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ORIGINAL ARTICLE

Anatomical Variations in Osteomeatal Complex among Patients undergoing Functional Endoscopic Sinus Surgery

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ABSTRACT

Aims: To study the anatomical variations of osteomeatal complex and the importance of preoperative computed tomography (CT) in patients with chronic sinusitis undergoing functional endoscopic sinus surgery. We studied the different variations and their frequency of occurrence.

Materials and methods: A total of 100 patients undergoing endoscopic sinus surgery were studied by nasal endoscopy, CT scanning, and at the time of definitive surgery, variations were recorded.

Results: The frequency of occurrence of sinonasal anatomical variations was septal deviation in 76%, agger nasi cells in 71%, concha bullosa in 61%, medialized uncinate process in 48%, prominent bulla ethmoidalis in 41%, paradoxical middle turbinate in 33%, accessory maxillary ostium in 28%, frontal cell in 22%, intumescentia septi nasi anterior in 21%, lateralized uncinate in 15%, pneumatized uncinate process in 4%, Haller cells in 12%, and Onodi cells in 8%.

Conclusion: The high incidence of variations emphasizes the need for proper preoperative assessment for safe and effective endoscopic sinus surgery.

Keywords: Anatomic variation, Chronic sinusitis, Osteomeatal complex, Paranasal sinuses.

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INTRODUCTION

In the past two decades, otorhinolaryngologists have developed a variety of diagnostic methods for a better understanding of the pathophysiology of chronic diseases and provided therapeutic methods for the management of nasal and sinus diseases.[1] The term "sinusitis" refers to a group of disorders characterized by inflammation of the mucosa of the paranasal sinuses. Chronic rhinosinusitis occurs when the duration of symptoms is greater than 12 weeks.[2]

Stammberger proposed that stenosis of the osteomeatal complex (OMC) can cause obstruction and stagnation of secretions, which may then become infected or perpetuate infection. Recently, diagnostic nasal endoscopic evaluation of the nose and paranasal sinuses is a routine component for evaluating patients with evidence of suspected chronic sinusitis, and the patients with significant findings are evaluated with computed tomography (CT) of the paranasal sinuses. The aim of doing CT of the paranasal sinuses is to delineate the extent of the disease and define any anatomical variants and relationship of the sinuses with the surrounding important structures, which provides essential preoperative information for the assessment of patients undergoing functional endoscopic sinus surgery (FESS).

Functional endoscopic sinus surgery was introduced in the 1990s by Messerklinger and Wigand and was popularized by Stammberger in Europe and by Kennedy in North America, and endoscopic techniques are now well established.[3] Modern endoscopic sinus surgery is arbitrarily divided into Messerklinger and Wigand approaches. The Messerklinger approach is from anterior to posterior sinuses. The Wigand approach is in contrast, from posterior to anterior.[4] The safe and effective performance of any surgery is dependent on a sound knowledge of anatomy.

MATERIALS AND METHODS

The study was conducted in our Department of ENT, between July 2013 and September 2014. The sources of data for our study were the patients attending the ear, nose, and throat outpatient department with proven history of sinusitis of 3 months' duration not responding to medical treatment with full course of antibiotics, analgesics, and decongestants and who were willing to undergo endoscopic sinus surgery and CT scanning of paranasal sinuses. This was a cross-sectional study and was carried out on 100 cases.

Patients were selected based on inclusion/exclusion criteria.

