ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 01 | January - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ROLE OF MDCT IN ASSESSMENT OF ANATOMICAL VARIANTS OF NASAL CAVITY AND PARANASAL SINUS IN PATIENTS OF CHRONIC SINUSITIS

Radio-Diagnosis

Dr. Anjali Pawar — Professor and HOD, Department of Radiology, Super speciality building (SSB building) , Government medical college, Chh. Sambhaji Nagar, 431001, Maharashtra, India

Dr. Sumit Nandkishor Mahalle* — Junior resident III, Department of Radiology, Government Medical College and Hospital, Chh. Sambhaji Nagar, 431001, Maharashtra, India. *Corresponding Author

Dr. Varsha Rote Kaginalkar — Professor and HOD, Department of Radiology, Government Medical College and Hospital, Chh. Sambhaji Nagar, 431001, Maharashtra, India.

Dr. Ajay Vare — Associate professor ,Department of Radiology, Government Medical College and Hospital, Chh. Sambhaji Nagar, 431001, Maharashtra, India.

Dr. Prashant Uddhaorao Titare — Associate professor, Department of Radiology, Government Medical College and Hospital, Chh. Sambhaji Nagar, 431001, Maharashtra, India.

ABSTRACT

Background: Anatomical variants of the paranasal sinuses can influence the development and persistence of chronic rhinosinusitis (CRS) by impairing sinus drainage. Computed tomography (CT) is the imaging modality of choice for identifying these variations and planning surgical interventions. **Objective:** To assess the prevalence of common sinonasal anatomical variants in CRS patients using CT and examine their association with clinical symptoms. **Methods:** This cross-sectional study included 50 patients with CRS who underwent CT imaging of the paranasal sinuses. Variants such as concha bullosa, agger nasi, Haller cells, and Onodi cells were recorded. Symptom profiles including nasal blockage, rhinorrhoea, headache, and epistaxis were analyzed for associations using chi-square tests. **Results:** Agger nasi cells were the most frequent variant (86%), followed by deviated nasal septum (56%) and concha bullosa (50%). Haller cells and Onodi cells were observed in 12% and 28% of cases, respectively. Epistaxis showed a significant association with concha bullosa ($p = 0.002$), agger nasi cells ($p = 0.02$), and had a negative correlation with Haller ($p = 0.03$) and Onodi cells ($p = 0.0018$). Other symptoms like nasal blockage, rhinorrhoea, and headache did not show statistically significant correlations. **Conclusion:** CT imaging reveals high prevalence of anatomical variants in CRS. Certain variants such as concha bullosa and agger nasi may be symptomatically significant, especially in relation to epistaxis. Preoperative identification of such variants through CT is crucial in guiding surgical planning and improving outcomes.

KEYWORDS

Paranasal Sinuses; Chronic Rhinosinusitis; Anatomical Variants; CT Scan; Concha Bullosa; Agger Nasi

INTRODUCTION:

Chronic rhinosinusitis (CRS) is a common and persistent inflammatory disorder affecting the nasal and paranasal sinus mucosa, typically persisting beyond 12 weeks. It presents clinically with symptoms such as nasal obstruction, facial pressure, headache, postnasal drip, and reduced olfaction-symptoms that significantly impact daily functioning and quality of life[1].

Anatomical factors often play a pivotal role in CRS pathogenesis by obstructing natural sinus drainage pathways, particularly at the osteomeatal complex, thereby impairing mucociliary clearance and predisposing patients to recurrent infections. Accurate anatomical assessment thus becomes essential in both diagnosis and surgical planning, especially for patients undergoing functional endoscopic sinus surgery (FESS)[2].

High-resolution computed tomography (CT), particularly in the coronal plane, has revolutionized sinonasal evaluation by providing detailed visualization of both mucosal pathology and bony structures. CT scans offer significant advantages over conventional radiographs in detecting sinus disease and planning surgery[3]. Coronal CT images simulate the endoscopic surgical view and enable detection of subtle anatomical variations such as concha bullosa, Haller cells, agger nasi cells, and Onodi cells, which may otherwise go unnoticed [1].

Although these anatomical variations do not always correlate with clinical severity, their identification is critical to minimize complications during surgery. The Kennedy CT staging system, in particular, demonstrates better correlation with intraoperative findings compared to purely symptom-based scoring systems[2]. Recent imaging studies have revealed that over 90% of CRS patients exhibit at least one anatomical variant, further emphasizing the relevance of CT in comprehensive assessment[4].

