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Evaluation of paranasal sinuses and nasal cavity using CT PNS study to determine the anatomical variations in a tertiary care centre at Chengalpattu, Tamilnadu

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ABSTRACT

Background: Variations in the anatomy of the paranasal sinuses and nasal cavity can significantly affect the development of sinus pathologies and the success of surgical interventions. This study aims to determine the prevalence of anatomical variants in these regions among patients visiting a tertiary care center in Chengalpattu, Tamil Nadu, utilizing CT scans of PNS for evaluation.

Methods: A retrospective observational study was conducted, analyzing CT scans of 200 patients who underwent imaging for sinus-related complaints. Variants were documented and categorized.

Results: Deviated nasal septum (DNS) was the most common finding (67%), followed by concha bullosa (40%), agger nasi cells (30%), Haller cells (15%), cribriform plate (15%)and paradoxical middle turbinate (10%). Detailed data on prevalence and distribution are provided in tables.

Conclusion: Anatomical variations in the PNS are highly prevalent and clinically significant. CT evaluation is indispensable for preoperative planning in functional endoscopic sinus surgery (FESS) and to understand the etiology of sinonasal diseases.

1. INTRODUCTION

The paranasal sinuses (PNS) and nasal cavity are anatomically complex structures consisting of four air spaces which are paired. They include maxillary, sphenoid, ethmoid and frontal sinuses. Paranasal sinuses allow air to flow through and maintaining the temperature of body. It also aids for voice resonance. However they are prone to variations even between sides in the same individual. This makes them a potential site for various sinonasal diseases. [1]. According to studies the following variations were identified in CT-PNS while evaluating for chronic rhinosinusitis which includes concha bullosa, posterior nasal septal deviations, uncinate process variations, paradoxical middle turbinate, agger nasi cells, cribriform plate etc. These variations often contribute to the pathogenesis of chronic rhinosinusitis (CRS) and pose challenges during surgical interventions such as functional endoscopic sinus surgery (FESS) [2]. High-resolution computed tomography (HRCT) is the imaging modality of choice for evaluating these anatomical details due to its ability to provide precise three-dimensional visualization [3].

This study aims to evaluate the prevalence of anatomical variations in the PNS and nasal cavity in patients presenting to a tertiary care center in Chengalpattu, Tamil Nadu, emphasizing their clinical significance.

2. METHODS

This study is a retrospective, observational study conducted at a tertiary care hospital in Chengalpattu, Tamil Nadu. The study included 200 patients above 18 years who underwent CT- PNS for sinus related complaints between September 2023 to august 2024. Exclusion criteria included prior sinus surgery, trauma, or sinonasal malignancy. CT scans were performed using a 32 slice CT scanner (SEIMENS SOMATOM) with standard protocol of 5-cm slice thickness, 120 kVp, and 300–500 mA. Exposure parameter for PNS view thickness was 3 mm, and an increment of 1.5 mm was taken. After obtaining institutional review board approval, we retrospectively examine images from unenhanced sinus CT examinations of patients referred to department of Radiodiagnosis from OPD, Karpaga Vinayaga Institute of Medical Sciences and Research Centre, Maduranthakam, Chengalpattu, Tamilnadu for CT PNS. The CT scans are evaluated for the presence of anatomic variants of the sinonasal cavities. The prevalence of each variant and the frequency of its bilaterality when applicable are calculated. In all cases, the existence of the following variants is investigated.

1. Cribriform plate: Depth and symmetry.
2. Ethmoid air cells: Agger nasi cells, Haller's cells.
3. Turbinates: Concha bullosa and paradoxical middle turbinate.
4. Nasal septum: Septal deviation (with or without nasal spur).

Statistical Analysis: Data will be collected and will be entered statistical package for the social sciences (SPSS, version 25). Data will be statistically described in terms prelavance for CT PNS will be calculated separately for each parameter.

3. RESULTS

The study included 200 patients (120 males, 80 females) with a mean age of 42 ± 12 years. Anatomical variations were identified in 85% of patients.

