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**Original Research Article**

# "STUDY OF VARIOUS OSTIOMEATAL COMPLEX ABNORMALITIES BY ENDOSCOPY AND CT SCAN AND ITS MANAGEMENT"

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**ABSTRACT:**

**Background:** The two cardinal factors in the maintenance of normal physiology of the paranasal sinuses and their mucous membranes are drainage and ventilation. Normal drainage of the paranasal sinuses depends on effective mucociliary clearance; this is dependant, among other things, on the condition of the sinus ostia.[1]

**OBJECTIVES:** To study the various sinonasal anatomical variations in the study population.

**MATERIAL & METHODS: Study Design:** Prospective Hospital based observational study. **Study area:** Department of E.N.T, Narayana Medical College and Hospital, Nellore, Andhra Pradesh. **Study Period:** August 2016 to July 2017. **Study population**: All the patients attending the E.N.T. outpatient department, who had chronic sinusitis for more three months duration not responding to the medical line of treatment and who were willing to undergo Functional Endoscopic Sinus Surgery. **Sample size:** study consisted a total of 50 cases. **Sampling method:** Simple random method.

**Results:** The uncinate was typical in 29 (58%), medialized in 22 (44%), anteriorly turned in 1 (2%), hypertrophied in 6 (12%) and pneumatized in 2 (4%). The superior attachment of the uncinate process was as follows: middle turbinate in 21 (42%), lamina papyracea in 18 (36%) and skull base in 11 (22 %). Ethmoidal bulla: The bulla was typical in31 (62 %), large in 11 (22%) and hypoplastic in 8 (16 %).

**CONCLUSION:** In view of the presence of these significant variations, we reemphasize the need for proper preoperative assessment in every patient in order to accomplish a safe and effective endoscopic sinus surgery.

**Keywords:** ostiomeatal complex, middle turbinate, lamina papyracea

## INTRODUCTION:

"If the ethmoids were placed in any other part of the body, it would be an insignificant and harmless collection of bone cells. In the place where nature has put it, it has major relationships so that diseases and surgery of the labyrinth often leads to tragedy. Any surgery in this region should be simple but it has proven one of the easiest ways to kill the patient" - Mosher in 1929.

The two cardinal factors in the maintenance of normal physiology of the paranasal sinuses and their mucous membranes are drainage and ventilation. Normal drainage of the paranasal sinuses depends on effective mucociliary clearance; this is dependant, among other things, on the condition of the sinus ostia.[1]

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Mucus transport from the sinuses into the nose is greatly enhanced by unimpeded nasal airflow creating negative pressure within the nasal cavity during inspiration.[1] The secretions of the various sinuses do not reach their respective ostia randomly but by definite pathways which seem genetically determined.[2] The two of the largest sinuses, the frontal and maxillary, communicate with the middle meatus via narrow and delicate prechambers. In each of these prechambers, the mucosal surfaces are closely opposed such that mucus can be more readily cleared by an effective ciliary action on two or more sides. However, when surfaces become more closely apposed due to mucosal swelling, the ciliary action is immobilized. This impairs the ventilation and drainage of larger sinuses, result in mucus stasis, predispose to further infection and establish a vicious cycle causing chronic sinusitis.2 The key region for these changes is that part of the lateral nasal wall that encloses the sinus ostia and their adjacent mucosa and prechambers. There is considerable anatomical variation in this area that may interfere with normal nasal function and predispose to recurrent or chronic sinusitis.[3]

Functional endoscopic sinus surgery restores normalcy by working on the key regions rather than on the larger sinuses. The safe and effective performance of any surgery is dependent on a sound knowledge of anatomy. This is most true during endoscopic sinus surgery because of the intimate association with such vital structures as the orbit, optic nerve, anterior and posterior ethmoidal vessels, skull base and internal carotid artery.

The difficulty is compounded by the occurrence of variations in sinonasal anatomy. The incidence with which these variations are seen in a normal population is less frequent than in those individuals with chronic sinusitis. The incidence of the sinonasal anatomical variation reported in literature shows considerable variation between populations. This study aims to study the various sinonasal anatomical variations in our population.

**OBJECTIVES:** To study the various sinonasal anatomical variations in the study population.

**MATERIAL & METHODS:**

**Study Design:** Prospective Hospital based observational study.

**Study area:** Department of E.N.T, Narayana Medical College and Hospital, Nellore, Andhra Pradesh.

**Study Period:** August 2016 to July 2017.

**Study population**: All the patients attending the E.N.T. outpatient department, who had chronic sinusitis for more three months duration not responding to the medical line of treatment and who were willing to undergo Functional Endoscopic Sinus Surgery.

