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Role of multislice CT in evaluation of anatomical variations of osteomeatal complex in chronic sinusitis

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Abstract
Objective: To study the frequency and types of anatomical variants of osteomeatal complex on Computed Tomography scan in clinically diagnosed chronic sinusitis patients.
Materials and Methods: A prospective study was done on 100 patients with chronic sinusitis over a period of 18 months.
Results: In our study anatomical variations in osteomeatal complex were seen in 77% of chronic sinusitis cases. Out of which 62.3% of the cases had 2 or more anatomical variations whereas 37.7% of the cases had single anatomical variation. Deviated nasal septum (85.7%) was found to be the most common anatomical variation followed by concha bullosa (45.4%). Least common anatomical variation seen was haller cell (2.6%).
Conclusion: The presence of anatomical variations in osteomeatal complex is high in chronic sinusitis patients which is best appreciated on CT scan, which has become a widely accepted tool for assessing these variations in a much simpler way and acts as a roadmap for endoscopic sinus surgery.

Keywords: chronic sinusitis*;* computed tomography; osteomeatal complex; anatomical variations

1. Introduction
Osteomeatal complex is often referred to the area encompassed by the ostium of maxillary sinus, the ostia of anterior ethmoidal air cells, the frontonasal duct, the ethmoidal infundibulum, and the middle meatus [1].
Anatomical variation in the osteomeatal complex may leads to impaired drainage of maxillary, frontal and anterior ethmoidal sinuses. If multiple variations occur in combinations they may considerably constrict the narrow clefts of osteomeatal unit, bringing facing mucosal surfaces into contact. These variations predispose to more rapid and frequent appearance and persistence of acute and chronic inflammations [2, 3].
The knowledge of anatomical variations is also important before Functional Endoscopic Sinus Surgery is planned to avoid damage to surrounding vital structures like orbit and the brain [4].
However, conventional radiology is inaccurate and do not provide detailed study of paranasal sinuses and is thus replaced by CT scan. Hounsfield and Ambrose devised computerized tomography in 1960's. Since then coronal plane CT scanning has dramatically improved the imaging of paranasal sinus anatomy as compared to sinus radiographs [5].
CT scan has the ability to delineate mucosal diseases, to determine the distribution and extent of diseases, to image those distal structures like posterior ethmoid and sphenoid sinuses which cannot be visualized by endoscopy. It also detects those anatomic variations that may place the patients at increased risk for intraoperative and postoperative Functional Endoscopic Sinus Surgery (FESS) complications [6].
CT scan also excels over MRI scan at evaluating fine bone details, assessment of fibro-osseous lesion of PNS and Sino facial trauma.

2. Materials and methods
A prospective study was conducted on 100 cases at the department of Radiodiagnosis, Navodaya Medical College & Hospital, Raichur from November 2014 to May 2016, after clearance from institutional ethics committee. All the patients were referred from the Department of Otorhinolaryngology, Navodaya Medical College who had chronic sinusitis for more than 3 months.

2.1 Methods
Both axial and coronal CT scan of patients were taken and the details of the anatomical variations were recorded.

2.2. Patient position
- Supine for axial sections
- Supine/ prone with neck extended for coronal section

2.3. Angulation
- Parallel to hard palate for axial sections
- Perpendicular to hard palate for coronal section

2.4. Thickness
- 5mm for both coronal & axial sections.
- 3mm were taken at osteomeatal unit on coronal section.

2.5. Extent
- Coronal – posterior margin of sphenoid sinus to anterior margin of frontal sinus.
- Axial – hard palate to upper margin of frontal sinus.

2.6. Inclusion Criteria
1. Above 12 years of age.
2. Clinical diagnosis of Chronic Sinusitis

2.7. Exclusion Criteria

1. Patients with congenital deformities.
2. Previous sinonasal surgery.
3. Facial trauma.
4. Paranasal sinus neoplasm.

3. Results

In the present study of 100 patients, anatomical variations were observed in 77% of the chronic sinusitis patients with a predominance of female (57%) patients over male (43%) patients with a ratio of 1.3:1. Age distribution varied from 12-65 years with a peak incidence (37%) in 21-30 years of age group. Out of 100 cases, 62.3% of the cases had 2 or more anatomical variations and 37.7% had single anatomical variation.

Sinuses most commonly involved were maxillary sinus (78%), followed by ethmoid sinus (56%) and frontal sinus (36%). Least commonly involved was sphenoid sinus (24%). Deviated nasal septum (85.7%) was found to be the most common anatomical variation in osteomeatal complex in chronic sinusitis patients followed by concha bullosa (45.4%) and paradoxical middle turbinate (16.8%) whereas uncinate process pneumatization, uncinate process hypertrophy and haller cell were the least common anatomical variations with 2.6% each. Other variations observed were agger nasi cell (10.4%), uncinate process deviation (7.7%) and ethmoid bulla (3.9%).

All cases of the uncinate process deviation and haller cell and majority of the concha bullosa and paradoxically middle turbinate were found to be unilateral compared to uncinate process hypertrophy and ethmoid bulla where predominantly bilateral anatomical variations were seen.

