Section: Otorhinolaryngology

Original Research Article

THE PREVALENCE OF ANATOMICAL VARIATION IN OSTEOMEATAL UNIT IN PATIENTS WITH CHRONIC RHINOSINUSITIS WITHOUT NASAL POLYPOSIS

Amudha S[1], Raam Deepak[2], Durga Lakshmi[2], Vijayakumar[3], Gowarthan[4]

[1]*Postgraduate, Trichy SRM Medical College Hospital and Research CentreIrungalur, Tiruchirapalli, Tamil Nadu, India*
[2]*Assistant Professor, Department of Otorhinolaryngology, Trichy SRM Medical College Hospital and Research Centre, Irungalur, Tiruchirapalli, Tamil Nadu, India*
[3]*Professor, Department of Otorhinolaryngology, Trichy SRM Medical College Hospital and Research Centre, Irungalur, Tiruchirapalli, Tamil Nadu, India*
[4]*Professor, Department of Radiology, Trichy SRM Medical College Hospital and Research Centre, Irungalur, Tiruchirapalli, Tamil Nadu, India*

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Corresponding Author:
Dr. Amudha S,
Postgraduate, Trichy SRM Medical College Hospital and Research CentreIrungalur, Tiruchirapalli, Tamil Nadu, India.
Email: amudha.s2@gmail.com

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ABSTRACT

Background: Chronic Rhinosinusitis (CRS) is a common condition, and anatomical variations of the osteomeatal unit (OMU) are considered important predisposing factors. Identifying these variants is essential for diagnosis and surgical planning. The objective is to determine the prevalence of anatomical variations in the osteomeatal unit among patients with CRS without nasal polyposis and to assess their association with specific sinus involvement

Materials and Methods: This cross-sectional observational study was conducted on 110 patients with clinically and radiologically diagnosed CRS without nasal polyposis. All patients underwent diagnostic nasal endoscopy and high-resolution computed tomography (HRCT) of the paranasal sinuses. Anatomical variations including deviated nasal septum (DNS), concha bullosa, agger nasi cells, paradoxical middle turbinate, Haller cells, and uncinate process variations were evaluated.

Results: The most common variation was DNS (82.7%), followed by concha bullosa (35.5%), paradoxical middle turbinate (31.8%), and uncinate process hypertrophy (30%). Agger nasi cells (12.7%), Haller cells (8.2%), and pneumatized uncinate (3.6%) were less frequent. DNS showed a significant association with maxillary sinusitis ($p = 0.042$), while agger nasi cells were more frequently associated with frontal sinusitis (42.9%), though not statistically significant.

Conclusion: Anatomical variations of the osteomeatal unit are highly prevalent in CRS patients without nasal polyposis, with DNS, concha bullosa being the most frequent. Recognition of these variants on preoperative CT scans is crucial for accurate diagnosis, prevention of complications, and improving surgical outcomes in functional endoscopic sinus surgery (FESS).

Keywords: Chronic Rhinosinusitis, Osteomeatal unit, Anatomical variations, deviated nasal septum & Concha bullosa.

INTRODUCTION

Chronic Rhinosinusitis (CRS) is a common inflammatory condition of the paranasal sinuses with significant morbidity worldwide, including India. The osteomeatal unit (OMU) is the key anatomical region responsible for the drainage and ventilation of the frontal, maxillary, and anterior ethmoidal sinuses. Any obstruction in this area can predispose to persistent infection and chronic inflammation. Anatomical variations such as deviated nasal septum, concha bullosa, agger nasi cells, Haller cells, and paradoxical middle turbinate are frequently implicated in disturbing the normal mucociliary clearance and ventilation pathways. Identifying these variations is therefore critical, as they can contribute to the pathogenesis of CRS in the absence of other risk factors like nasal polyps or systemic disease.[1]

Several Indian studies have attempted to quantify the prevalence of anatomical variations in patients with CRS, highlighting that these anomalies are frequent and may differ across regions. For instance, CT and nasal endoscopy are widely recognized as the most reliable diagnostic tools to identify such variations. A prospective study in Patiala, Punjab, reported agger nasi cells (73%), deviated nasal septum (68%), and uncinate process variations (58%) as the most common findings among CRS patients, whereas Haller's cells and accessory maxillary ostia were less frequent.[1] Similarly, a study from Andhra Pradesh found deviated nasal septum in 60%, agger nasi cells in 58.3%, and concha bullosa in 26.8% of cases, further reinforcing the significance of these variants in CRS patients without polyposis.[2] These studies emphasize that anatomical variants play an important role in obstructing sinus pathways, leading to disease persistence.[1]