**Sample size:** study consisted a total of 50 cases.

**Sampling method:** Simple random method.

**Inclusion criteria:** All the patients with clinically proven chronic sinusitis not responding to routine medical line of treatment.

**Exclusion criteria:**

- Patients with acute attack of sinusitis.
- Patient with sinus malignancies.
- Patient who were not willing to undergo FESS.

**Ethics committe consideration:** Institutional Ethics committee permission was taken prior to the commencement of the study.

**Study tools and Data collection procedure:**

1) The cases selected for the study were subjected to detailed history taking and examination.

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2) A routine haemogram (HB, BT, CT, TC, DC) and urine examination (albumin, sugar, microscopy), swab from middle meatus for culture sensitivity along with X-ray para nasal sinuses were done for the patients.

3) All the patients in active stage of the disease were treated with course of suitable antibiotic, systemic antihistamines and local decongestants. They were also treated for medical conditions like diabetes mellitus, hypertension, nasal allergy. No patient received steroid therapy or immunotherapy.

4) Each patient underwent a systematic diagnostic nasal endoscopy and computed tomography of nose and para nasal sinuses.

**Equipments Used:**

 Nasal endoscope: Karl Storz Hopkins rod optical with cold light source and fibre optic light delivery system. Endoscopes used were with 0, 30,45 and 70 degree angles of view of 4mm diameters.

 Karl Storz Endovision Telecam deluxe camera sytem with monitor.

 Topical decongestant and anesthetic agent (4% Xylocaine with 1:100.000 adrenaline).

 Antifog solutions (Savlon).

 Suction apparatus, Cannula, Ball probe and Freer's elevator.

Position: Supine with head slightly elevated and turned towards the examiner, who is standing at the right side of the patient.

Anaesthesia:

Topical decongestant 4% Xylocaine with 1: 100.000 adrenaline solution using applicators like cottonoid strips.

Procedures: Endoscopy was performed by three passes.

I. Pass:

Along the floor of nasal cavity towards nasopharynx to visualize the status of inferior turbinate and meatus, Eaustachian tube orifice, nasopharyngeal mucosa, naslacrimal duct orifice and any pathological variations.

II. Pass:

Scope was inserted along the superior surface of inferior turbinate. As the endoscope was withdrawn the sphenoid ostium, spheno-ethmoidal recess, fontanellae, middle meatus, natural ostium of maxillary sinus and any pathological or anatomical variations were noted .

III. Pass:

Is to visualize the frontal recess. A gentle medial subluxation of middle turbinate or use of a cannula placed under middle turbinate helps the introduction of the scope in middle meatus.

Fifty patients from the outpatient department of ENT, MAHATHMA GANDHI MEMORIAL HOSPITAL, WARANGAL between july 2010-June.2012 in this study. These patients after detailed evaluation and routine investigations were submitted for CT scan paranasal sinuses prior to functional endoscopic sinus surgery.

As per the protocol, chronic sinusitis was defined as nasal blockade, anterior nasal discharge, post nasal drip, headache or facial pain, abnormalities of smell. These patients were refractory to medical treatment for more than 3 months duration. All CT Scans were obtained with Siemens Somatom AR star, spiral scanner (Forchheim, Germany). After obtaining the scout projection, the area of scanning was defined to include the region from roof of frontal sinus upto the hard palate. Axial sections were performed with the patient in

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supine position and the plane of data acquisition parallel to hard palate. The sections were taken with slice thickness of 5 mm and table feed of 7 mm i.e. pitch of 1.4. Images were reconstructed at 4 mm intervals i.e. image overlap of 1 mm.

Scanning parameters included 105 mA, 130 kV and tube rotation time of 1.5 seconds. Coronal sections were performed with the patients in prone position with extended neck and the plane perpendicular to axial plane.The scan parameters were same as in axial plane. Extended cephalic / caudal sections were done in a few patients to see extension of the disease process.

**OBSERVATIONS & RESULTS:**

Age distribution: The age of the patients varied from 11 years to 60 years. The majority of the patients i.e. 16 (22.5%) were in the third decade of life.

**Table1 Age distribution**

| Age group | No. cases |
|---|---|
| 11-20 | 8 |
| 21-30 | 12 |
| 31-40 | 16 |
| 41-50 | 9 |
| 51-60 | 5 |

**Table 2: Sex distribution**

| Sex | No.of patients | Percentage |
|---|---|---|
| Male | 28 | 56 |
| Female | 22 | 44 |

The sex distribution showed a slight male preponderance with 28 (56%) males and 22 (44%) females by endoscopic study. Thus male to female ratio 1.27:1.