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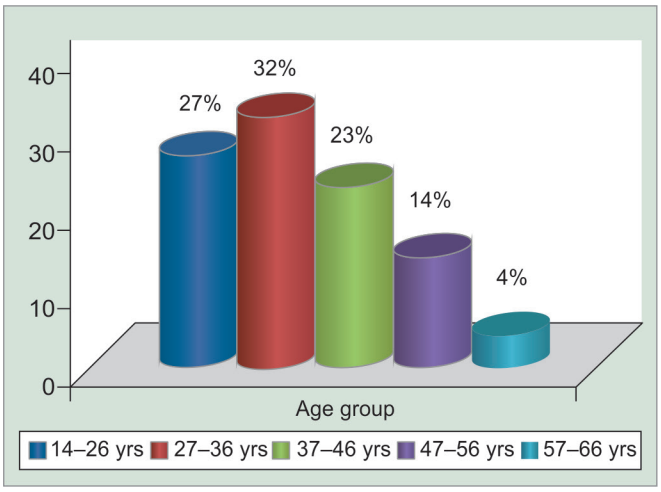
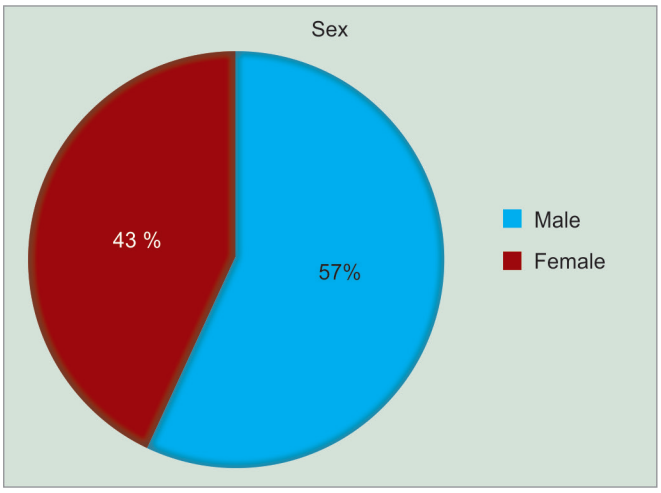


Graph 1: Age-wise distribution (n = 100)



Graph 2: Sex-wise distribution (n = 100)

INCLUSION CRITERIA

- All patients aged > 17 years who fulfill the criteria for chronic sinusitis clinically
- All chronic patients who have failed to respond to previous medical/conservative management
- Patients willing to undergo surgery, CT, and diagnostic nasal endoscopy of paranasal sinuses

Exclusion Criteria

- Age < 17 years
- Facial trauma and nose and paranasal sinus tumors
- Patients not consenting to participate in the study.

After the selection, patients were subject to endoscopic nasal evaluation. All these patients were then evaluated with CT scan of paranasal sinus, and if indicated, they were posted for FESS.

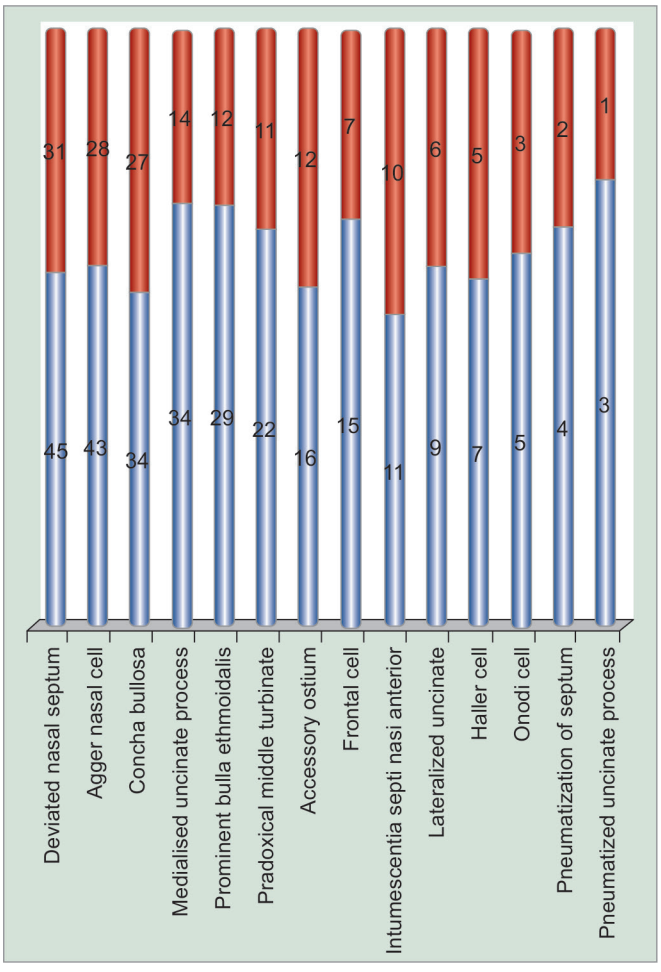
RESULTS

The demographic profile shows the most common age group to be between 27 and 36 years (Graph 1). Among the 100 cases studied, 57% (57) were male and 43% (43) were female (Graph 2).

