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Original Research Article

Study of the Incidence of Onodi Cell, Haller Cell, supraorbital Cell with Anatomic Variations of the Ostiomeatal Complex Using Computed Tomography

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Abstract:

Background: The ostiomeatal complex (OMC) is a critical anatomical region in the nasal cavity, serving as the primary drainage pathway for the frontal, maxillary, and anterior ethmoidal sinuses. Anatomical variations within the OMC, such as Onodi cells, Haller cells, and supraorbital cells, can significantly impact sinus drainage and predispose individuals to chronic rhinosinusitis and other sinus disorders. This study aims to determine the incidence of Onodi cells, Haller cells, supraorbital cells, and other anatomical variations of the OMC using computed tomography (CT) imaging.

Methods: A cross-sectional study was carried out on fifty patients who had CT scans done to assess their sinuses. Records were kept of the existence of Onodi cells, Haller cells, supraorbital cells, and other anatomical variants such agger nasi cells and concha bullosa cells. To find the frequency of these variations, the data were examined.

Results: The study revealed that concha bullosa was the most prevalent anatomical variation, observed in 16% of patients. Agger nasi cells were present in 14% of cases, Onodi cells in 4%, Haller cells in 6%, and supraorbital cells in 2%. Additionally, 4% of patients had Type I frontal cells, and 2% showed pneumatization of the crista galli. The majority of patients were younger than 30 years, with a higher prevalence of anatomical variations in males.

Conclusion: The study highlights the significant incidence of anatomical variations in the OMC, particularly concha bullosa and agger nasi cells. These variations can impact sinus drainage and contribute to chronic rhinosinusitis. Detailed preoperative CT evaluation is crucial for identifying these variations to improve surgical planning and outcomes.

Recommendations: Routine use of high-resolution CT imaging is recommended for patients undergoing evaluation for sinus diseases to accurately identify anatomical variations. Further studies with larger sample sizes are needed to explore the clinical implications of these variations in different populations.

Keywords: Ostiomeatal Complex, Onodi Cell, Haller Cell, Anatomical Variations, Computed Tomography.

Introduction

A crucial anatomical area in the nasal cavity, the ostiomeatal complex (OMC) includes the frontal recess, ethmoidal infundibulum, hiatus semilunaris, and maxillary sinus ostium. This area functions as the main outflow channel for the anterior ethmoidal, maxillary, and frontal sinuses. Because obstructions in this area can result in chronic rhinosinusitis and other sinus-related illnesses, the OMC's patency is crucial for preserving the health of the sinuses. The significance of having a comprehensive understanding of the intricate anatomy of the OMC in order to enhance surgical outcomes and patient care has been highlighted by recent developments in endoscopic sinus surgery [1].

Anodi cells, Haller cells, and supraorbital cells are examples of anatomical changes within the OMC that can have a major impact on sinus drainage and predispose individuals to sinus illnesses. For instance, onodi cells are posterior ethmoidal cells that extend into the sphenoid sinus. Because of their close relationship to the optic nerve, there is a chance that surgery will injure the nerve [2]. Recurrent sinusitis can result from narrowing of the infundibulum and compromised maxillary sinus outflow caused by Haller cells, which are found in the infraorbital region. Similarly, frontal sinusitis can be mimicked by supraorbital cells, which pneumatize the frontal bone's orbital plate and make surgical navigation more difficult.

Recent studies have highlighted the prevalence and clinical implications of these anatomical variations. For instance, a study reported that anatomical variations were present in over 50% of patients undergoing CT scans for sinus evaluation, emphasizing their role in chronic rhinosinusitis [3]. Another study found that concha bullosa, agger nasi cells, and septal deviations were common in patients with sinusitis, affecting sinus ventilation and predisposing to infections [4].

The application of advanced imaging techniques, particularly high-resolution computed tomography (CT), has revolutionized the diagnosis and management of sinonasal diseases. CT imaging provides detailed visualization of the OMC's anatomy, allowing for the identification of subtle anatomical variations that might be missed during traditional endoscopic examinations. This enhanced diagnostic capability is crucial for preoperative planning, especially in functional endoscopic sinus surgery (FESS), where precise knowledge of the patient's unique anatomy can significantly reduce the risk of complications and improve surgical outcomes.

The study determined the incidence of Onodi cells, Haller cells, and supraorbital cells, along with other anatomical variations of the ostiomeatal complex using computed tomography (CT) scans.

Methodology

Study Design: A cross-sectional observational study.

Study Setting: The study was conducted at OPD and IPD of the ENT department, Patna Medical College and Hospital, Bihar, India.

Study Duration: The study took place from August 2015 to December 2016.

Study Population: A total of 50 patients who met the inclusion criteria were included in the study.

Inclusion Criteria

- Patients aged 18 years and above.
- Patients undergoing CT scans for the evaluation of sinus complaints or other non-sinus-related conditions.