The paranasal sinuses-frontal, maxillary, ethmoid, and sphenoid-are air-filled cavities lined by respiratory epithelium. They serve functions such as humidifying air, reducing skull weight, enhancing voice resonance, and aiding in mucociliary clearance [5]. Their development and anatomy are highly variable. For instance, the maxillary sinus is radiologically evident shortly after birth, while frontal and sphenoid sinuses mature during adolescence[6].

From a radiological standpoint, understanding this intricate anatomy is essential. CT imaging, especially via multidetector scanners, allows accurate visualization of sinonasal structures and drainage pathways, enabling surgeons to tailor interventions and avoid intraoperative complications such as cerebrospinal fluid leaks or optic nerve damage. CT imaging not only confirms disease presence but also maps anatomical variants like concha bullosa or Haller cells, which may predispose to obstruction or surgical difficulty[6].

Despite CT's high sensitivity, its specificity in correlating with symptom severity remains limited. Emerging CT scoring systems based on Hounsfield units have shown improved correlation with patient-reported symptoms. Nonetheless, CT remains the gold standard imaging modality for CRS, with MRI reserved for selected cases where radiation exposure or soft tissue delineation is a concern[7].

Population-specific studies have highlighted significant ethnic and geographical variation in sinonasal anatomy. Therefore, evaluating anatomical variants in Indian patients with CRS using MDCT can offer vital data to guide surgical planning and improve clinical outcomes[7]. This study aims to evaluate anatomical variations of the nasal cavity and paranasal sinuses using MDCT in patients with CRS and to explore their association with presenting symptoms, thus providing region-specific insights to enhance diagnostic accuracy and surgical safety.

Methodology:

This cross-sectional observational study was conducted in the Department of Radiodiagnosis at Government Medical College and Hospital, Aurangabad, from July 2023 to January 2025. Ethical

clearance was obtained from the Institutional Ethics Committee, and written informed consent was secured from all participants. Patients above 12 years of age referred for CT evaluation of the paranasal sinuses with clinical suspicion of chronic rhinosinusitis or anatomical abnormalities were included. Exclusion criteria comprised prior sinonasal surgery, trauma, neoplasms, congenital craniofacial anomalies, and poor-quality scans. The sample size was estimated at 50, based on a reported prevalence of 60–80% for anatomical variants in chronic sinusitis cases, using an absolute precision of 10%.

Multidetector computed tomography (MDCT) scans were performed using a standard protocol. Images were analyzed in axial, coronal, and sagittal planes to identify anatomical variations including deviated nasal septum, concha bullosa, agger nasi cells, Haller cells, Onodi cells, and Keros classification.

Data were entered into Microsoft Excel and analyzed using SPSS version 23.0. Descriptive statistics were used for frequencies and percentages. Associations between anatomical variants and clinical symptoms were assessed using Chi-square or Fisher's exact test, with significance set at $p < 0.05$.

RESULT:

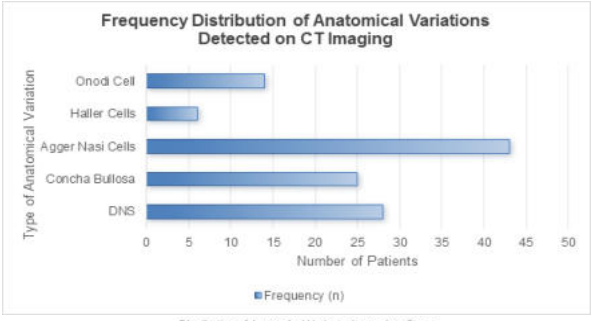
The study included 50 patients undergoing CT evaluation for suspected chronic rhinosinusitis. The mean age was 50.96 ± 19.07 years (range: 17–79), with 70% of participants aged over 40 years. Females constituted a slightly higher proportion (56%) compared to males (44%).

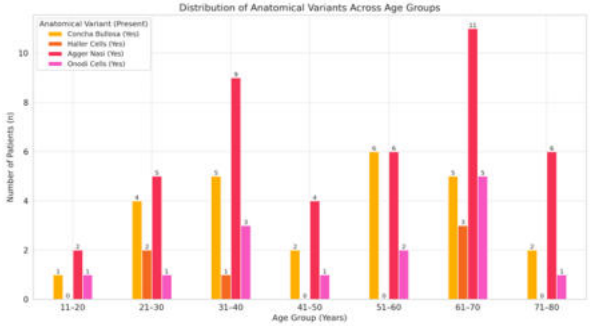
Among anatomical variants, agger nasi cells were the most common, observed in 86% of patients. Deviated nasal septum (DNS) was present in 56%, concha bullosa in 50%, Onodi cells in 28%, and Haller cells in 12%. Regarding Keros classification of the olfactory fossa, Type 2 was predominant (64%), followed by Type 1 (26%), Type 3 (6%), and Type 4 (4%).