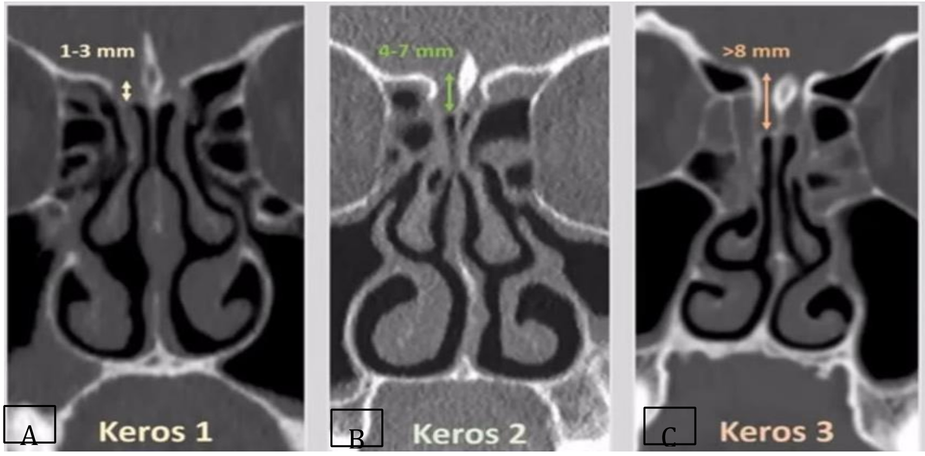
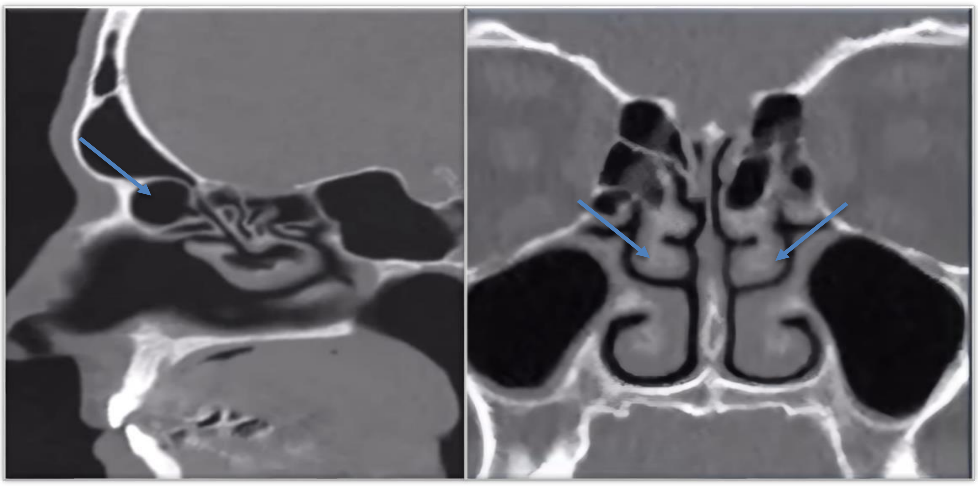