Variations:

Skull base types: The following was the incidence of various skull base types-

1) Keros Type I: 6 (12%)
2) Keros Type II: 32 (64%)
3) Keros Type III: 12 (24%)

Table 3 Skull base types

Keros type Number Percentage

Septum: Septal deviations were seen in 27 (54%). Of these 10 (37.03%) were to right and 17 (62.9%) were to the left.

Septal spurs were seen in 16 (32). Of these 7 were to right and 9 were to the left. Thick septum was found in 5 (10%). Pneumatization of the septum was found in 2(4%).

**Table 3**: Septal variations

| Variation | Number | Prevalence |
|---|---|---|
| Deviation | 27 | 54% |
| Spur | 16 | 32% |
| Thick | 5 | 10% |
| Pneumatized | 2 | 4% |

Agger nasi:

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Pneumatization of agger nasi was seen in 58 (72.5%) nasal cavities. When present, the agger cells were always bilateral.

Frontal sinus: The frontal sinus was present in 95 (93.5%) sides, absent in 5 (6.25%) sides, and Hyperpneumatized in 14 (27.5%). The sinus was larger on the right in 24 subjects and on the left in 26 subjects. Interfrontal cells were seen in 8 (16%).

Frontal recess:

The frontal recess was found to be obstructed in 14 of 75 (18%). Of these 8 (57%) were on the right and 6 (43%) were on the left. The obstruction was caused by agger nasi cells in 6 (43%), ethmoidal bulla or accessory cells in 4 (28.5%) and polyps in 4 (28.5%).

Middle turbinate:

The middle turbinate was typical in 25 (50%). Of these 14 (28%) were on the right and 11 (22%) were on the left.

It was paradoxically curved in 6 (12%). Of these 4 (8%) were on the right and 2 (4%) were on the left.

Hyperplastic non-pneumatized middle turbinate was seen in 2 (4%). Of these 0(0%) were on the right and 2 (4%) was on the left.

Pneumatized middle turbinate was seen in 17 (34%). Of these 7 (14%) were on the right and 10 (20%) were on the left.

**Table 4**: **Middle turbinate variations**

| Variation | Number | Percentage |
|---|---|---|
| Typical | 25 | 50 |
| Paradoxically curved | 6 | 12 |
| Pneumatized | 17 | 34 |
| Large non pneumatized | 2 | 4 |

Pneumatized turbinates, 22 (44%) showed lamellar pattern, 2 (4 %) showed bulbous pattern and 26 (52%) were true concha bullosae.

Uncinate process:

The uncinate was typical in 29 (58%), medialized in 22 (44%), anteriorly turned in 1 (2%), hypertrophied in 6 (12%) and pneumatized in 2 (4%).

The superior attachment of the uncinate process was as follows: middle turbinate in 21 (42%), lamina papyracea in 18 (36%) and skull base in 11 (22 %).

Ethmoidal bulla: The bulla was typical in31 (62 %), large in 11 (22%) and hypoplastic in 8 (16 %).

Supra-orbital cells:

Supra-orbital ethmoid pneumatization was seen in 18 (36%). Of these 10 (20%) were on the right and 8 (16%) were on the left. In 8 (16%) patients, it was bilateral.

Accessory ostia:

Accessory maxillary sinus ostia were seen in 12 (24%). Of these, 8 (16%) nasal cavities showed accessory ostia in anterior fontanelle and 4 (8%) in the posterior fontanelle. In 2 (4%) of patients, there were multiple accessory ostia.

Maxillary sinus septations:

Septations were found in 4 (5%) maxillary sinuses. Of these 1 (25%) was on the right and 3 (75%) were on the left. In 1 (2.5%), it was bilateral.