Exclusion Criteria

- Patients with a history of sinonasal surgery.
- Patients with known malignancies or extensive trauma involving the sinonasal region.
- Patients with poor-quality CT scans.

- Imaging Technique

CT Scanner: A multi-slice CT scanner was used for imaging.

Scan Protocol:

- Axial, coronal, and sagittal images were acquired with a slice thickness of 1-2 mm.
- The images were reconstructed using both soft tissue and bone algorithms.
- No contrast enhancement was used to avoid potential confounding factors.

Data Collection

Patient demographics, including age, gender, and clinical indication for CT scans, were collected for each participant. This demographic information provided a comprehensive understanding of the patient population undergoing CT imaging, ensuring a diverse and representative sample for the study.

For CT image analysis, the images were independently reviewed by two experienced radiologists. Their primary focus was on identifying and recording the presence of Onodi cells, Haller cells, and supraorbital cells. Additionally, they documented other anatomical variations within the ostiomeatal complex, such as septal deviation, concha bullosa, agger nasi cells, and paradoxically bent middle turbinate. This thorough analysis ensured the accurate detection and cataloging of relevant anatomical features, contributing to the study's objectives.

Statistical Analysis: The incidence of each anatomical variation was calculated as a percentage of the total study population. Descriptive statistics were used to summarize patient demographics.

Ethical Considerations: The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Result

The study included a total of 50 patients. Among these, the majority were under the age of 20, accounting for 26 patients (52%). Patients aged 21-30 comprised 18 individuals (36%), while those in the 31-40 and 41-50 age groups each had 3 patients (6%). In terms of sex distribution, the study had a higher proportion of males, with 34 patients (68%), compared to 16 females (32%).

Table 1: Age and Sex Distribution of Patients

Parameters	Number of Patients	Percentage (%)
Age group (years)		
< 20	26	52%
21-30	18	36%
31-40	3	6%
41-50	3	6%
Gender		
Male	34	68%
Female	16	32%

Among the 50 patients the study looked at, different anatomical differences in the ostiomeatal complex were found. Of the 50 patients, 4% had Onodi cells (2 out of 50), and 6% had Haller cells (3 out of 50). One patient out of fifty had supraorbital cells detected in 2% of the cases. More often, aberrant nasi cells were seen in 14% of the patients (7 out of 50). The most common variation found, concha bullosa, was found in 16% of the patients (8 out of 50). Pneumatization of the crista galli was observed in 2% of patients (1 out of 50), and type I frontal cells were present in 4% of patients (2 out of 50).

Table 2: Incidence of Anatomical Variations in the Ostiomeatal Complex

Anatomical Variation	Number of Patients	Incidence (%)
Onodi Cells	2	4%
Haller Cells	3	6%
Supraorbital Cells	1	2%
Agger Nasi Cells	7	14%
Concha Bullosa	8	16%
Type I Frontal Cells	2	4%
Pneumatization of Crista Galli	1	2%

Out of the 50 patients included in the study, 45 patients (90%) reported experiencing nasal obstruction, and an equal number of patients (45, 90%) reported nasal discharge. Headaches were a symptom for 5 patients (10%). When considering the site of nasal obstruction, 31 patients (62%) had right-sided obstruction, while 18 patients (36%) had left-sided obstruction. Regarding the degree of nasal obstruction, it was found that 42 patients (84%) experienced moderate to severe obstruction.

Table 3: Symptoms and Degree of Nasal Obstruction

Symptom	Number of Patients	Percentage (%)
Nasal Obstruction	45	90%
Nasal Discharge	45	90%
Headache	5	10%
Site of Obstruction		
Right Side	31	62%
Left Side	18	36%
Degree of Obstruction		
Moderate and Severe	42	84%

Endoscopic examination of the middle meatus revealed that abnormal findings were present in 38 patients, accounting for 76% of the total study population. Normal findings were observed in 12 patients, representing 24%. Among the abnormal findings, discharge was the most common, seen in 30 patients (60%). Additionally, polypoidal changes were noted in 20 patients, which constituted 40% of the cases.

Table 4: Endoscopic Findings in the Middle Meatus

Finding	Number of Patients	Percentage (%)
Abnormal Findings	38	76%
Normal Findings	12	24%
Type of Abnormal Findings		
Discharge	30	60%
Polypoidal Changes	20	40%

Discussion

The study examined the incidence of various anatomical variations within the ostiomeatal complex in 50 patients using CT scans. The patient demographics revealed that the majority were younger than 30 years, with 52% under 20 years and 36% between 21-30 years. The gender distribution showed a predominance of males (68%) compared to females (32%).