Anatomical variations of the OMC are provided in Graph 3 and Table 1. Nasal septal deviation is the most common anatomical variation noted in our study.

Agger nasi is the next most common anatomical variation of the OMC, present in about 71 (71%) patients. Of these, unilateral presentation is 38 (53.5%) and bilateral presentation 33 (46.5%). Of the unilateral presentation, the right side is more common (21 patients) than the left side (17 patients).

Our next common anatomical variation is concha bullosa [61% (61)], which may present unilaterally or bilaterally. In our study, the most common was the unilateral presentation of concha bullosa [34 (55.7%)]



Graph 3: Distribution of anatomical variation (n = 100)

patients, which was also associated with other anatomical variations. Of this, unilateral presentation in both right and left sides were same for 17 patients.

Medialized uncinate process presented in 48 (48%) patients. Of these, bilateral presentation was more common [26 (54.16%)]. Bulla ethmoidalis came next, in about 41 patients (41%). Of these, unilateral presentation was common, in about 30 patients (73.17%), and bilateral

Table 1: Distribution of anatomical variation with respect to sides

		Males				Females			
Sl. no.	*Anatomic variation*	*Right*	*Left*	*Bilateral*	*Total*	*Right*	*Left*	*Bilateral*	*Total*
1	Deviated nasal septum	15	30	—	45	13	18	—	31
2	Agger nasi cell	12	10	21	43	9	7	12	28
3	Medialized uncinate process	9	7	18	34	4	2	8	14
4	Concha bullosa	8	10	16	34	9	7	11	27
5	Paradoxical middle turbinate	7	6	9	22	3	2	6	11
6	Prominent bulla ethmoidalis	9	12	8	29	2	7	3	12
7	Accessory ostium	2	8	6	16	2	4	6	12
8	Onodi cell	1	1	2	4	1	0	2	3
9	Haller cell	2	2	3	7	1	1	3	5
10	Lateralized uncinate	2	3	4	9	2	2	2	6
11	Pneumatized uncinate process	1	1	0	2	1	0	0	1

presentation in 11 (26.82%). Unilateral presentation was on the left side in 19 patients and on the right side in 11 patients.

Paradoxical middle turbinate was present in 33 patients (33%), of which unilateral was in 18 (54.54%) and bilateral in 15 (45.45%), right side being common in 10 patients. Although deviated nasal septum is not a part of the OMC, it contributes to anatomical crowding of the OMC area. Deviated nasal septum was present in about 76 (76%) patients. Of these, left side deviation was common in about 48, and right side in 28. Accessory ostium presented in 28 (28%) patients, of which unilateral presentation [16 (57.14%)] was more common than bilateral presentation [12 (42.85%)]. Frontal cell presented in 22 patients (22%), of which males had more presentation (15) than females.

Lateralized uncinate presented in 15 (15%) patients, of which 9 (60%) patients presented with unilateral presentation, left side being more common (5). Intumescentia septi nasi anterior presented in 21 (21%) patients, being more common in males [11 (52.38%)] than females [10 (47.61%)]. Haller cell was noted in 12 patients (12%), of which unilateral and bilateral presentation were the same [about 6 (50%)].

Onodi cell presented in 7 (6%) patients, of which 4 (57.14%) patients presented with bilateral presentation, right side being more common (2). Pneumatization of septum presented in 6 patients, being more common in males [4 (66.66%)] than in females [2 (33.33%)]. Pneumatized uncinate process presented in four patients, being more common in males [3 (75%)] than in females [1 (25%)].