Table 1: Types and distribution of Anatomical Variations

Anatomical variations	Number of cases	Percentage (%)
Deviated nasal septum	66	85.7
Concha bullosa	35	45.4
Paradoxical middle turbinate	13	16.8
Agger Nasi Cell	8	10.4
Uncinate process deviation	6	7.7
Uncinate pneumatization	2	2.6
Uncinate process hypertrophy	2	2.6
Ethmoid bulla	3	3.9
Haller Cell	2	2.6

Table 2: Laterality of Anatomical Variations

Anatomical ariations	Unilateral No %		Bilateral No. %	
Concha bullosa	19	24.6	16	20.8
Paradoxically middle turbinate	10	13	3	3.8
Agger Nasi Cell	4	5.2	4	5.2
Uncinate process deviation	6	7.7	0	0
Uncinate pneumatization	1	1.3	1	1.3
Uncinate process hypertrophy	0	0	2	2.6
Ethmoid bulla	1	1.3	2	2.6
Haller Cell	2	2.6	0	0

(a) (b)

Fig 1 a, b: Coronal & axial section showing right sided deviated nasal septum with bony spur.

Fig 2: coronal section showing left sided concha bullosa with right sided DNS

Fig 3: coronal section showing bilateral paradoxical middle turbinate

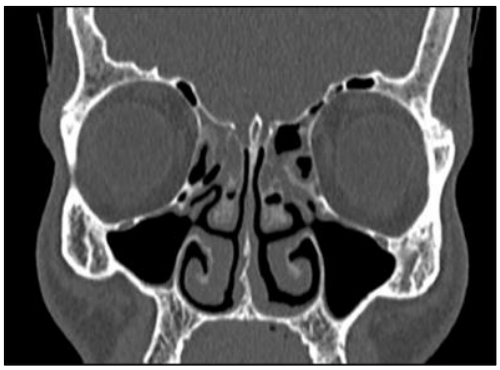

Fig 4: coronal section showing left sided agger nasi

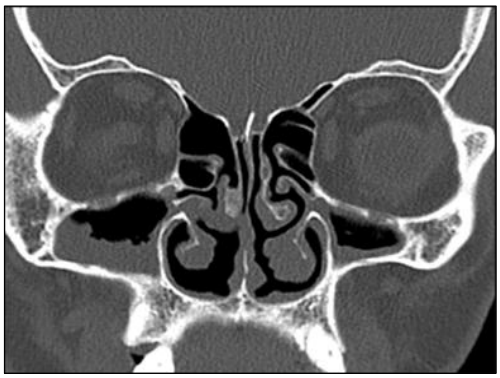

Fig 5: Coronal section showing left sided deviated uncinate

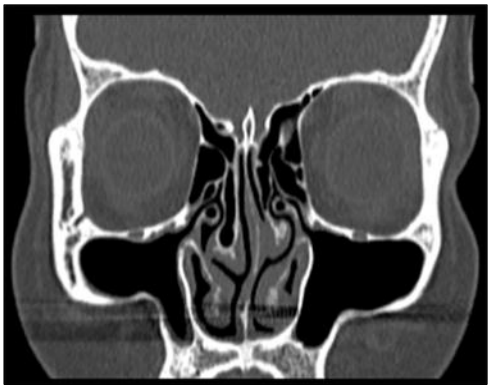

Fig 6: Coronal section showing bilateral pneumatization of uncinate process with right sided concha bullosa and left sided DNS

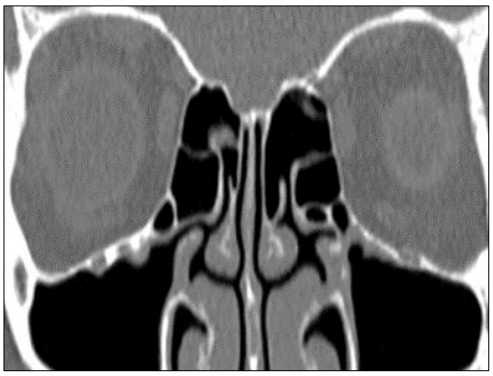

Fig 7: Coronal section showing bilateral uncinate process hypertrophy

Fig 8: Coronal section showing bilateral ethmoid bulla

Fig 9: Coronal section showing left sided haller cells with right sided DNS

4. Discussion

Stenosis of the osteomeatal complex, from either the anatomical configuration or hypertrophied mucosa, can cause obstruction and stagnation of secretions, which secondarily become infected or perpetuate infection. Wide variety of anatomical variations in osteomeatal complex must be distinguished from pathological changes which may be the underlying cause of recurrent disease. In the recent past, it is accepted that CT is the best imaging method to know the anatomical variations of osteomeatal complex. It is the gold standard in terms of imaging the extent of the disease and fine detailed anatomy.