The clinical implications of these findings are considerable. Preoperative CT scans and diagnostic nasal endoscopy not only help in identifying such variations but also aid in surgical planning, especially for functional endoscopic sinus surgery (FESS). Addressing these anatomical anomalies during surgery can improve ventilation and sinus drainage, thereby enhancing treatment outcomes. Although some variations are also found in asymptomatic individuals, their prevalence is notably higher among CRS patients, suggesting a contributory rather than incidental role. In summary, anatomical variations of the OMU are highly prevalent in Indian CRS patients without nasal polyposis and should be considered an essential factor in both diagnosis and management strategies.[1,3]

MATERIALS AND METHODS

The hospital based cross-sectional study was conducted in the Department of Otorhinolaryngology at a tertiary care hospital in India over a period of 6 months. The study included patients clinically diagnosed with chronic Rhinosinusitis (CRS) without nasal polyposis, based on the diagnostic criteria laid down by the American Academy of Otolaryngology–Head and Neck Surgery, which requires symptoms to persist for more than 12 weeks with objective evidence on nasal endoscopy and/or computed tomography (CT) scans.

Study population and sampling: All patients aged 18–60 years presenting with nasal obstruction, nasal discharge, headache, facial pain/pressure, and/or postnasal drip suggestive of CRS were enrolled. Patients with sinonasal polyposis, previous sinonasal surgery, sinonasal tumors, fungal sinusitis, allergic fungal Rhinosinusitis, craniofacial trauma, or immunocompromised states were excluded. A minimum sample size of (calculated based on prevalence from previous studies) was included to achieve adequate statistical power. Convenient consecutive sampling was employed until the desired sample size was reached. Sample size calculation was based on the study by Mendiratta V et al (6)., the prevalence of anatomical variations in the osteomeatal unit (OMU) among patients with chronic rhinosinusitis without nasal polyps was found to be 76%.

Using this prevalence, the sample size was calculated as follows:

n = (Z^2 * p * (1 - p)) / d^2
= (1.96^2 * 0.76 * 0.24) / (0.08^2)
≈ 110

Final Sample Size: 110 patients (rounded up)

Clinical evaluation: Detailed history and clinical examination were carried out in all patients. Diagnostic nasal endoscopy (DNE) was performed using 0° and 30° rigid nasal endoscopes to evaluate the osteomeatal unit region for anatomical variations. High-resolution computed tomography (HRCT) of the paranasal sinuses (coronal and axial sections, 3–5 mm slice thickness) was performed in all cases. The scans were interpreted by two independent radiologists/ENT surgeons to reduce observer bias.

Anatomical variations assessed: The anatomical variations studied included deviated nasal septum (DNS), concha bullosa, agger nasi cells, paradoxical middle turbinate, Haller's cells, Onodi cells, uncinate process variations and accessory maxillary ostia. Prevalence of each variant was recorded in both symptomatic and contralateral sides.

Statistical analysis: Data were entered into Microsoft Excel and analyzed using SPSS (version 16). Categorical variables were expressed as frequency and percentage. Associations between specific anatomical variations and CRS were assessed using the Chi-square test, with $p < 0.05$ considered statistically significant.

RESULTS

Anatomical variations were observed in 110 patients. Deviated nasal septum (DNS) was the most common variation, detected in 91 cases (82.7%). Concha bullosa was noted in 39 patients (35.5%), while Haller cells were identified in 9 cases (8.2%). Agger nasi cells were present in 14 patients (12.7%), and paradoxical middle turbinate was observed in 35 cases (31.8%). Variations of the uncinate process included pneumatization in 4 cases (3.6%) and hypertrophy in 33 cases (30.0%). Additional anatomical variants were identified in 27 patients (24.5%). Overall, DNS accounted for the highest proportion of anatomical variations, followed by concha bullosa, while uncinate pneumatization was the least common finding. [Table 1]

