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Main Article

CT scan evaluation of the anatomical variations of the ostiomeatal complex

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Abstract

Introduction Functional endoscopic sinus surgery (FESS) has revolutionized the approach and treatment of chronic rhinosinusitis. Certain anatomical variations are thought to be predisposing factors for the development of sinus disease and it is necessary, for the surgeon to be aware of these variations, especially if the patient is a candidate for FESS.

Objective The aim of the present study was to identify the various anatomical variations of the ostiomeatal complex in patients of chronic rhinosinusitis who underwent FESS.

Materials and methods A total of 150 patients of chronic rhinosinusitis (medical treatment failures) who were subjected to FESS were CT scanned preoperatively to find any bony anatomic variation and the extent of mucosal disease.

Results Concha bullosa was the commonest anatomic variation and was seen in 45 (30%) patients. The other anatomic variations noted included: paradoxical middle turbinate in 9.33% patients, uncinate process variations in 25% patients, agger nasi cells in 9.33%, Haller cells in 8.66% and posterior septal deviations in 25.33% patients. The mucosal disease was most commonly seen in anterior ethmoids (87.33%), followed by maxillary sinus ostial area (70%), maxillary sinus disease (65.33%) , posterior ethmoidal disease (38%), frontal sinus disease (15%) and sphenoid sinus mucosal disease (8.66%) patients.

Conclusion A thorough preoperative CT evaluation of the patients undergoing FESS is necessary to detect various anatomical variations in the ostiomeatal complex.

Keywords Ostiomeatal complex · CT scan · Anatomical variations

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Introduction

Chronic rhinosinusitis, with its classical symptoms of nasal obstruction, nasal discharge (anterior and/or posterior), headache and facial pain, and abnormalities of smell is the most common disease for which consultation of otorhinolaryngologist is sought. The approach to the evaluation and management of chronic sinusitis changed after Messerklinger [1] published the first comprehensive account of technique of nasal endoscopy and its application to the diagnosis and treatment of sinonasal disease. The same author earlier gave the concept of mucociliary clearance of paranasal sinuses, a primary physiological process used by the upper airway to remain in a state of health. Disruption of the mucociliary clearance due to anatomic variations and mucosal disease of the ostiomeatal complex is considered to be the prime factor for the continuation of symptoms and chronicity of rhinosinusitis. Functional endoscopic sinus surgery (FESS) addresses these anatomical variations and mucosal diseases and restores the normal physiology of the paranasal sinuses. For FESS to be effective, accurate localization of the disease is very important. Although nasal endoscopy is very helpful, the convoluted anatomic framework of the ethmoids precludes the direct non-invasive endoscopic evaluation of deeper ostiomeatal complex, posterior ethmoids and sphenoid sinus disease [1]. CT scan has proved to be indispensable in identifying the magnitude and extent of the disease in sinonasal areas. Subtle anatomic variations such as Haller cells, agger nasi cells, pneumatization or paradoxical curvature of the middle turbinate,

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uncinate process and ethmoid bulla can now be imaged with a level of clarity along with the mucosal or polypoidal changes in the paranasal sinus [2]. The coronal plane best shows the osteomeatal unit and the relationship of the brain to the ethmoids roof. It correlates closely with the surgical orientation and is thus the primary imaging orientation for the valuation of the sinonasal tract in all patients with inflammatory sinus disease who are endoscopic surgical candidates [3].

The present study was undertaken to study the various anatomical variations in patients with chronic rhinosinusitis.

Materials and methods

The study was conducted in the Department of ENT, Head and Neck Surgery, Government Medical College, Srinagar over a period of two years. The patients included in the study were medical treatment failures and underwent functional endoscopic sinus surgery. Treatment failures were defined as those patients who had taken medical treatment for at least six months and were suffering from at least three of the following symptoms:

1. Nasal obstruction
2. Anterior and/or posterior nasal discharge
3. Headache and facial pains
4. Abnormalities of smell

All the patients underwent CT scan, with contiguous 3 mm-thick images in the coronal plane, i.e. perpendicular to the hard palate, starting from the anterior wall of the frontal sinus through the posterior wall of the sphenoid sinus. Axial cuts were taken whenever necessary.

