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Original Research Paper

Anatomy

# ANATOMICAL VARIATIONS OF THE OSTEOMEATAL COMPLEX: A CROSS-SECTIONAL CT SCAN STUDY

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**ABSTRACT** **Background:** The osteomeatal complex (OMC) is responsible for drainage of the anterior group of paranasal sinuses. Anatomical variations of the osteomeatal complex, involve the uncinate process and ethmoid bulla, may predispose individuals to impaired sinus drainage and chronic rhinosinusitis. Preoperative identification of these variations is essential for safe and effective Functional Endoscopic Sinus Surgery (FESS). **Aims And Objectives:** To study the anatomical variations of the osteomeatal complex using computed tomography (CT) and to assess any age- or gender-related differences in these variations. **Materials And Methods:** A cross-sectional study was conducted on 120 patients clinically diagnosed with chronic sinusitis at Motilal Nehru Medical College, Prayagraj. CT scans of the nose and paranasal sinuses were analyzed using bone and soft-tissue windows. Variations of the uncinate process were assessed based on Landsberg and Friedman classification, and OMC abnormalities were evaluated using Earwaker classification. Data were analyzed using SPSS software. **Results:** Among the study population, 60% were males and 40% females, with a mean age of 40.28 ± 17.99 years. Type II superior attachment of the uncinate process was the most common (35%). According to Earwaker classification, Type 5 OMC variation (horizontal uncinate process with normal ethmoid bulla) was the most prevalent (54%). Horizontal orientation of the uncinate process was observed in 45% of cases and was frequently associated with OMC narrowing. **Conclusion:** Anatomical variations of the osteomeatal complex are common and play a significant role in the pathogenesis of chronic sinusitis. CT imaging is indispensable for detecting these variations and guiding surgical planning in FESS.

**KEYWORDS :** chronic sinusitis, uncinate process

## INTRODUCTION

Before fine surgical procedures anatomical variations of utmost importance are to be considered, one such structure is osteomeatal complex which is a collection of structures that act as a drainage pathway of all the anterior sinuses. It is a three-dimensional space in the bones of the face above and to either side of the nose and in the forehead and cheeks[1].

Variation of osteomeatal complex can block it resulting in impaired drainage of paranasal air sinuses which is one of the commonest causes of chronic sinusitis [2]. Paranasal sinuses are important as it reduces the relative weight of the front of skull, it regulates the intranasal and serum gas pressure, it maintains resonance of voice, provide resistance against trauma, therefore protecting sensitive structures like dental roots and eyes from rapid temperature fluctuations in nasal cavity.

Contributing structures of osteomeatal complex are middle turbinate, middle meatus, maxillary sinus, infundibulum, uncinate process and hiatus semilunaris. Amongst which uncinate process is a key component of the ostiomeatal unit.

### Uncinate Process:

The Uncinate Process being not a simple structure; plays an important role in ventilatory mechanisms within the nasal cavity. Uncinate Process is a thin, semi-circular bony process of variable length and covered with the mucosa[5]. Uncinate process projecting postero-inferiorly from the ethmoidal labyrinth. The concave postero-superior free margin of uncinate process lies parallel to the anterior surface of the bulla ethmoidalis and the convex anterior margin of uncinate process is on contact with the lateral nasal wall. Inferiorly, it ends by the joining of the ethmoidal process of the inferior nasal conchae. The upper most segment of the uncinate process is a blind spot for the surgeons. Pneumatization of the uncinate process is a rare entity, which can result in narrowing of infundibulum and sinus drainage occlusion.[6,7]

**Landsberg And Friedman** classified superior attachment of uncinate process into six types[8].

**Type 1**: Insertion into the lamina papyracea (LP).
**Type 2**: Insertion into posterior wall of Agger Nasi Cell (ANC).
**Type 3**: Insertion into lamina payracea and junction of the middle turbinate with the cribriform plate (MTCP).
**Type 4**: Insertion in to junction of middle turbinate with the cribriform plate.
**Type 5**: Insertion into ethmoid skull base (ESB).
**Type 6**: Insertion into the middle turbinate (MT).
**Type 7**: Blunt type.

Narrowness in OMC, due orientation of the uncinate process, can increase the likelihood of a full blockage and obstruction during inflammation.

Abnormalities in OMC are classified into six types by Earwaker as follows:
type 1: vertical UP orientation and enlarged or prolapsed ethmoid bulla,
type 2: vertical UP orientation and normal ethmoid bulla,
type 3: vertical UP orientation and absent or hypoplastic ethmoid bulla,
type 4: horizontal UP orientation and enlarged or prolapsed ethmoid bulla,
type 5: horizantal UP orientation and normal ethmoid bulla,
type 6: horizantal UP orientation and absent or hypoplastic ethmoid bulla.[8]

Messerklinger and Wigand introduced Functional

Endoscopic Sinus Surgery (FESS) which was popularized by Stammberger in Europe and by Kennedy in North America, which is significant in clearing drainage [3]. Computed tomography (CT) scan plays a fundamental role in the diagnosis and pre operative assessment in order to evaluate the variation and hence act as a better guidance in the decision making about clinical, therapeutic and surgical approaches [4].

## AIMS AND OBJECTIVE

- To study the anatomical variation of osteomeatal complex by CT scan.
- To provide data and study any gender-related or age-related difference in anatomical variation in osteomeatal complex.

## MATERIAL AND METHOD

This is a cross-sectional study done in the department of Anatomy in collaboration with department of Radiology and Otorhinolaryngology of Motilal Nehru Medical College, Prayagraj.

