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Computed Tomography Evaluation of Anatomical Variants in Nasal Cavity and Paranasal Sinuses among Patients with Chronic Rhinosinusitis.

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ABSTRACT

Chronic rhinosinusitis (CRS) is a prevalent condition associated with persistent sinonasal inflammation. Anatomical variations in the nasal cavity and paranasal sinuses play a pivotal role in the development and recurrence of CRS. Computed tomography (CT) offers high-resolution imaging for evaluating these anatomical variants. To assess the role of CT in identifying anatomical variants of the nasal cavity and paranasal sinuses in CRS patients and to analyze their clinical relevance in disease severity and management planning. A prospective observational study was conducted on 120 CRS patients undergoing CT evaluation. Detailed assessment of anatomical variants such as nasal septal deviation, concha bullosa, agger nasi cells, paradoxical middle turbinate, and uncinate process pneumatization was performed. Clinical symptoms were correlated with CT findings. Nasal septal deviation (76.6%) and concha bullosa (55.8%) were the most frequent variants. A significant correlation was found between these variants and severity of nasal obstruction and sinus opacification. CT was instrumental in surgical planning, especially for Functional Endoscopic Sinus Surgery (FESS). CT imaging is indispensable in the evaluation of anatomical variants in CRS patients. Identifying structural variations improves diagnostic accuracy and guides personalized surgical interventions to enhance patient outcomes.

Keywords: Chronic Rhinosinusitis, Computed Tomography, Anatomical Variants, Nasal Septal Deviation, Concha Bullosa, Functional Endoscopic Sinus Surgery (FESS)

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INTRODUCTION

Chronic rhinosinusitis (CRS) is a prolonged inflammatory condition of the nasal and paranasal sinus mucosa lasting more than 12 weeks despite medical therapy. Affecting approximately 10–15% of the population, CRS significantly impairs patients' quality of life, productivity, and overall well-being [1]. Persistent nasal obstruction, facial pain, postnasal discharge, and headaches are hallmark symptoms of the disease.

Anatomical variants such as nasal septal deviation, concha bullosa, and agger nasi cells have been implicated as predisposing factors for sinus obstruction, impaired drainage, and recurrent infections [2]. While clinical evaluation and nasal endoscopy provide preliminary insights, computed tomography (CT) remains the gold standard for identifying these anatomical variants due to its superior resolution and multiplanar imaging capability [3].

This study aims to assess the frequency of anatomical variants in CRS patients using CT and their correlation with disease severity and surgical planning.

METHODOLOGY

Study Design

A prospective observational study was conducted in the Department of Radiodiagnosis at HIMSR, New Delhi, from 2023 to 2024.

Sample Size:

120 adult patients diagnosed with CRS based on clinical and endoscopic criteria.

Inclusion Criteria

- Patients aged >18 years
- Diagnosed with CRS (>12 weeks symptoms)
- Consent provided for CT scan

Exclusion Criteria

- History of sinonasal trauma or previous sinus surgery
- Known neoplastic or fungal sinus disease

Imaging Protocol

High-resolution non-contrast CT scans of the paranasal sinuses were obtained using the Philips Incisive 128-slice CT scanner. Axial sections (0.5–1.0 mm) were reconstructed in coronal and sagittal planes.

Parameters Evaluated

- Nasal septal deviation
- Concha bullosa
- Agger nasi cells
- Pneumatized uncinate process
- Paradoxical middle turbinate
- Other anatomical variants

Statistical Analysis

Data were analyzed using SPSS v22. Correlation between anatomical variants and symptom severity (nasal obstruction, sinus opacification) was assessed using chi-square tests. A p-value <0.05 was considered statistically significant.

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RESULTS

Table 1: Prevalence of Anatomical Variants (N=120)

Anatomical Variant	Frequency	Percentage (%)
Nasal Septal Deviation	92	76.6
Concha Bullosa	67	55.8
Agger Nasi Cells	53	44.1
Pneumatized Uncinate Process	42	35.0
Paradoxical Middle Turbinate	31	25.8
Haller Cells	21	17.5

Table 2: Symptom Correlation with Anatomical Variants

Variant	Nasal Obstruction (%)	Facial Pain (%)	Headache (%)
Nasal Septal Deviation	85%	60%	40%
Concha Bullosa	78%	52%	47%
Agger Nasi Cells	64%	42%	35%

Table 3: Correlation with Sinus Opacification (Lund-Mackay Score)