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Haller cell:
Haller cell was seen in 3 (6%).
Pneumatized superior turbinate:
Superior turbinate pneumatization was seen in 5 (6.25%). Of these 3 (60%) were on the right and 2 (40%) were on the left. In 1 (2.5%) patient, it was bilateral.
Supreme turbinate:
The presence of supreme turbinate could not be discerned in any of the subject examined.
Sphenoid sinus: The ostium was circular in 15 (30 %), oval in 23 (46%) and slit in 12 (24 %).
The various patterns of pneumatization seen were: absent in 1 (2 %), conchal in 1 (2 %), presellar in 12 (24%) and sellar in 36 (72 %).
The various intrasphenoidal projections seen were:
1) Optic nerve in 19 (38%).
2) Maxillary nerve in 14 (28 %).
3) Vidian nerve in 17(34%).
4) Unable to see internal carotid artery projections due to most of the ct pns taken by coronal cuts in our centre
Onodi cell:
Onodi cells were seen in 18 (36%). Of these 10 (20%) were on the right and 8 (16%) were on the left. In 7 (14%) of patients, it was bilateral.
Large inferior turbinate:
A large inferior turbinate was found in 29 (58%). Of these 14 (28 %) were on the right and 15 (30%) were on the left. In 8 (16%) of patients, it was bilateral. In 22 (44%), the large inferior turbinate was associated with pathology in ipsilateral maxillary sinus and in 7 (14 %) there was no ipsilateral maxillary sinus pathology.

**CORRELATION OF DIAGNOSTIC ENDOSCOPY FINDINGS WITH COMPUTED TOMOGRAPHY FINDINGS:**

The parameters correlated in our study include middle turbinate, middle meatus, bulla ethmoidalis, hiatus semilunaris, forntal recess and shenoethmoid recess. The false positive, false negative, sensitivity and specificity were calculated for diagnostic endoscopy as compared to CT findings.
Diagnostic endoscopy was found to have sensitivities for frontal recess, hiatus semilunaris and shenoethmoidal recess as 90%, 94% and 100% respectively. While sensitivity for middle turbinate, bulla ethmoidalis and middle meatus was 74%, 62% and 85% respectively.
The sensitivity of diagnoistic endoscopy for frontal recess, middle turbinate and bulla ethmoidalis was found as 91%, 84% and 76% respectively and for shenoethmoidal recess, hiatus semilunaris and middle turbinate as 80%, 53% and 67% respectively.
So diagnostic endoscopy was found to be more sensitive for frontal recess, shenoethmoidal recess and hiatus semilunaris and more specific for middle turbinate, bulla ethmoidalis.

| **Sl.No** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|
| **Parameter** | **Middle turbinate** | **Middle meatus** | **Bulla ethmoidalis** | **Hiatus semilunaris** | **Frontal recess** | **Sphenoethmid recess** |
| Normal DE(N) +CT ( N ) | 38 | 27 | 32 | 25 | 51 | 32 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| Abnormal DE(A) +CT(A ) | 35 | 46 | 13 | 30 | 27 | 3 |
| False positive DE(A) +CT( N) | 12 | 8 | 8 | 2 | 3 | 0 |
| False negative DE(N) +CT(A ) | 7 | 13 | 10 | 22 | 5 | 8 |
| Sensitvity | 74.47 | 85.19 | 61.9 | 93.75 | 90 | 100 |
| Specificity | 84.44 | 67.50 | 76.19 | 53.19 | 91.07 | 80 |
| Predictive +ve | 83.33 | 77.97 | 56.52 | 57.69 | 84.38 | 27.27 |
| Predictive –ve | 76.00 | 77.14 | 80 | 92.59 | 94.44 | 100 |

**DISCUSSION:**

Age and sex distribution:

The age of the patients varied from 11 years to 60 years. The sex distribution showed a slight male preponderance with 56% males and 44% females.

Septal variations:

We found septal deviations in 54% of cases. In our study, there was slight preponderance of deviation to the left (61.6%) compared to deviation to the right (38.4%). The reported incidence of septal deviations in literature ranges from 40% (Calhoun et al[4]) to 96.9% (Takanishi et al[5]). The prevalence of septal spurs in our study was 32%. Among these, over half (57.8%) had contact area with the turbinates. The prevalence of deviations of nasal septum as reported by various workers is 21% (Zinreich[6]), 24% (Jones NS[7]), 38% (Yadav SPS[8]), 40% (Bolger[9]) . Our results are comparable to the higher ranges reported. The prevalence of septal ridges or spurs is reported as 33% (Danese M et al[10]) and 25.3% (Jareoncharsri P et al[11]).

The mere presence of a septal deviation does not suggest pathology. However, a marked deviation can force the middle turbinate laterally, thus narrowing the entrance to the middle meatus. Also, ridges and spurs coming into contact with turbinates or other areas of the lateral wall can predispose to recurrent sinusitis. We found septal pneumatization in 4%.

