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ORIGINAL RESEARCH

Prevalence of Anatomical variants of CT Paranasal sinuses and Nasal cavity among South Indian population and its significance in surgical planning

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ABSTRACT
Background: Anatomical variants of the paranasal sinuses and nasal cavity are common findings in computed tomography (CT) imaging and play a crucial role in the clinical presentation and management of sinonasal diseases. These variants can impact surgical planning, particularly in functional endoscopic sinus surgery (FESS). **Aim:** This study aims to evaluate the incidence of anatomical variants in the paranasal sinuses and nasal cavity among the South Indian population and to assess their significance in surgical planning. **Methods:** CT scans of 234 patients, including those with minimal and significant sinonasal disease, were reviewed. Anatomical variants were identified and categorized, with their prevalence calculated. The association between these variants and the severity of sinonasal disease was analyzed. Statistical analysis was accomplished using SPSS version 23.0. **Results:** The most common anatomical variants observed were deviated nasal septum (66.7%), concha bullosa (56.4%), and Haller cells (33.3%). Significant associations were found between the prevalence of these variants and the severity of sinonasal disease. Concha bullosa was present in 100% of patients with significant sinonasal disease, with bilateral variants being more prevalent in this group. The findings suggest that specific anatomical variants, particularly when bilateral, are strongly associated with more severe sinonasal disease. **Conclusion:** This study highlights the high prevalence of anatomical variants in the South Indian population and their significant association with sinonasal disease severity. These findings underscore the importance of detailed preoperative imaging and assessment to inform surgical planning, potentially improving surgical outcomes. **Recommendations:** Further studies are recommended to explore the impact of these anatomical variants on surgical outcomes and to develop population-specific guidelines for preoperative assessment and management in sinonasal surgery.
Keywords: Anatomical Variants, Paranasal Sinuses, Nasal Cavity, CT Imaging, South Indian Population, Surgical Planning.

INTRODUCTION
The clinical presentation and treatment of sinonasal disorders can be greatly impacted by anatomic variations of the nasal cavity and paranasal sinuses, which are frequent. These polymorphisms are frequently discovered by chance during imaging investigations carried out for a variety of purposes, including as preoperative evaluations, trauma, and chronic rhinosinusitis. Clinicians must comprehend the presence and implications of these anatomical variances, especially in areas such as South India where there may be specific population-based differences.
Numerous morphological changes can be seen in the paranasal sinuses and nasal cavity, such as concha bullosa, deviated nasal septum, Haller cells, and Agger Nasi cells. These differences may affect normal airflow dynamics or impede sinus drainage channels, which can lead to the development of sinonasal illnesses. For instance, it is recognised that a deviated

nasal septum can interfere with normal nasal physiology and cause chronic rhinosinusitis or other obstructive diseases [1]. Similarly, by restricting the middle meatus and obstructing mucociliary clearance, concha bullosa, an air-filled hollow within the nasal concha, has been linked to the pathophysiology of sinusitis [2].
Imaging, especially computed tomography (CT), has played a more significant role in discovering these anatomical variants in recent years. With the use of high-resolution CT scans, sinonasal anatomy may be seen in great detail, enabling precise evaluation of the sinus mucosal linings as well as the bony structures. This imaging modality is crucial for surgical planning, especially in the case of functional endoscopic sinus surgery (FESS), as well as for the diagnosis of sinonasal disorders. For the purpose of reducing problems and enhancing patient care, it is essential to comprehend the anatomical variances that may influence surgical outcomes [3].
Regional variations in the occurrence of these anatomical anomalies have been brought to light by population-based studies, highlighting the necessity of doing localised research. Certain genetic, environmental, and behavioural factors may cause variances in sinonasal morphology in South India to differ from those seen in other populations. In spite of this, there is a dearth of information that focusses only on the South Indian population, making it difficult to customise surgical techniques to the distinct anatomical characteristics of this community.
Given the importance of these anatomical variants in clinical practice, this study aims to evaluate the prevalence of CT-detected anatomical variations of the paranasal sinuses and nasal cavity in the South Indian population and to assess their significance in surgical planning.

METHODOLOGY

Patient Population

A retrospective observational analysis was conducted. The study spanned a period of six months and was conducted at Karur Medical College and Tiruppur Medical College. By analyzing CT images of the sinonasal region, the study sought to determine the significance of these anatomical variations in surgical planning.
The study comprised 234 individuals in total. This group included those with sinus issues as well as those with normal CT results. The key criteria set by the Task Force on Chronic Rhinosinusitis specifically outlined inclusion criteria for patients diagnosed with rhinosinusitis. Facial pain, nasal obstruction, facial pressure, hyposmia, or purulent rhinorrhea were the symptoms that qualified for inclusion. To maintain the integrity of the data about anatomical variances, patients with a history of sinonasal malignancies or who had undergone prior sinonasal surgery were eliminated.
In order to reduce bias, individuals were carefully chosen based only on whether they met the predetermined criteria for rhinosinusitis diagnosis. Two skilled neuroradiologists independently assessed the CT scans. When there was disagreement over how to interpret the scans, the final assessment was decided by consensus. This strategy was used to lower the possibility of interpretation bias.