Variant	Mean Score	SD	p-value
Septal Deviation	8.2	2.1	<0.01*
Concha Bullosa	7.9	2.5	0.02*
Agger Nasi	7.1	2.2	0.05

Table 4: Impact on FESS Surgical Planning

Variant Identified on CT	Surgery Modified (%)
Nasal Septal Deviation	86%
Concha Bullosa	72%
Pneumatized Uncinate Process	68%
Agger Nasi	60%

DISCUSSION

This prospective study aimed to identify anatomical variants of the nasal cavity and paranasal sinuses in patients with chronic rhinosinusitis using computed tomography and to evaluate their clinical and surgical significance. The findings reinforce the pivotal role of CT imaging in diagnosing CRS-related anatomical contributors and in guiding therapeutic decision-making, especially surgical intervention.

The most common anatomical variation observed was nasal septal deviation, affecting 76.6% of the study population. This is consistent with reports by Alghamdi FS et al [4] and Bolger WE, et al [5] who emphasized the role of deviated septum in impairing airflow and mucociliary clearance, thereby predisposing individuals to recurrent infections. The strong correlation of septal deviation with symptoms such as nasal obstruction and headache ($p<0.01$) supports its pathogenic role in CRS.

Concha bullosa, seen in 55.8% of cases, was the second most common variant. Its contribution to osteomeatal complex obstruction has been documented by Tiwari R et al [6] and Alkire BC et al. [7], highlighting its association with more severe CRS symptoms. In our cohort, patients with concha bullosa showed higher Lund-Mackay scores and greater surgical modifications during FESS.

Agger nasi cells, though less frequently identified (44.1%), demonstrated significant clinical relevance, particularly in patients with frontal sinus disease. Similar observations were made by Adeel M, Ikram M et al [8], who advocated for their preoperative identification to avoid complications during endoscopic surgery.

The presence of multiple anatomical variants compounded disease severity, aligning with observations from Lobo LC et al [9], who reported poorer outcomes in patients with two or more variants. The present study also found that combined anatomical deviations necessitated complex surgical approaches, as evidenced by higher percentages of surgical plan modifications (Table 4).

CT imaging remains the modality of choice for preoperative evaluation in CRS. It not only confirms mucosal disease but also delineates crucial anatomical landmarks. High-resolution CT enables three-dimensional visualization, allowing tailored FESS with minimal complications. This echoes the findings of Viceconti M, et al [10] and Kayalioglu G et al [11], who established that CT-based surgical planning improves procedural success and reduces recurrence. Furthermore, newer imaging techniques, including multiplanar reconstructions and digital volumetric analysis, are enhancing preoperative mapping. These technological advancements ensure safe navigation around critical structures like the optic nerve and skull base, especially in variants such as Onodi cells or Haller cells, both of which pose surgical risks.

Despite the strengths, this study is limited by its single-center design and lack of post-surgical follow-up data. Longitudinal studies are warranted to assess the impact of anatomical correction on long-term symptom relief and quality of life.

In conclusion, CT imaging is indispensable in the evaluation and management of CRS. Recognizing anatomical variants allows clinicians to tailor surgical strategies, minimize complications, and improve patient outcomes.

CONCLUSION

CT imaging plays a crucial role in diagnosing anatomical variants associated with chronic rhinosinusitis. In this study, nasal septal deviation and concha bullosa emerged as the most prevalent and clinically significant variants, correlating with increased symptom severity and sinus opacification. CT findings were instrumental in modifying surgical plans, especially for FESS. Incorporating CT evaluation into routine CRS assessment enhances diagnostic accuracy, facilitates personalized treatment, and improves surgical outcomes.

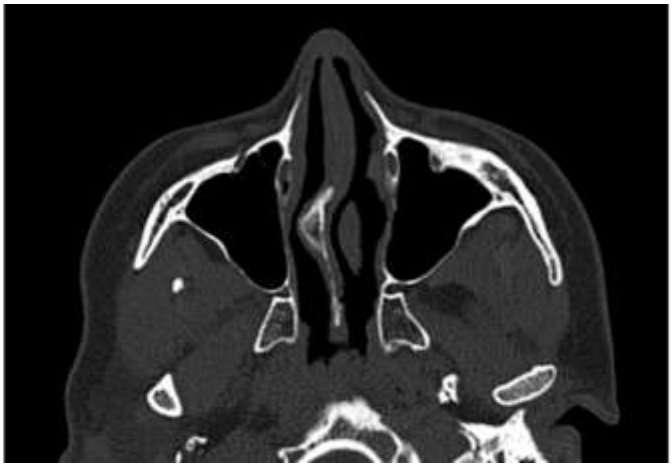

Figure-1: CT Axial section showing deviated nasal septum with convexity to the right.