Figure 1:- Keros classification A- Type 1 B- Type 2 C- Type 3



A B

Figure 2:- A- Agger nasi cells, B – Paradoxical middle turbinate

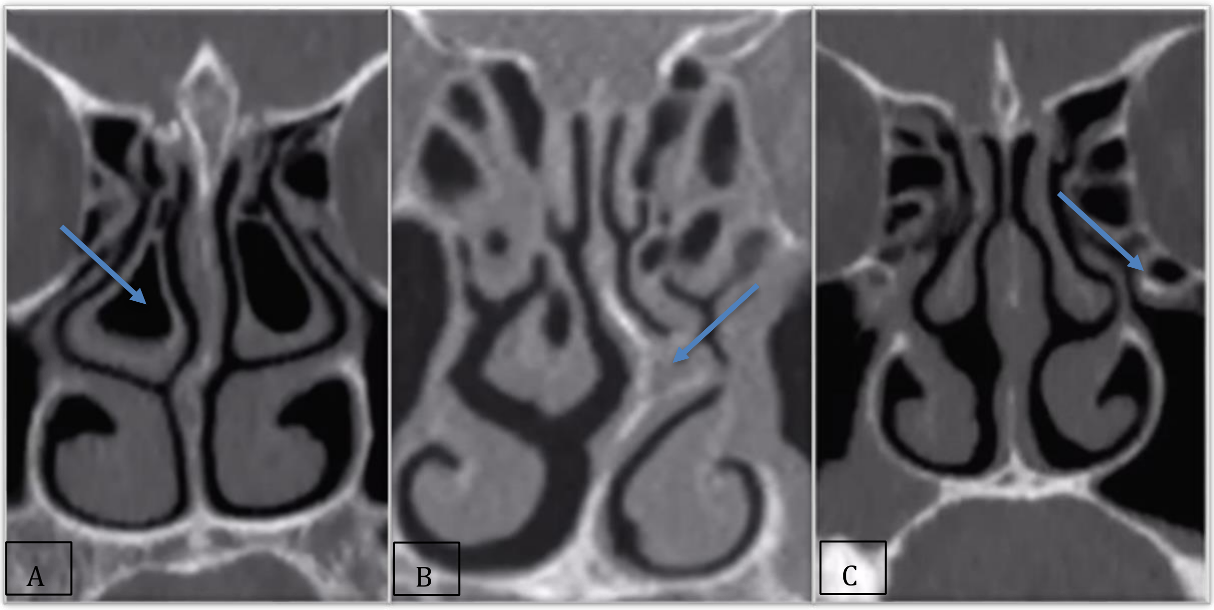


Figure 3:- A- Bilateral middle turbinate concha bullosa B- Deviated nasal septum to left C- Haller's cell

Table 1: Prevalence of Anatomical Variations in the Study Population

Anatomical Variation	Frequency (n)	Percentage (%)
Deviated Nasal Septum (DNS)	134	67
Concha Bullosa	80	40
Agger Nasi Cells	60	30
Haller Cells	30	15
Paradoxical Middle Turbinate	20	10
Cribriform plate	30	15

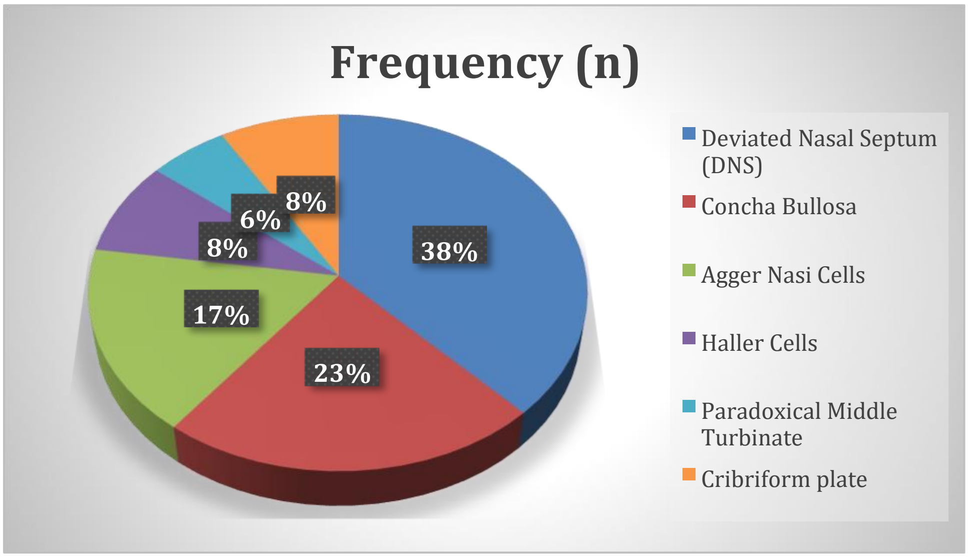


Figure 4:- Prevalence of Anatomical Variations in the Study Population

Table 2: Distribution of Deviated Nasal Septum

Type of DNS	Frequency (n)	Percentage (%)
Left-sided deviation	70	52.2
Right-sided deviation	50	37.3
S-shaped deviation	14	10.5