Among the anatomical variations studied, deviated nasal septum (DNS) was the most frequent, accounting for 91 cases. Of these, 35 patients (38.5%) had right-sided DNS, 36 patients (39.6%) had left-sided involvement, and 20 patients (22.0%) showed bilateral deviation. Concha bullosa was observed in 39 cases, with right-sided presentation in 16 patients

(17.6%), left-sided in 14 patients (15.4%), and bilateral in 9 patients (9.9%). Haller cells were identified in 9 patients, of which 3 (3.3%) were on the right side, 4 (4.4%) on the left side, and 2 (2.2%) bilaterally. Agger nasi cells were noted in 14 cases, with 6 patients (6.6%) showing right-sided, 5 (5.5%) left-sided, and 3 (3.3%) bilateral involvement. Paradoxical middle turbinate was found in 35 patients, distributed as 15 cases (16.5%) on the right, 14 cases (15.4%) on the left, and 6 cases (6.6%) bilaterally. Overall, unilateral involvement was more common than bilateral across all anatomical variations, with left-sided predominance noted in DNS and near-equal distribution between sides in other variations. [Table 2]

Table 1: Prevalence of Anatomical Variations in Osteomeatal Unit (N = 110)

Anatomical Variation	Frequency	Percentage (%)
Deviated Nasal Septum (DNS)	91	82.7%
Concha Bullosa	39	35.5%
Haller Cells	09	8.2%
Agger Nasi Cells	14	12.7%
Paradoxical Middle Turbinate	35	31.8%
Uncinate variations		
Pneumatized	4	3.6%
Hypertrophy	33	30.0%
Variants	27	24.5%

Table 2: Distribution of Anatomical Variations by Side Involvement

Variation	Right Side		Left Side		Bilateral		Total Cases
	N	%	N	%	N	%	
Deviated Nasal Septum	35	38.5%	36	39.6%	20	22.0%	91
Concha Bullosa	16	17.6%	14	15.4%	9	9.9%	39
Haller Cells	3	3.3%	4	4.4%	2	2.2%	9
Agger Nasi Cells	6	6.6%	5	5.5%	3	3.3%	14
Paradoxical MT	15	16.5%	14	15.4%	6	6.6%	35

Table 3: Association Between Anatomical Variation and Sinus Involvement

Variation	Maxillary Sinusitis	Ethmoid Sinusitis	Frontal Sinusitis	Sphenoid Sinusitis	Total	P-value
DNS	52 (57.1%)	26 (28.6%)	7 (7.7%)	6 (6.6%)	91	0.042
Concha Bullosa	20 (51.3%)	12 (30.8%)	4 (10.3%)	3 (7.6%)	39	0.118
Haller Cells	6 (66.7%)	2 (22.2%)	1 (11.1%)	0	9	0.307
Agger Nasi	4 (28.6%)	3 (21.4%)	6 (42.9%)	1 (7.1%)	14	0.083

A total of 153 patients with anatomical variations were analyzed for sinus involvement. Deviated nasal septum (DNS) was observed in 91 cases, with maxillary sinusitis being the most frequent (52, 57.1%), followed by ethmoid sinusitis (26, 28.6%), frontal sinusitis (7, 7.7%), and sphenoid sinusitis (6, 6.6%), showing a statistically significant association ($p = 0.042$). Concha bullosa was present in 39 cases, most commonly associated with maxillary sinusitis (20, 51.3%) and ethmoid sinusitis (12, 30.8%), while frontal and sphenoid sinusitis were less frequent (4, 10.3% and 3, 7.6% respectively), without significant association ($p = 0.118$). Haller cells were detected in 9 patients, with maxillary sinusitis predominating (6, 66.7%), followed by ethmoid (2, 22.2%) and frontal sinusitis (1, 11.1%); no sphenoid involvement was noted, and the association was not significant ($p = 0.307$). Agger nasi cells were observed in 14 cases, most commonly associated with frontal sinusitis (6, 42.9%), followed by maxillary (4, 28.6%), ethmoid (3, 21.4%), and sphenoid sinusitis (1, 7.1%), with borderline significance ($p = 0.083$). Overall, maxillary sinusitis was the most frequently involved sinus (82, 53.6%), followed by ethmoid (43, 28.1%), frontal (18, 11.8%), and sphenoid sinusitis (10, 6.5%).