Agger nasi cells: We found pneumatization of the agger nasi cells in 72.5%. In all patients, the pneumatization when present was bilateral. The prevalence of agger nasi cells varies

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widely as reported by various workers: 10-15% (Messerklinger[12]); 14% (Lloyd et al[13]); 65% (Davis[14]); and 100% (Kennedy and Zinreich[15]). Depending on the degree of pneumatization, agger nasi cells may reach laterally to the lacrimal fossa and superiorly to cause narrowing of frontal recess.

On coronal CT, these cells appear inferior to frontal recess and lateral to the middle turbinate. Because of this intimate relationship these cells form excellent surgical landmarks. Opening the agger nasi cells usually provides a good view of the frontal recess. Therefore, identification of this variation is important in diagnosis and treatment of recurrent or chronic frontal sinusitis.

Frontal sinus:

We found the prevalence of nonpneumatization of frontal sinus in 6.25%. This correlates with the study by Natsis K[16] who reported a prevalence of 5%. In all our patients, frontal sinuses on either side were always asymmetrical with right being large in 47.5% and the left sinus being large in 52.5%.

Frontal recess:

As the axis of the frontal recess is tilted approximately 50 degrees to the canthomeatal line, this drainage pathway cannot be included entirely within a single coronal section. Therefore, coronal oblique views are required for complete information.

In our study, we found that the frontal recess was obstructed in 18%. Of these, in 43% the obstruction was by agger nasi cells, in 28.5% by ethmoid bulla or accessory cells and in 28.5% by polyps. As the natural ostium of the frontal sinus is very wide with average anteroposterior diameter of 7.22 mm and transverse diameter of 8.92 mm, the obstruction to the frontal sinus drainage and ventilation most often lies in the frontal recess rather than the ostium as is evident from our results. Therefore merely clearing the recess is sufficient to achieve patency of frontal sinus ostium in most cases.25

Middle turbinate:

Typically, the middle turbinate is said to have convex medial and concave lateral surfaces with smooth uniform curvature with no obstruction to middle meatus and adequate space between the turbinate and septum. However, the middle turbinate in known for several variations.

Pneumatized middle turbinate: We found pneumatized middle turbinate in 50%. Of these, 44% showed lamellar pattern, 4 % showed bulbous pattern and 52% showed true concha bullosae. The origin of the pneumatization can sometimes be seen as depressions on the lateral surface. Literature reports a wide variation in the incidence of middle turbinate pneumatization and is a follows: Joe JK28 et al -15%; Liu X27 et al – 34.85%, Basic N30 et al -42%, Lothrop61 -9%, Davis58 -8%, Shaeffer62 -11%.

Our results are close to that reported by Lie X et al. Presence of a concha bullosa does not suggest a pathological finding. However, in the setting of chronic sinus disease, resection of the concha bullosa should be considered to improve paranasal sinus access. Further, the concha bullosa interior may be affected by disease in other sinuses.

Paradoxically bent middle turbinate:

A middle turbinate which is distorted such that the convex surface faces towards the meatus is in itself not pathologic but can contribute to severe narrowing of the middle meatus if other

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mucosal derangements are present. We found paradoxical curvature of middle turbinate in 12%. This correlates well with that reported by Calhoun[4] (7.9%) and Lusk63 (8.5%).

Skull base configuration: The roof of the ethmoid bone is formed by the fovea ethmoidalis laterally and the cribriform plate medially. The lateral lamella of the cribriform plate is thin and may be of substantial height making it vulnerable to injury. The anatomy of the anterior ethmoid is critical for two reasons. First, this area is most vulnerable to iatrogenic cerebrospinal fluid leaks. Second, the anterior ethmoid artery is vulnerable to injury which can cause devastating bleeding into the orbit. In our study, we found Keros type I (1 to 3 mm deep) olfactory fossa in 12 %, type II (4 to 7 mm) in 64% and type III (8 to 16 mm) in 24%. Though several authors draw attention to the importance of deep skull base conformation, we did not find any studies reporting the incidence of various types of conformations. Arslan et al[17] reported that average depth was 8 mm on right side and 9.5 mm on the left side.

**CONCLUSION:**

The medialised uncinate process (double middle turbinate) was most common uncinate process variation and pneumatized middle turbinate was the most common middle turbinate variation. Extramural pneumatization like septal, supraorbital, sphenoid wing and pterygoid plates was quite common. Inferior turbinate enlargement in association with ipsilateral maxillary sinusitis was common. The depth of olfactory fossa was of Keros Type II in majority of patients. In view of the presence of these significant variations, we reemphasize the need for proper preoperative assessment in every patient in order to accomplish a safe and effective endoscopic sinus surgery.

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