Results

A total of 150 patients were included in the study. The majority of the patients were males (65.3%) with 52 (34.5%) females. The average age at the time of scanning was 35.6 years. Headache and facial pains were the main symptoms (90%) followed by nasal discharge (86.6%) and nasal obstruction (85.33%). Hyposmia was seen in 20% of the patients. Among the various bony anatomic variations seen on CT scan (Table 1), concha bullosa was the commonest one and was seen in 45 (30%) patients, unilateral (U/L) in 38 (25.33%) patients and bilateral (B/L) in 7 (4.66%) patients. Paradoxical curvature of middle turbinate was seen in 14 (9.33%) patients [U/L 13 (8.66%); B/L 1 (0.66%)]. Hypertrophied uncinate process was noticed in 21 (14%) patients [U/L 15 (10%); B/L 6 (4%)], medially curved uncinate process was present in 17 (11%) patients [U/L 11 (7.33%); B/L 6 (4%)]. Haller cells were seen in 13 (8.6%) patients. Abnormalities of agger nasi cells were seen in 14 (9.33%) patients [U/L 8 (5.33%); B/L 6 (4%)]. Posterior septal deviation was seen in 38 (25.33%) patients. Mucosal disease was seen most commonly in the anterior ethmoids. One hundred and thirty one (87.33%) patients had anterior ethmoid disease with 53 (35.33%) patients having unilateral and 78 (52%) bilateral disease. Posterior ethmoidal disease was seen in 57 (38%) patients [U/L 23 (15.33%); B/L 34 (22.66%)]. Maxillary sinus ostial disease was seen in 105 (70%) patients [U/L 45 (30%); B/L 60 (40%)]. Frontoethmoid recess involvement was present in 30 (20%) patients [U/L 26 (17.33%); B/L 4 (2.66%)]. Frontal sinus was diseased in 23 (15%) patients [U/L 12 (5%); B/L 5 (3.33%)]. Lastly, sphenoid sinus involvement was observed in 13 (8.66%) patients with 11 (7.33%) patients showing unilateral and 2 (1.33%) patients bilateral sphenoidal involvement.

Discussion

Nasal endoscopy combined with CT scan has made the approach to sinonasal disease more specific, rational and accurate. The success rate of FESS for treating chronic sinusitis has been put as more than 80% [4], 82% [5], 95% [6]. Such high rates are possible only by accurate preoperative localization of the disease. The standard radiograph views (Caldwell Luc, Water's, Lateral etc.) are quick and inexpensive ways to evaluate nose and paranasal sinuses and can view maxillary, frontal, sphenoid, posterior ethmoids as well as lower one-third of the nose but are insufficient for adequate visualization of anterior ethmoids, upper two-third

Table 1 Incidence of anatomic variations

Anatomic variations	Total no. of patients	Percentage of patients (%)	Unilateral		Bilateral	
			No.	%	No.	%
Concha bullosa	45	30	38	25.33	7	4.66
Paradoxical middle turbinate	14	9.33	13	8.66	1	0.66
Hypertrophied uncinate process	21	14	15	10	6	4
Medially curved uncinate process	17	11	11	7.33	6	4
Haller cell	13	8.66	13	8.66	-	-
Agger nasi cell	14	9.33	8	5.33	6	4
Posterior septal deviation	38	25.33	-	-	-	-

Table 2 Incidence of mucosal disease

Diseased area	Total no. of patients	Percentage of patients	Unilateral		Bilateral	
		(%)	No.	%	No.	%
Anterior ethmoid	131	87.33	53	35.33	78	52
Posterior ethmoid	57	38	23	15.33	34	22.66
Maxillary sinus ostium	105	70	45	30	60	40
Maxillary sinus	98	65.33	45	30	53	35.33
Frontoethmoid recess	30	20	24	16	6	4
Frontal sinus	23	15	18	12	5	3.33
Sphenoid sinus	13	8.66	11	7.33	2	1.33

Fig. 1 CT scan showing bilateral concha bullosa

of the nose and the frontal recess. Moreover in the X-ray examination, opacity of paranasal sinuses is the common finding that can be found because of fluid (pus, mucopus, blood etc.) thickened mucosa, tumor etc. thus lacking specificity [7]. CT scan with its excellent capability of displaying bone and soft tissue is the current diagnostic modality of choice for sinonasal disease. In contrast to standard radiographs, CT scan clearly shows the fine bony anatomy of the ostiomeatal complex. It readily identifies the minor ana-

Fig. 2 CT scan showing Haller cell

tomic variations and mucosal disease [2]. CT scans are performed after a course of adequate medical therapy to eliminate reversible mucosal inflammation. The coronal plane is considered to be the best orientation for evaluation of the sinonasal tract as it clearly shows the ostiomeatal complex and the relationship of the brain to the ethmoidal roof and correlates closely with the surgical orientation [2].