DISCUSSION

In the present study, anatomical variations of the osteomeatal unit were observed in a significant proportion of patients with chronic rhinosinusitis (CRS) without nasal polyposis. Deviated nasal septum (DNS) was the most common variant (82.7%), followed by concha bullosa (35.5%), paradoxical middle turbinate (31.8%), and uncinate process hypertrophy (30%). Less common variations included agger nasi cells (12.7%), Haller cells (8.2%), and pneumatized uncinate process (3.6%). These findings are consistent with previous Indian studies which have highlighted the role of anatomical variations in disturbing mucociliary clearance and predisposing to CRS.

DNS was found in 82.7% of our cases, with significant association with maxillary sinusitis ($p = 0.042$). This high prevalence is in agreement with studies by Gill et al,[1] and Bhadouriya et al,[2] who reported DNS in 68% and 70% of CRS patients, respectively. The deviation of the septum may compromise sinus ventilation directly by narrowing the osteomeatal complex, or indirectly by causing compensatory hypertrophy of the turbinates. Concha bullosa, seen in 35.5% of patients, was the second

most frequent variant. Similar prevalence has been reported in South Indian studies by Reddy et al. (26.8%),[3] and Balodiya et al. (32%).[4] Although our study did not demonstrate a statistically significant association between concha bullosa and specific sinus involvement (p = 0.118), the presence of this variation can alter nasal airflow and contribute to obstruction when large or bilateral.

Paradoxical middle turbinate (31.8%) were other notable findings. Their prevalence is higher compared to reports by Sharma et al. (24% and 18%, respectively).[5] These variations may compress adjacent structures such as the infundibulum, thereby predisposing to ethmoid or frontal sinusitis. Agger nasi cells were found in 12.7% of our patients, predominantly associated with frontal sinusitis (42.9%). Previous Indian studies have also highlighted agger nasi as an important contributor to frontal sinus disease, with frequencies ranging between 15–20%.[2,4] Haller cells, although less frequent (8.2%), were associated with maxillary sinus involvement in our study, consistent with findings by Reddy et al.[3] The clinical implications of these results are considerable. Preoperative assessment of anatomical variants using high-resolution CT is essential for accurate diagnosis and surgical planning. Functional endoscopic sinus surgery (FESS) outcomes are improved when such variants are recognized and corrected, thereby restoring sinus drainage and ventilation. However, it must be emphasized that anatomical variations alone may not be sufficient to cause CRS; they act synergistically with mucosal factors and infections. The variations seen in asymptomatic individuals underscore this complexity. Nonetheless, the significantly higher prevalence of DNS, concha bullosa among CRS patients in our study reinforces their pathogenic contribution.[6-9]

The study was conducted in a single tertiary care center, which may limit the generalizability of the results to the wider population. The sample size, though adequate, was relatively modest, and larger multicentre studies are required to validate the findings. Asymptomatic individuals were not included for comparison; hence, the true causal association between anatomical variations and CRS could not be fully established. In summary, our findings align with most Indian studies, confirming that anatomical variations of the osteomeatal unit are highly prevalent in CRS patients without polyposis. DNS, concha bullosa, are the most common anomalies, with certain variants like agger nasi and Haller cells showing sinus-specific associations. Routine CT evaluation of paranasal sinuses should be considered in all CRS patients prior to surgical intervention to minimize complications and optimize outcomes.

CONCLUSION

The present study highlights that anatomical variations of the osteomeatal unit are highly prevalent among patients with chronic rhinosinusitis (CRS) without nasal polyposis. Deviated nasal septum, and concha bullosa were the most frequent findings, while agger nasi cells and Haller cells were less common. Certain variations, such as DNS and agger nasi cells, showed significant associations with maxillary and frontal sinusitis, respectively, indicating their contributory role in the pathogenesis of CRS. These observations emphasize the importance of routine preoperative CT evaluation to detect such variants, which can aid in accurate diagnosis, better surgical planning, and improved outcomes of functional endoscopic sinus surgery (FESS). Anatomical variations, though not solely responsible for CRS, act as predisposing factors that, in combination with mucosal disease, can significantly impact sinus ventilation and drainage.

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