DISCUSSION

The osteomeatal unit is not a discrete anatomic structure but refers collectively to several middle meatal structures. It is bounded by middle turbinate medially, lamina papyracea laterally, and basal lamella superiorly and posteriorly. The inferior and anterior borders of the OMC are open. The space before the basal lamella is called anterior OMC, and the space behind the basal lamella containing the posterior ethmoid cells is referred to as posterior OMC.[5] The osteomeatal unit is a functional rather than an anatomic designation, coined by Naumann in discussing the pathophysiology of sinusitis.

Deviated Nasal Septum

Deviated nasal septum can be cartilaginous, or cartilaginous-bony type, or a combination of both. Since septal deviation causes lateral compression of the middle turbinate and uncinate process pushing them into the infundibulum and thus causes obstruction of the OMC, it is included in this study. Deviation of the nasal septum was found in 76% of the cases in the present study. In other studies, this finding ranged from 14.1 to 80%: Dutra and Marchiori[6] 14.1%, Earwaker[7] 44%, and Pérez-Piñas et al[8] 80%. Pneumatization of septum in our study presented in six patients, being more common in males [4 (66.66%)] than in females [2 (33.33%)].

Agger Nasi

It is a prominence appreciated at and just anterior to the middle turbinate's insertion into the lateral nasal wall. This cell usually takes its origin from the superior aspect of the infundibulum or the frontal recess.[9] The agger nasi can pneumatize inferomedially to pneumatize the uncinate process.[10] In our study, agger nasi cells were observed in 71 patients (71%). They were unilateral in 38 cases (53.5%) and bilateral in 33 cases (46.5%). Schaefer et al[11] reported an incidence of 10%, while van Alyea[9] had observed an incidence of 89% in their series of anatomic dissections.

Concha Bullosa

Any pneumatization of the middle turbinate is technically referred to as a concha bullosa. If the vertical portion or lamella of the middle turbinate is pneumatized, the cell

i.e., formed is referred to as the interlamellar cell. The term "interlamellar cell" distinguishes this pattern of middle turbinate pneumatization from pneumatization that includes the more inferiorly located bulbous portion of the turbinate. This is more commonly referred to as a concha bullosa. A large concha bullosa is an anatomic variation that can narrow the middle meatus and reduce mucociliary clearance and ventilation. Zinreich et al[12] report that conchae bullosae are best diagnosed radiographically and easily identified with CT. Bolger et al[13] reported 53% while Goldman[14] reported 80% of patients. In our study, choncha bullosa was seen in 61% patients, of which unilateral was in 34 cases (55.7%) and bilateral in 27 cases (44.3%).

Uncinate Process – Deviation and Pneumatization

Two main types of variation – deviation and pneumatization – are associated with the uncinate process. The structure may deviate laterally, compromising the infundibulum, or medially, compromising the middle meatus. The uncinate process may also be pneumatized. Bolger et al[13] state that pneumatization of this structure occurs when an agger nasi cell extends into the most anterosuperior region of the uncinate process.

Returning to its superior aspect, the uncinate projects posterior and superior to the middle turbinate attachment and most commonly bends laterally to insert on the lamina papyracea of the orbit. Inferior and lateral to this portion of the uncinate lies the superior aspect of the infundibular air space, the recessus terminalis. Alternatively, the uncinate can attach centrally to the skull base or medially to the superior aspect of the vertical lamella of the middle turbinate near the turbinate's insertion to the cribriform plate. In our study, medialized uncinate process presented in 48 (48%) patients, of which bilateral presentation was more common, in 26 (54.16%). Lateralized uncinate presented in 15 (15%) patients, of which 9 (60%) patients presented with unilateral presentation. Pneumatized uncinate process presented in four patients, being more common in males [3 (75%)] than in females [1 (25%)].

Enlarged Ethmoid Bulla

The ethmoid bulla is located within the middle meatus directly posterior to the uncinate process and anterior to the basal lamella of the middle turbinate. Superiorly, the anterior wall of the ethmoid bulla can extend to the skull base and form the posterior limit of the frontal recess. Posteriorly, the bulla can blend with the ground lamella. When unpneumatized, a bony projection from the lamina papyracea results and is referred to as the torus lateralis.[15] In our study, enlarged ethmoid bulla was seen in 41 patients (41%). Of these, unilateral presentation was common, in about 30 patients (73.17%), and bilateral presentation in 11 (26.82%). Other studies show 30.30% (Liu et al[16]) and 10% (Mazza et al[17]).