Even though nasal anatomy varies significantly from patient to patient, there are some specific variations that occur repeatedly within the population. Certain variations are thought to be predisposing factors for the development of sinus disease and operative complications. Thus it is pertinent for the surgeon to be aware of these variations especially if the patient is a candidate for FESS. The present study was conducted to study these anatomical variations in patients of chronic rhinosinusitis and who underwent FESS.

Concha bullosa (CB) was the commonest anatomic variation seen in patients with chronic rhinosinusitis, being present in 30%. CB is a ballooned out middle turbinate due to pneumatization. The pneumatization can grow to such an extent that the bulging end of turbinate completely fills the

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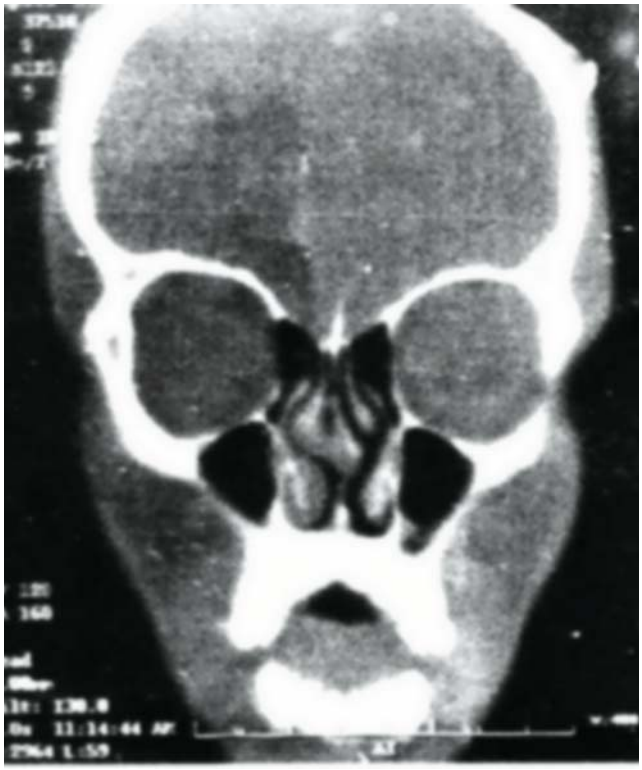

Fig. 3 CT scan showing paradoxical curved middle turbinate

Fig. 4 CT scan showing pneumatized septum

space between the septum and lateral nasal wall resulting in the blockade to the entrance to the middle meatus [8]. In the present study also significant contact areas of CB with adjacent surface were seen. There is a great variation in the reported prevalence of concha bullosa. Two separate cadaveric studies found concha bullosa in 8% and 20% of specimens, respectively [9]. The reported prevalence of the radiographic appearance of concha bullosa on coronal CT scans ranges from 14% to 53% [10].

The results in our study were similar to this reported incidence, with 30% of the patients showing CB. Many factors are responsible for the wide range of prevalence of concha bullosa. Attempts to determine the general prevalence of this variation have been characterized by the use of diverse study populations, different criteria for pneumatization, and analytic methods. These varying features have undoubtedly affected the results of the investigations.

Paradoxical middle turbinate was seen in 14 (9.33%) patients, unilaterally in 13 (8.6%) patients and bilaterally in 1 (0.66%) patient. This anomaly consists of a reversal of the normal outward concavity of the middle turbinate. The inferior edge of the middle turbinate may have various shapes with excessive curvature which in turn may obstruct the nasal cavity, infundibulum and the middle meatus. Because of this potential narrowing or obstruction, paradoxical middle turbinate can be a contributing factor to sinusitis. However, Lloyd [11] reported no correlation between the variant and increased incidences of asymptomatic sinusitis, and Calhoun et al. [12] found no statistical correlation between paradoxical curvature of the middle turbinate and symptomatic sinusitis.