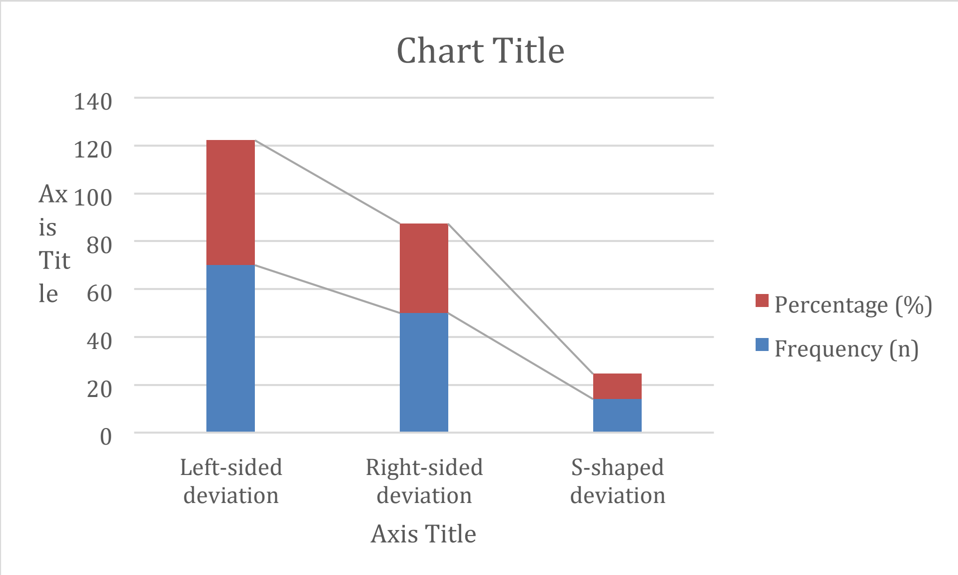


Figure 5:- Distribution of Deviated Nasal Septum

4. DISCUSSION

The findings from this study provide a comprehensive understanding of the anatomical variations of the paranasal sinuses (PNS) and their implications for clinical and surgical practices. Anatomical variations in the PNS are a common occurrence, as demonstrated by the high prevalence (85%) in the current study population. These variations can contribute to the pathogenesis of sinonasal diseases and present challenges in both diagnosis and treatment, particularly in functional endoscopic sinus surgery (FESS).

Deviated nasal septum (DNS) was the most frequently observed anatomical variant (67%). DNS can significantly alter the airflow dynamics within the nasal cavity, potentially leading to mucosal inflammation, impaired mucociliary clearance, and an increased risk of chronic rhinosinusitis (CRS) [1]. This observation aligns with studies by Earwaker et al. and Kennedy et al., which also reported DNS as the most prevalent variation, with rates ranging between 50% and 70% [2,3]. In this study, left-sided deviation (52.2%) was more common than right-sided deviation (37.3%), while S-shaped deviations were noted in 10.5% of cases. This asymmetry underscores the importance of precise preoperative imaging for determining the extent of deviation and its potential impact on adjacent structures.

Concha bullosa, observed in 40% of patients, represents the pneumatization of the middle turbinate. Its clinical significance lies in its ability to impinge upon the middle meatus, obstructing the drainage pathways of the maxillary, frontal, and anterior ethmoidal sinuses [4]. This obstruction can predispose individuals to recurrent sinus infections. Studies by Bolger et al. reported similar prevalence rates of 35–40%, corroborating the findings of this study [5]. Surgical correction of concha bullosa during FESS often alleviates symptoms and improves sinus ventilation.

Agger nasi cells (Fig.2) were identified in 30% of cases. These cells are located anterior to the frontal recess and are key landmarks during FESS. Their pneumatization can narrow the frontal recess and contribute to frontal sinusitis [6]. Stamm et al. emphasized the critical role of identifying agger nasi cells during preoperative planning to avoid inadvertent damage to the frontal recess and to ensure complete clearance of the drainage pathway [7].