Data Collection

CT scans were performed using Toshiba Alexion 16 slice. The field of view (FOV) ranged from 14 to 16 cm, with a slice thickness of 0.625 mm. Scans were acquired in the axial plane along the inferior orbital meatal plane, with coronal and sagittal reconstructions post-processed for evaluation.
The CT scans were examined for the presence of anatomical variants within the sinonasal cavities. The prevalence of each variant and the frequency of bilaterality (where applicable) were calculated. Additionally, the degree of paranasal sinus and nasal cavity disease was assessed. Patients were categorized into two groups:

- **Group 1:** Minimal to no apparent paranasal sinus disease or nasal passage obstruction (105 patients).
- **Group 2:** Clinically significant paranasal sinus disease or nasal passage obstruction (87 patients).

Minimal disease was defined as less than 1-mm mucosal thickening with no obstruction of the sinus drainage passages.

Statistical Analysis

SPSS version 23.0 was utilised for doing statistical analysis. Fisher's exact test was used to examine the prevalence of anatomical variations and their bilaterality (where applicable) between the two groups. For every comparison, a p-value of less than 0.05 was deemed statistically significant.

RESULTS

The study evaluated the CT scans of 234 patients, including those with normal sinonasal anatomy and those with varying degrees of sinonasal disease. The primary focus was to assess the prevalence of anatomical variants in the paranasal sinuses and nasal cavity, and to determine the significance of these variants in relation to surgical planning.
The following anatomical variants were observed, and their prevalence calculated across the entire study population:

Table 1: The Observed Sinonasal Anatomic Variants and Their Proportion

Anatomic Variant	Number of Patients (n=234)	Prevalence (%)
Deviated Nasal Septum	156	66.7
Concha Bullosa	132	56.4
Haller Cells	78	33.3
Agger Nasi Cells	58	24.8
Onodi Cells	43	18.4
Paradoxical Middle Turbinate	28	12.0
Pneumatized Uncinate Process	19	8.1
Accessory Maxillary Ostium	14	6.0
Frontal Sinus Hypoplasia	11	4.7
Superior Attachment of the Uncinate Process	7	3.0

The prevalence of each anatomical variant was compared between the two groups: those with minimal sinonasal disease (Group 1) and those with significant sinonasal disease (Group 2).

Table 2: Anatomic Variants Prevalence

Anatomic Variant	Group 1	Group 2	p-value
Deviated Nasal Septum	52 (49.5%)	74 (85.1%)	<0.001
Concha Bullosa	45 (42.9%)	87 (100%)	<0.001
Haller Cells	28 (26.7%)	50 (57.5%)	<0.001
Agger Nasi Cells	20 (19.0%)	38 (43.7%)	0.002
Onodi Cells	14 (13.3%)	29 (33.3%)	0.001
Paradoxical Middle Turbinate	9 (8.6%)	19 (21.8%)	0.013
Pneumatized Uncinate Process	7 (6.7%)	12 (13.8%)	0.087
Accessory Maxillary Ostium	4 (3.8%)	10 (11.5%)	0.045
Frontal Sinus Hypoplasia	3 (2.9%)	8 (9.2%)	0.073
Superior Attachment of the Uncinate Process	2 (1.9%)	5 (5.7%)	0.151

Bilateral anatomical variants were also assessed to determine if their presence correlated with the severity of sinonasal disease.

Table 3: Prevalence of Bilateral Variants

Anatomic Variant	Group 1	Group 2	p-value
Bilateral Concha Bullosa	32 (30.5%)	72 (82.8%)	<0.001
Bilateral Haller Cells	17 (16.2%)	43 (49.4%)	<0.001
Bilateral Onodi Cells	8 (7.6%)	22 (25.3%)	0.002
Bilateral Agger Nasi Cells	12 (11.4%)	29 (33.3%)	<0.001