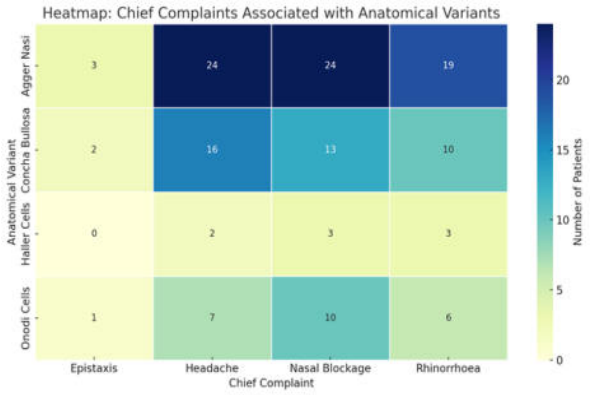
The most frequently reported symptoms were nasal blockage (58%) and headache (54%), followed by fever (50%) and rhinorrhoea (46%). Epistaxis was the least common complaint (8%).

Statistically significant associations were observed between specific anatomical variants and symptoms. Concha bullosa was significantly associated with epistaxis ($p = 0.002$), agger nasi with epistaxis ($p = 0.02$), Haller cells with epistaxis ($p = 0.03$), and Onodi cells with epistaxis ($p = 0.0018$). No significant correlation was found between other variants and common symptoms such as headache or nasal blockage.

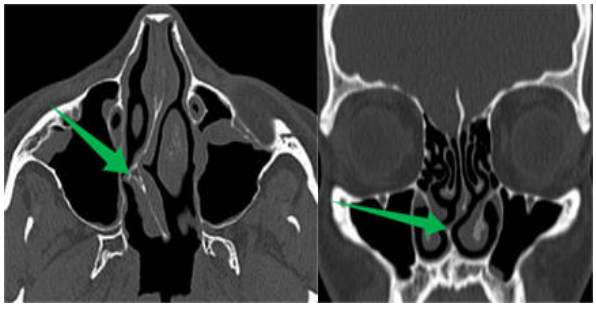
These findings highlight the high prevalence of sinonasal anatomical variants and their potential clinical relevance, particularly in preoperative planning for endoscopic sinus surgery.







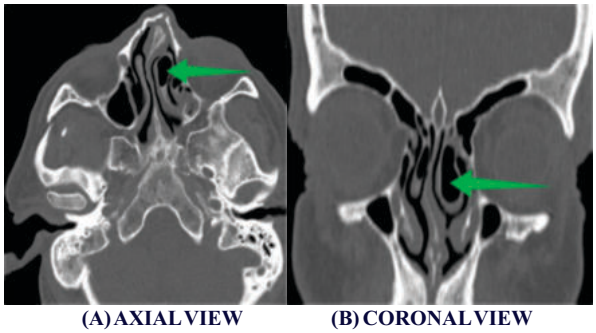
Case 1 : 29 Year Old Patient Came With Complaints Of Running Nose And Nasal Congestion From 5 Months



(A) AXIAL VIEW **(B) CORONAL VIEW**

Figure 1: NCCT paranasal sinuses: (A) axial and (B) coronal sections show a deviated nasal septum with convexity towards the **right** (arrows), causing relative narrowing of the right nasal cavity. (NCCT = non-contrast computed tomography.)

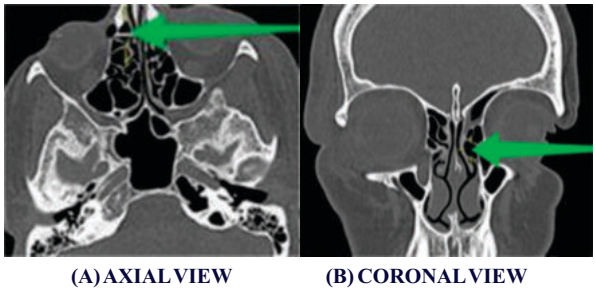
CASE 2 : 29 Year Old Patient Complaints Of Running Nose, headache And Nasal Congestion Since 15 Months



(A) AXIAL VIEW **(B) CORONAL VIEW**

Figure 2: Concha bullosa of the left middle turbinate. NCCT paranasal sinuses: (A) axial and (B) coronal images demonstrate **pneumatization of the left middle turbinate** (arrows), consistent with concha bullosa.