Uncinate process variations can be appreciated on CT scan and in the present study were seen to be present in the form of hypertrophied uncinate process in 21 (14%) patients [U/L 15 (10%); B/L 6 (4%)] and curved uncinate process in 17 (11%) patients [U/L 11 (7.33%); B/L 6 (4%)]. The uncinate process is an important bony structure of the wall lateral wall of the nose. Along with the ethmoidal bulla, it forms the boundaries of the hiatus semilunaris and ethmoid infundibulum, the structures through which the frontal and maxillary sinuses drain. Uncinate process variations are in the form of deviation of the uncinate process, variations of the attachment and pneumatization of the uncinate process also called uncinate bulla.

The hypertrophied and laterally curved uncinate process causes narrowing of hiatus semilunaris and the ethmoid infundibulum. The medially curved posterior margins of uncinate process may approximate to middle turbinate [13].

Haller cells or infraorbital ethmoidal air 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. These cells are considered as a factor in recurrent maxillary sinusitis as they contribute to the narrowing of the infundibulum and the adjacent ostium of the maxillary sinus [13, 14] In our study Haller cells were present in 13 (8.66%) patients, and were unilateral in all patients.

Variations in agger nasi cells were seen in 14 (9.33%) patients, unilaterally in 8 (5.33%) and bilaterally in 6 (4%)

Table 3 Reported prevalence of anatomic variations

	Concha bullosa	Paradoxical middle turbinate	Haller cells	Pneumatized/deviated uncinate process	Agger Nasi cells	Posterior septal deviation
Lloyd [15]	14%	17%	2%	16%	3%	NA
Bolger [16]	53%	26.1%	45.1%	2.5%	98.5%	18.8%
Messerklinger [17]	NA	NA	NA	NA	10–15%	NA
Tonai-Baba [18]	28%	25.3%	36%	NA	86.7%	NA
Perez-Pinas et al. [19]	73%	10%	3%	4.5%	Nearly all	80%

NA = not available

patients. Agger nasi cells are present in the area anterior and superior to the insertion of middle turbinate at the lateral nasal wall. Even when not diseased they may narrow the frontal recess depending upon the pneumatization and may completely block it when diseased. Recognition of this relationship on CT and during surgery is essential to the diagnosis and treatment of chronic frontal sinusitis [13].

Posterior septal deviation was seen in 38 (25.33%) patients. The diagnosis of this condition is important not only in the context of the relieving obstruction, but because of the fact that septal spurs (especially in contact with lateral nasal wall can lead to headache) [14].

A comparison of the incidence of the various anatomical variations as reported previously is given in Table 3.

The anterior ethmoid disease was seen in 131 (87.33%) patients, unilaterally in 53 (35.33%) and bilaterally in 78 (52%). The anterior ethmoid, especially its infundibulum (at the entrance to maxillary ostium) and frontal sinus build upon a system of fissures and clefts in the middle nasal meatus. Occlusion of these narrow areas can directly lead to involvement of maxillary and frontal sinus. The diagnosis and correction of abnormal anatomic variations and mucosal disease here can result in reversal of disease process. The maxillary sinus ostial disease was seen in 105 (70%) patients unilaterally in 45 (30%) patients and bilaterally in 60 (40%) patients. The importance of natural maxillary sinus ostial disease is due to the fact that all the routes of the secretion and transport converge at the natural ostium. Small polyps and mucosal edema can easily occlude the natural ostium, affecting the sinus ventilation and drainage in the maxillary sinus. The maxillary sinus disease was itself picked up in 98 (65.33%) patients, unilaterally in 45 (30%) and bilaterally in 53 (35.33%) patients. Similarly posterior ethmoid involvement was seen in 60 (40%) patients unilaterally in 23 (15.33%) and bilaterally in 37 (24.66%), frontoethmoid recess involvement in 30 (20%) patients; unilaterally in 26 (17.33%) and bilaterally in 6 (4%) and secondary involvement of frontal sinus was observed in 23 (15%) patients, unilaterally in 18 (12%) and bilaterally in 5 (3.33%). Sphenoid sinus was the least involved sinus and was found diseased in 13 (8.66%) patients, unilaterally in 11 (7.33%) and bilaterally in 3 (2%) patients.

In conclusion, the preoperative detection of the various anatomical variations is essential as it significantly influences the selection of the technique and also helps in avoiding complications.

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