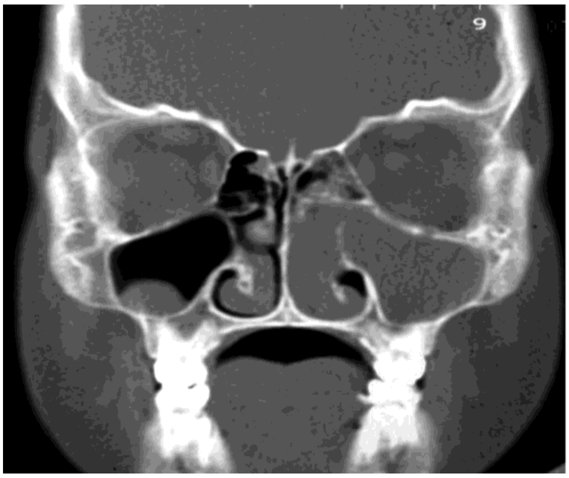

Figure 2: CT showing total opacification of left maxillary sinus and nasal cavity

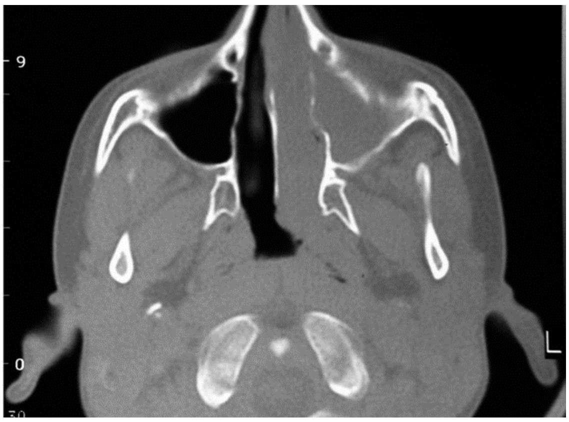

Figure 3: CT image showing polypoidal growth in left maxillary sinus

DISCUSSION

Chronic rhinosinusitis (CRS) is multifactorial, and anatomic variations within the osteomeatal complex (OMC) critically influence ventilation and drainage pathways that predispose to persistent inflammation.[9] Our study was undertaken to quantify OMC variations on CT, correlate them with diagnostic nasal endoscopy (DNE), and evaluate agreement to inform preoperative planning.

In our cohort, deviated nasal septum (DNS) was most frequent (64% on CT; 61% on DNE). Dua et al. reported a comparable DNS prevalence of 62% on CT among Indian CRS patients and noted its association with maxillary disease, reinforcing its etiologic relevance in obstruction patterns.[10] Pérez-Piñas et al., in a CT series of 110 subjects, observed DNS in approximately 65%, concluding that septal deviation is the most consistent anatomic abnormality encountered in CRS workups.[11] Concha bullosa in our data (32% CT; 29% DNE) also accords with CT-based prevalence ranges reported in anatomical mapping studies; Pérez-Piñas et al. documented conchal pneumatization as a frequent variant with potential to narrow the middle meatus when large or bilateral.[11]

Accessory cells with surgical implications were common: agger nasi (21%) and Haller cells (14%) on CT. Mafee et al. emphasized that agger nasi cells alter frontal recess configuration and that Haller cells can constrict the maxillary ostium—both findings that should be anticipated in pre-FESS planning.[12] Kantarci et al. similarly highlighted the clinical importance of such variants, reporting notable rates of Haller and Onodi cells and underscoring their role in ostiomeatal obstruction and surgical risk (e.g., orbital floor proximity).[13] Paradoxical middle turbinate was identified in 18% on CT (15% on DNE), a pattern that Kantarci et al. linked to infundibular narrowing requiring correction when symptomatic.[13]

Methodologically, our CT–DNE concordance was substantial across major variants ($\kappa = 0.66$–0.82), highest for DNS ($\kappa = 0.82$, $p < 0.001$). Bhandary et al., studying 75 CRS patients, likewise demonstrated significant CT–endoscopy correlation, with κ values around 0.65–0.70 for common variants, supporting a dual-modality approach for reliable case definition.[14] From a functional standpoint, DNE documented mucosal edema/polyps in 68%, close to CT-detected mucosal thickening (72%). Setliff and Parsons stressed the complementary role of endoscopy in visualizing active mucosal disease and guiding targeted intervention, while CT supplies the anatomic roadmap.[15]

Clinically, these data affirm that CT is superior for subtle or deep bony variants (e.g., Haller, Onodi) and hazard identification, whereas DNE excels in real-time mucosal assessment. Integrating both modalities reduces intraoperative surprises and enhances safety.

Limitations include single-center design and moderate sample size; nevertheless, blinded dual-review and consensus mitigate observer bias. Future multicenter cohorts and incorporation of cone-beam CT (dose-sparing, high spatial resolution) may refine variant detection and risk stratification.

CONCLUSION

CT is indispensable for detecting subtle OMC abnormalities, while endoscopy complements by providing real-time mucosal evaluation. Their combined use enhances diagnostic accuracy and guides surgical planning in CRS patients.

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Conflict of Interest

The authors declare no conflict of interest related to this study.

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