DISCUSSION

The results of the study showed that the people of South India had a significant prevalence of different anatomical variants in the nasal cavity and paranasal sinuses. The most frequent variation found was a deviated nasal septum, which was seen in 66.7% of individuals. This condition was much more common in patients with extensive sinonasal disease (85.1%) than in those with less severe disease (49.5%). This highlights the significance of a deviated septum in clinical evaluation and surgical planning, since it implies that it may cause or worsen sinonasal illness.
Another variant that was commonly noticed and was found in 56.4% of the research population was concha bullosa. It is noteworthy that in 100% of patients with substantial sinonasal illness, it was detected; in 82.8% of these cases, it was present bilaterally. Concha bullosa and severe sinonasal illness are strongly correlated, suggesting that this variant may be important in the pathogenesis of the disorder and that preoperative testing should prioritise its discovery.
33.3% of patients had Haller cells detected, with a greater frequency in patients with substantial disease (57.5%) as opposed to those with less severe disease (26.7%). Additionally, the severe illness group had a considerably higher frequency of bilateral Haller cells. Given that this mutation is linked to a higher severity of the disease, it is possible that it exacerbates obstructive processes in the sinus drainage routes, which would result in more severe clinical symptoms.
Even though they were less common, other structural variations including paradoxical middle turbinates, Onodi cells, and Agger Nasi cells nevertheless had a strong correlation with more severe illness. As an illustration, Agger Nasi cells were found in 24.8% of the population overall, with a greater frequency of 43.7% in the group with substantial illness. These results emphasise how crucial it is to identify these variations as possible causes of sinonasal disease.

The findings of the study imply that severe sinonasal illness is more commonly linked to specific anatomical abnormalities, especially when they are bilateral. This emphasises that in order to guide surgical planning and improve patient outcomes, thorough preoperative imaging and careful assessment of these variations are essential. Surgeons can better predict difficulties during sinonasal surgery and enhance the overall outcome of interventions by being aware of the occurrence and implications of these variants.

A multidetector computed tomography (MDCT) study assessed the frequency of the common anatomical variations of the paranasal sinuses. A deviated nasal septum was the most prevalent variation (58%), with large bulla ethmoidalis (46%) and agger nasi cells (45%) following closely behind. The research highlights how crucial it is to comprehend these differences in order to plan ahead for surgical treatments and prevent complications [4].

The purpose of a different investigation was to ascertain how frequently structural variations in the paranasal sinuses were detected on normal CT scans. 72.2% of patients had a deviated nasal septum, and 67.8% had agger nasi cells. According to the study's findings, being aware of these variances is essential to preventing surgical problems [5].

Analysing CT scans of the paranasal sinuses allowed researchers at a tertiary care facility in South India to assess anatomical variances. The most frequent results were pneumatised pterygoid base, concha bullosa, and deviated nasal septum. These differences were important for surgical planning, especially in instances of chronic rhinosinusitis [6].

Moreover, a study used multidetector computed tomography (MDCT) to assess anatomical differences in the nose and paranasal sinuses. The most prevalent variation, according to the study, was deviated nasal septum (62%), which was followed by concha bullosa (32%) and ethmoidal bulla (30%). The study emphasises how crucial CT imaging is for spotting these differences and averting surgical problems [7].

A study evaluated the clinical significance of structural differences in the paranasal sinus region using CT. The most frequent changes observed were middle concha bullosa and deviated nasal septum. The research emphasises how important these variations are in raising the possibility of intraoperative problems when performing sinus surgery [8].

The assessment of olfactory fossa depth in the South Indian population by CT scanning was the main focus of the investigation. The results showed that the most prevalent olfactory fossa depth classification was Keros Type II. In order to reduce surgical problems in this sensitive area, this information is crucial [9].

An analysis of the prevalence of anatomical variants in CT scans of the paranasal sinus was conducted. It was shown that superior concha pneumatization (13.3%) and nasal septal deviation (55.1%) were highly prevalent. The research emphasises how crucial it is to understand these differences in order to prevent difficulties after sinus surgery [10].

Similarly, a study looked at how often it was for patients with chronic rhinosinusitis to have structural differences in their paranasal sinuses. The most prevalent variant was deviated nasal septum (72%), which was followed by agger nasi cells (69%). The study emphasises how crucial it is to comprehend these variances in order to achieve favourable results from sinus surgery [11].

Concha hypertrophy is the most prevalent morphological variation among patients getting CT scans for chronic rhinosinusitis, according to a study done in Denpasar, Indonesia. The significance of preoperative CT scans for surgical planning and problem avoidance is emphasised in the study [12].

CONCLUSION

This study highlights the significant prevalence of anatomical variants in the paranasal sinuses and nasal cavity among the South Indian population. The findings demonstrate a strong association between certain variants, particularly when bilateral, and the severity of sinonasal disease. These insights are crucial for improving preoperative planning and surgical outcomes in patients undergoing sinonasal surgery. Identifying and understanding these anatomical variations can help surgeons anticipate potential complications and tailor surgical approaches to individual patient anatomy.

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