In the present study, anatomical variations of osteomeatal complex were seen in 77% of chronic sinusitis patients, out of which 62.3% of the patients had two or more anatomical variations and 37.7% had single anatomical variation. Similar findings were reported by Murthy *et al* [7]. (77.7%) and Liu X *et al* [8] (81%) respectively. Anita *et al* [9]. reported relatively more percentage of anatomical variations in osteomeatal complex (87%) in their study, out of which 53.7% of the cases showed more than one anatomical variations.

In our study, maxillary sinus was the most commonly involved sinus (78%), followed by ethmoidal sinus (56%) and frontal sinus (36%). These findings corresponds with the studies done by Clement *et al* [10]. (73%), Lloyd *et al* [11]. (83%) and Mamatha *et al* [2]. (67.5%).

The reported prevalence of Deviated nasal septum varies widely. 85.7% of the patients in our study presented with the nasal septal deviation and was the most common anatomical variants seen. Since septal deviation causes lateral compression of the middle turbinate and uncinate process pushing them into the infundibulum and thus causes obstruction of osteomeatal complex, it was included in this study. Similar findings were observed by Mohammed Atik Ahmed *et al* [12] (90%), Perez *et al* [13]. (80%), J. Biswas *et al* [14]. (78%) and Murthy *et al* [7]. (73.2%) in their respective studies.

Concha bullosa has been implicated as a possible etiological factor in the causation of recurrent chronic sinusitis. The present study has adopted the definition by Zinriech *et al* [15]. who have considered any pneumatization degree as concha bullosa (pneumatized middle turbinate). It was seen in 45.4% of patients in the present study which was almost similar to study done by Murthy *et al* [7]. (45.5%), Stallmann *et al* [16]. (44%), and Maru *et al* [17]. (42.6%). The prevalence was on the higher side as compared to the findings of Wani *et al.* K. Dua *et al.* Mamtha *et al.* Zinreich et al and Llyod *et al.* who reported it to be 36%, 30%, 16%, 15% and 14% respectively. [18, 19, 2, 20, 21]. The middle turbinate may be paradoxically curved i.e. bent in the reverse direction. It may lead to impingement of the middle meatus and thus to sinusitis. Paradoxical middle turbinate was found in 16.8% of cases in present study which was similar to the Llyod GA *et al* [11]. (17%) and Fikret K *et al* [22]. (16.3%).

Agger nasi cells are the most anterior ethmoid cells and extend anteriorly into the lacrimal bone. They are located in the anterior floor of the frontal sinus, on the drainage pathway of the frontal sinus, and therefore are possibly involved in recurrent or chronic frontal sinusitis. In our study, agger nasi cells were observed in 10.4% of cases. They were unilateral in 5.2% of cases and bilateral in also 5.2% of cases. The findings of Schaefer *et al* [23]. (10%), Mirza Aneesa A *et al* [24]. (10%) and Murthy *et al* [7]. (8%) were similar to our study. The prevalence was less when compared with studies of Bolger *et al.* (98.5%), Maru *et al.* (88.5%). [25, 26].

We observed that the uncinate process may be deviated, pneumatized and hypertrophied. Deviation of uncinate process in our series were found in only 7.7% of cases which was comparable to the studies of K Dua *et al* [19]. (6%) and Anita *et al* [9]. (9.3%). Above all, 2.6% of the cases had uncinate process pneumatization. The incidence of pneumatization of uncinate process from previous reports ranged from 0.4% - 4%. Hypertrophy of the uncinate process was observed in 2.6% of the cases which was closer to the findings of Anita *et al* (5.6%) and Murthy *et al.* (5.6%). [9, 7]

The ethmoidal bulla can be so extensively pneumatized that it completely fills the sinus of the middle turbinate bone. It may contribute to sinus disease by obstructing the infundibulum or middle meatus. In our study, 3.9% cases of ethmoid bulla were observed which was similar to the studies done by Shrikrishna BH *et al* [1]. (4%), Scribano E *et al* [27]. (3.5%) and Jyothi AC *et al* [28]. (3%).

Haller's cells are ethmoidal air cells that project inferiorly to the ethmoidal bulla into the floor of the orbit in the region of the maxillary sinus ostium. Davis *et al* [29]. noted the haller cell is thought to cause chronic sinusitis cases by impinging on the ostium of the maxillary sinus and infundibulum by inhibiting the ciliary function, leading to obstruction of the ostium. The prevalence of Haller's cells in our study was 2.6% and the results were similar as observed by Murthy *et al* [7]. (2.7%), Anita *et al* [9]. (1.9%) and Liu X *et al* [8]. (1%). On the contrary study of Tonai and Baba[26] (36%), Alkire BC *et al* [30]. (39.9%) and Bolger *et al* [25]. (45.9%) showed higher frequency of haller's cell.

5. Conclusion

This study re-emphasized the fact that anatomical variations in Osteomeatal complex in chronic sinusitis patients are frequent and may be multiple. These variations can be best appreciated on CT scan which should not only be used exclusively to diagnose chronic sinusitis or to determine the need for surgery but also to provide supplementary clinical data to the history. The radiologist plays a vital role in providing the information required by the surgeons that may decrease the risk of intra-operative complications.

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