Haller cells (Fig.3)were noted in 15% of patients. These ethmoid air cells are situated along the orbital floor and can encroach upon the maxillary sinus ostium, leading to obstruction and recurrent maxillary sinus infections [8]. Although the prevalence of Haller cells varies across populations, their presence has been consistently associated with increased sinonasal pathology. Surgeons must carefully evaluate Haller cells preoperatively to avoid complications, particularly orbital injuries, during FESS.

The depth of olfactory fossa is determined by height of lateral lamella of cribriform plate. The depth of cribriform plate is given by keros classification(Fig.1).Keros classification – Type 1- depth 1-3mm, Type 2- depth 4-7mm, Type 3- depth 8-16mm. depth of Type 3 and asymmetry of cribriform plate increases the vulnerability of olfactory bulb and anterior ethmoidal artery to injury and predisposes to CSF rhinorhea.

Paradoxical middle turbinate(Fig 2) where the curvature of the turbinate is directed laterally instead of medially, was identified in 10% of cases. This variation can obstruct the middle meatus and compromise the drainage of the anterior ethmoidal and maxillary sinuses. Although relatively less common, paradoxical middle turbinate warrants attention due to its potential to exacerbate sinus-related symptoms [9].

5. CLINICAL IMPLICATIONS

The clinical relevance of these anatomical variations cannot be overstated. Variations such as DNS, concha bullosa, and ethmoid air cells often act as contributing factors rather than sole causes of CRS. However, when present in conjunction with mucosal disease, they can significantly exacerbate symptoms and complicate management. For otolaryngologists and radiologists, identifying these variations preoperatively is crucial to anticipate potential challenges, plan tailored surgical approaches, minimize risk of injury to critical structures, enhance patient safety. Moreover, understanding the regional prevalence of these variations, as highlighted by this study, allows for better anticipation of challenges specific to the population of Tamil Nadu.

6. COMPARISON WITH PREVIOUS STUDIES

The findings of this study are consistent with similar research conducted in other regions of India and globally.

TITLE	AUTHOR	YEAR AND PLACE OF STUDY
Evaluation of Anatomical Variants in Paranasal Sinuses with Computed Tomography in Central India Region	Parihar, *et al* Journal of Datta Meghe Institute of Medical Sciences University	2021 India
A CT-Scan review of anatomical variants of sinonasal region and its correlation with symptoms of sinusitis	Maryam Faiz Qureshi et al. Pak J Med Sci January - February 2021	2021 Pakistan
Anatomical Variations of Paranasal Sinuses on Coronal CT-Scan in Subjects with Complaints Pertaining to PNS	Rajendra Kumar Narasipur Lingaiah et al. International Journal of Anatomy, Radiology and Surgery. 2016	2016 India
The Preoperative Sinus CT: Avoiding a "CLOSE" Call with Surgical Complications	O'Brien et al. Radiology 2016; RSNA	2016 US
CT of Anatomic Variants of the Paranasal Sinuses and Nasal Cavity: Poor Correlation with Radiologically Significant Rhinosinusitis but Importance in Surgical Planning	Shpilberg et al. AJR:204, June 2015	NewYork.2014

For instance, studies from Northern India reported DNS and concha bullosa as the most common variants, with comparable prevalence rates [10]. This consistency reinforces the notion that certain variations, such as DNS and concha bullosa, are universally prevalent, while others, such as Haller cells, may show regional variability.

7. LIMITATIONS AND FUTURE DIRECTIONS

This study is not without limitations. Being a single-center study, the findings may not be generalizable to the broader population. Additionally, the retrospective nature of the study limits the ability to establish causative links between anatomical variations and sinus pathology. Future prospective studies incorporating larger, multicenter cohorts are needed to validate these findings and explore the functional implications of these variations.

8. CONCLUSION

CT imaging remains indispensable in evaluating the complex anatomy of the PNS and nasal cavity. This study highlights the high prevalence of anatomical variations in a South Indian population, emphasizing their significance in the management of sinonasal diseases and surgical interventions.

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