After consent regarding the study, patients further underwent CT scan for nose and paranasal sinuses.

Patients gender and age were taken into consideration.

CT scans were performed using SIEMENS single slice spiral CT machine. Plane 1-2 mm axial scans were made and exposure settings were kept on 140 Kvp and 75 mA. Scans were evaluated on DIACOM software and data analysis was done using SPSS software.

Using the above particulars anatomical variations were analyzed. The images were viewed using bone and soft tissue windows and variation of osteomeatal complex in relation to uncinate process and ethmoid bullae appearance was analyzed.

### Inclusion Criteria

Subjects more than 16 years, residents of urban and rural Prayagraj or north Indian ancestory, with history of nasal obstruction, headache and who are subjected to radiological investigations after a clinical examination and diagnosis as chronic sinusitis were included in the study.

### Exclusion Criteria

History of previous sinus surgery, facial trauma, sinonasal tumors, less than 16 years, maxillofacial trauma or fracture were excluded from the study.

## RESULT

A total of 120 patients was referred for CT scan in radiology department with complaints pertaining to paranasal sinus. Out of 120 study subjects, 72 are males (60%) and 48 are females (40%). The age of all subjects was ranging between 18-86 years with "mean ± SD" 40.28 ± 17.99 years and median 38 years. The age of the males and females were ranging between 19-82 years and 18-86 years respectively with means ±SD being 41.34 ± 18.12 yrs and 38.68 ± 17.87 years respectively. We statistically divided the data into two groups on the basis of gender and age and data is evaluated by the correlations between the groups respectively.

### Uncinate Process Attachment And Orientation

Superior Attachment of the Uncinate Process according to Landsberg and Friedman Classification;

Type II (attachment to the posterior wall of the Agger Nasi Cell) was the most common, found in 42 cases (35%) where 28 cases (38.8%) are of males and 14 cases (29.2%) are of females.

Ostiomeatal Complex (OMC) Earwaker Classification, Based on Uncinate Process Orientation & Ethmoid Bulla Appearance; Type 5 was the most prevalent (54%), indicating that horizontal orientation of the UP with a normal ethmoid bulla is the dominant pattern in this population, followed by, Type 4 with 10% prevalence with Horizontal UP with enlarged/prolapsed bulla followed by type 2 with 5.8% prevalence showing Vertical UP with normal bulla. The least common was type 6 Horizontal UP with absent/hypoplastic bulla.

A significant proportion (45%) of patients had horizontal orientation of the uncinate process, commonly associated with OMC abnormalities.

The presence of OMC variations-especially involving the UP-may lead to narrowing or blockage of sinus drainage pathways, increasing the risk for chronic rhinosinusitis.

These OMC variations, especially Type 5, are surgically important for ENT surgeons performing Functional Endoscopic Sinus Surgery (FESS).

CT imaging is crucial for identifying these variations preoperatively, minimizing surgical risks, and enhancing outcomes.

## DISCUSSION

The osteomeatal complex (OMC) serves as a critical anatomical region for drainage of the anterior group of paranasal sinuses, and its variation has a direct correlation with the development of chronic rhinosinusitis. The anatomical complexity and narrowness of this region often predispose it to blockage and inflammation, especially when anatomical variations are present.

In this study, a high incidence of anatomical variation in the uncinate process and ethmoid bulla was observed. The most common orientation of the uncinate process was vertical, found in 35% of cases. Previous studies have also shown a predominance of vertical uncinate processes, supporting the notion that even this common orientation can be associated with sinus pathology depending on associated variations in adjacent structures such as the ethmoid bulla or agger nasi cells[5].

Landsberg and Friedman proposed a classification of uncinate process attachment into six types, which have since served as a reference standard in radiological and surgical evaluation of the OMC. These variations influence the size and patency of the infundibulum and may result in compromised mucociliary drainage when associated with hypertrophied or pneumatized ethmoid bulla[8]. In our study, the horizontal orientation of the uncinate process was found in 45% of cases with OMC abnormality, highlighting a potential role in obstructive sinus pathology.

Earwaker classified OMC abnormalities into six types based on the orientation of the uncinate process and the size of the ethmoid bulla, which was found to be a useful radiological guide in our evaluation[8]. CT imaging played a crucial role in this assessment, which aligns with previous findings that stress its value in preoperative planning, particularly in Functional Endoscopic Sinus Surgery (FESS)[4]. The introduction of FESS by Messerklinger and Wigand, and its subsequent popularization by Stammberger and Kennedy, has made detailed anatomical knowledge of the OMC indispensable[3].

The uncinate process, although often overlooked, plays a significant role in sinus ventilation and drainage. Its pneumatization, while rare, may occlude the infundibulum, leading to stagnation and infection[6,7]. Surgeons must be

especially cautious of the superior blind end of the uncinate process, a known "blind spot" that, if not visualized properly, can result in incomplete surgical clearance and persistence of disease.

The current study also aimed to identify any gender- or age-related anatomical differences. Though the incidence of vertical uncinate orientation was slightly higher in males (38.8%) compared to females (29.2%), this difference was not statistically significant. Nevertheless, such demographic trends are important for understanding population-specific anatomical variations, especially in north Indian populations. Overall, the findings reinforce the need for detailed radiological assessment of the osteomeatal complex prior to sinus surgery and suggest that individualized surgical planning based on anatomical variation can potentially improve clinical outcomes.

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