Paradoxical Middle Turbinate

Paradoxical middle turbinate is identified when the curve of the middle turbinate projects laterally, toward the nasal septum. Usually, the turbinate curves more medially, toward the lateral sinus wall. Paradoxical middle turbinate in our study was present in 33 patients (33%), of which unilateral in 18 (54.54%) and bilateral in 15 (45.45%); in other studies, this finding ranged from 12 to 26.1%: Calhoun et al[18] 12% and Bolger et al[13] 26.1%.

Accessory Ostium

The uncinate has no bony attachment anterior and posterior to its attachment to the inferior turbinate bone. Here, the lateral nasal wall is made not of bone but rather of middle meatal mucosa, a small layer of intervening connective tissue, and sinus mucosa. These areas are referred to as the anterior and posterior fontanelles. Accessory ostia are frequently encountered in the posterior fontanelle region, occurring in approximately 20 to 25% of patients.[19] In our study, accessory ostium presented in 28 (28%) patients, of which unilateral presentation in 16 (57.14%) was more common than bilateral presentation in 12 (42.85%).

Frontal Cell

Frontal cells are a less common type of anterior ethmoid air cell. The recognition and subsequent definition of the appearance and etiology of frontal cells was initiated by J. Parson Schaeffer. Schaeffer[20] coined the term "frontal cell" to describe this phenomenon. Bent et al[21] have defined frontal cells more specifically as belonging to one of four categories. In our study, frontal cells presented in 22 patients (22%), of which males had more presentation (15) than females.

Intumescentia Septi Nasi Anterior

Intumescentia septi nasi anterior is a common anatomical variation, i.e., not routinely noticed by surgeons or radiologists. It is a mucosal bulging located on each side of the anterior part of the septum.[22] It can indirectly cause narrowing of OMC. Intumescentia septi nasi anterior in our study presented in 21 (21%) patients, being more common in males [11 (52.38%)] than in females [10 (47.61%)].

Haller Cells

Haller cells are pneumatized ethmoid air cells that project along the medial roof of the maxillary sinus and the most inferior portion of the lamina papyracea, below the ethmoid bulla and lateral to the uncinate process. Most often, they arise from the anterior ethmoid cells and are closely related to the infundibulum.[23] In the present study, Haller cells were noted in 12 patients (12%), unilateral and bilateral presentation being the same [about 6 (50%)]. Zinreich et al[24] reported it in 10% of the cases. However, using the same criteria, Bolger et al[13] reported it in 45.1% of the cases. Earwaker[7] reported it in 20% of the cases.

Onodi Cells

An Onodi cell is defined as the pneumatization of the most posterior ethmoid air cell, where a bulge of the optic canal into the posterior ethmoid is apparent. Kainz and Stammberger reported a 42% prevalence using endoscopic dissection. Gross anatomic and radiographic evaluation studies reported much lower prevalence, ranging anywhere from 1.3 to 8%[25] respectively. In the present study, Onodi cells presented in 7 (6%) patients, of which 4 (57.14%) patients had bilateral presentation

CONCLUSION

The anatomical variations of OMC are not the pathology for chronic sinusitis. But they predispose the individual to chronic sinusitis. Anatomical variations studied on diagnostic nasal endoscopy and CT scan are found to block the OMC, leading to impaired drainage of paranasal sinuses, thus causing chronic sinusitis. Our present cross-sectional study of anatomical variation of OMC reveals many parameters. Nasal septal deviation, agger nasi, and concha bullosa are the most common anatomical variations noted in chronic sinusitis patients, and the Onodi cells and pneumatized uncinate are the rarest ones noted in our study. In our study, all the patients had at least one anatomical variation. With the proper preoperative evaluation of anatomical variations, we can reduce inadvertent complications during surgery and also ensure complete cure of the disease.

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