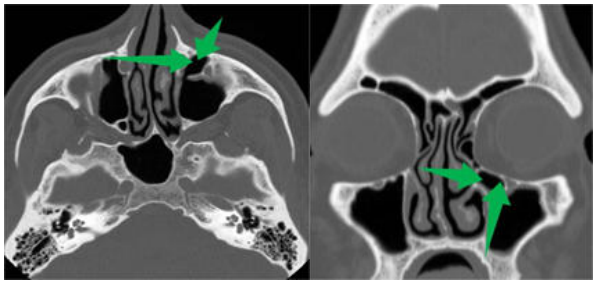
CASE 3: 30 Year Old Patient Complaints Of Running Nose, Headache And Nasal Congestion Since 9 Months



(A) AXIAL VIEW **(B) CORONAL VIEW**

Figure 3: Right agger nasi cell. NCCT paranasal sinuses: (A) axial and (B) coronal views depict a **prominent right agger nasi cell** (arrows) anterior to the anterior ethmoids, indenting the frontal recess region.

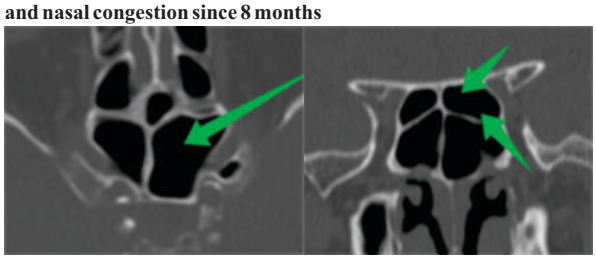
CASE 4: 47 Year Old Patient Complaints Of Running Nose, Headache And Nasal Congestion Since 17 Months



(A)AXIAL VIEW (B) CORONAL VIEW

Figure 4. Left Haller (infraorbital ethmoid) cell. NCCT paranasal sinuses: (A) axial and (B) coronal images show a **left infraorbital ethmoid (Haller) cell** (arrows) along the medial orbital floor, narrowing the ipsilateral infundibulum.

CASE 5: 48 year old patient complaints of running nose,headache and nasal congestion since 8 months



(A) AXIAL VIEW (B) CORONAL VIEW

Figure 5: Left Onodi (sphenoethmoidal) cell. NCCT paranasal sinuses: (A) axial and (B) coronal sections reveal a **left Onodi cell** (arrows) superolateral to the sphenoid sinus with close relation to the optic canal-an important surgical landmark.

DISCUSSION:

In this MDCT-based study of 50 patients with chronic rhinosinusitis, the mean age was 50.96 ± 19.07 years, with most patients in the 51–60 year group, slightly higher than that reported by Tarim Usmani et al. A female predominance (56%) was observed, comparable to findings by Madani Gisma Ahmed et al., indicating a possible gender influence in sinonasal variants.

Agger nasi cells (86%) were the most frequent anatomical variant, followed by deviated nasal septum (56%) and concha bullosa (50%), consistent with reports by Misra Pooja et al. and Azgaonkar Sarvesh et al. Keros Type II (64%) was the most common olfactory fossa configuration, in agreement with Igor Djorić et al., with no sex-related differences noted.

Nasal blockage (58%) and headache (54%) were the most prevalent symptoms, similar to the findings of Qureshi Maryam Faiz et al. Concha bullosa and agger nasi cells demonstrated significant associations with epistaxis ($p = 0.002$ and $p = 0.02$), whereas Haller and Onodi cells were negatively correlated.

MDCT remains a pivotal modality for evaluating sinonasal anatomy. Recognition of such variants is essential for surgical planning and may contribute to understanding the pathophysiological basis of chronic rhinosinusitis.

CONCLUSION:

This study underscores the pivotal role of multidetector computed tomography (MDCT) in identifying anatomical variations of the paranasal sinuses in chronic rhinosinusitis. Variants near the osteomeatal complex may contribute to disease pathophysiology by obstructing normal drainage pathways. Although some anatomical variants showed significant associations with clinical symptoms such as nasal obstruction, headache, rhinorrhoea, and epistaxis, others did not, suggesting a multifactorial origin of symptoms. Recognition of high-risk variants is vital for preoperative assessment and surgical planning in functional endoscopic sinus surgery (FESS), minimizing intraoperative complications.

Overall, detailed CT evaluation remains indispensable in the diagnostic and preoperative workup of chronic sinonasal disease.

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