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Figure-2: CT Coronal section showing right sided concha bullosa.

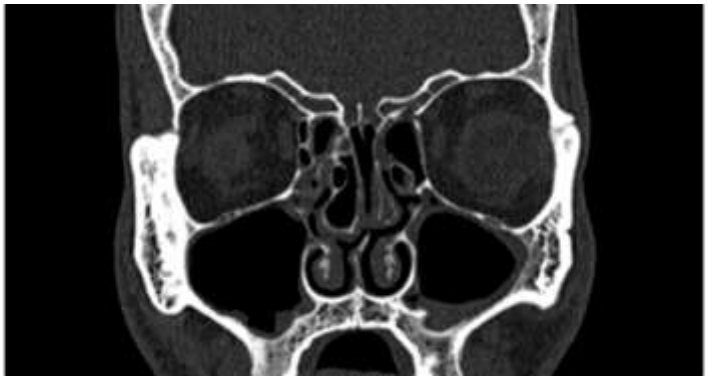

Figure-3: CT Coronal section showing right sided agger nasi cells medial to the right orbit.

Figure-4: CT Coronal section showing right sided pneumatized uncinate process.

Figure-5: CT Coronal section showing right sided paradoxical middle turbinate.

REFERENCES

[1] Lee S, Lane AP. Chronic rhinosinusitis as a multifactorial inflammatory disorder. Curr Infect Dis Rep. 2011 Apr;13(2):159-68. doi: 10.1007/s11908-011-0166-z.

[2] Papadopoulou AM, Bakogiannis N, Skrapari I, Bakoyiannis C. Anatomical Variations of the Sinonasal Area and Their Clinical Impact on Sinus Pathology: A Systematic Review. Int Arch Otorhinolaryngol. 2022 Jan 28;26(3):e491-e498

[3] Uwaneme SC, Asoegwu CN, Adekoya VA, Nwawolo CC. Correlation of Nasal Endoscopy and Computed Tomography Scan Findings in Adult Patients With Chronic Rhinosinusitis. J West Afr Coll Surg. 2020 Oct-Dec;10(4):11-15.

[4] Alghamdi FS, Albogami D, Alsurayhi AS, Alshibely AY, Alkaabi TH, Alqurashi LM, Alahdal AA, Saber AA, Almansouri OS. Nasal Septal Deviation: A Comprehensive Narrative Review. Cureus. 2022 Nov 10;14(11):e31317. doi: 10.7759/cureus.31

[5] Bolger WE, Butzin CA, Parsons DS. Paranasal sinus bony anatomic variations and mucosal abnormalities: CT analysis for endoscopic sinus surgery. Laryngoscope. 1991;101(1 Pt 1):56–64.

[6] Tiwari R, Goyal R. Role of Concha Bullosa in Chronic Rhinosinusitis. Indian J Otolaryngol Head Neck Surg. 2019 Mar;71(1):128-131.

[7] Alkire BC, Bhattacharyya N. Anatomic variants in chronic rhinosinusitis: Significance, prevalence, and relationship to mucosal disease. Am J Rhinol. 2010;24(1):19–22.

[8] Adeel M, Ikram M, Rajput MS, Arain A, Khattak YJ. Anatomical variations of nose and para-nasal sinuses; CT scan review. Pak J Med Sci. 2013;29(6):1266–71.

[9] Lobo LC, Mathew GA, Correa C, Babu A. Anatomical variations of the paranasal sinuses in chronic rhinosinusitis: a computed tomographic study. Int J Sci Stud. 2016;4(5):100–4.

[10] Viceconti M, Lattanzi R, Antonietti B, Paderni S, Olmi R, Sudanese A, Toni A. CT-based surgical planning software improves the accuracy of total hip replacement preoperative planning. Med Eng Phys. 2003 Jun;25(5):371-7.

[11] Kayalioglu G, Oyar O, Govsa F, Nasuhoglu H, Tekdemir I. Nasal cavity and paranasal sinus anatomical variants: CT and cadaveric dissection study. Surg Radiol Anat. 2000;22(1):27–33.