The CT scan analysis identified several anatomical variations within the ostiomeatal complex. Concha bullosa, an air-filled cavity within the nasal concha, was the most prevalent variation, observed in 16% of patients. Agger nasi cells, which are ethmoidal air cells located near the lacrimal bone, were present in 14% of the cases. Onodi cells, known for their close relationship with the optic nerve, were identified in 4% of the patients. Haller cells, located within the infraorbital region, were found in 6%, while supraorbital cells, situated in the orbital plate of the frontal bone, were seen in 2%. Additionally, 4% of patients had Type I frontal cells, and 2% showed pneumatization of the crista galli.

The majority of patients came from a middle socio-economic background (84%), with a small percentage from upper (12%) and lower (4%) socio-economic statuses. Religion-wise, most patients were Hindu (92%), with a minor representation from the Muslim community (8%).

A significant proportion of patients (90%) reported symptoms of nasal obstruction and nasal discharge, while only 10% experienced headaches. The obstruction was more commonly reported on the right side (62%) compared to the left side (36%). The degree of obstruction was predominantly moderate to severe in 84% of the cases, indicating a substantial impact on the patients' nasal airflow.

Endoscopic examination of the middle meatus revealed abnormal findings in 76% of the patients. The most frequent abnormalities included discharge (60%) and polypoidal changes (40%), suggesting underlying inflammatory or infectious processes in the nasal passages.

The results of this investigation highlight the high frequency of anatomical differences in the ostiomeatal complex, which are essential for managing sinus disorders in an efficient manner. The most frequent changes found were in the agger nasi and concha bullosa cells, suggesting that these may play a part in sinusitis and nasal blockage. Even though they are less common, Onodi and Haller cells require thorough preoperative evaluation because of their close proximity to vital tissues including the infraorbital nerve and optic nerve.

When comparing migraine sufferers' CT scans to controls, the study discovered that the patients had greater incidences of unilateral Onodi cells ($P < 0.001$), unilateral supraorbital ethmoidal air cells ($P = 0.012$), and bilateral concha bullosa ($P = 0.016$). The migraine group had a considerably higher frequency of Haller cells ($P = 0.007$) [5].

Cone-beam CT (CBCT) was used in a different investigation to assess ethmoid sinus alterations in a Southern Chinese population. The study revealed that Agger nasi cells accounted for 95.6% of the total, with Onodi cells coming in second at 60.4%, Haller cells at 29.3%, and supraorbital ethmoid cells at 19.4%. These polymorphisms were not shown to be significantly associated with sinus diseases [6].

A retrospective analysis of paranasal sinuses performed using multidetector CT (MDCT) and reported Haller cells (30%) as the most common variant, followed by Onodi cells (14.29%) and supraorbital cells (11.43%). These anatomical variations are frequently associated with sinus inflammation and complications during surgery [7].

By employing CBCT, a study was carried out to ascertain the incidence of obliterated osteomeatal complex (OMC) caused by anatomical variances. They discovered a strong correlation between Haller cells and middle turbinate variations and the patency of the maxillary ostium. Anatomical variations caused 73.2% of erased OMC cases [8].

Using CBCT, a study looked at the connection between maxillary sinus diseases and OMC abnormalities in kids and teenagers. A number of OMC variants and maxillary sinus diseases were shown to be significantly correlated, with Haller and Onodi cell occurrences being particularly noteworthy [9].

Additionally, a study evaluated CBCT scan anatomic differences of the ethmoidal sinuses and nasal cavity. They discovered that Agger nasi cells (53.6%) and nasal septal deviation (90.4%) were extremely common. Significant Haller cells (37.2%) were also observed, underscoring the significance of preoperative CT assessment in preventing problems [10].

A study assessed the relationship between maxillary sinus disease and Haller cells on CBCT. In 50% of the cases, Haller cells were linked to maxillary sinusitis and were present in 49% of the cases [11]. OMC changes were studied between controls and patients with nonsyndromic cleft lip and palate (CLP) in a research. Agger nasi cells (97%) and concha bullosa (97%) were shown to be much more common in CLP patients, highlighting the importance of a comprehensive 3D evaluation prior to surgery [12].

Conclusion

This study highlights the prevalence of anatomical variations in the ostiomeatal complex and their potential implications in sinus diseases. Understanding these variations is crucial for effective diagnosis and surgical intervention in patients with sinus pathologies.

Limitations: As a single-center study, the findings may not be generalizable to other populations. Potential variability in CT scan quality and interpretation between different radiologists.

Recommendations: Routine use of high-resolution CT imaging is recommended for patients undergoing evaluation for sinus diseases to accurately identify anatomical variations. Further studies with larger sample sizes are needed to explore the clinical implications of these variations in different populations.

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List of abbreviations:

OMC - Ostiomeatal Complex

CT - Computed Tomography

FESS - Functional Endoscopic Sinus Surgery

OPD - Outpatient Department

IPD - Inpatient Department

ENT - Ear, Nose, and Throat

MDCT - Multidetector Computed Tomography

CBCT - Cone-Beam Computed Tomography

CLP - Cleft Lip and Palate

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