Main Article

ANTERIOR SKULL BASE: HIGH RISK AREAS IN ENDOSCOPIC SINUS SURGERY IN CHRONIC RHINOSINUSITIS: A COMPUTED TOMOGRAPHIC ANALYSIS

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ABSTRACT: *Computed Tomography (CT) scan of nose and paranasal sinuses play a key role in pre-operative evaluation of patients undergoing endoscopic sinus surgeries (ESS) for chronic rhinosinusitis. The asymmetry of ethmoid fovea, olfactory fossa, anatomical variations of lateral lamella and course of anterior ethmoid artery are critical in ESS as it may predispose to dangerous consequences like hemorrhage, CSF leak and intracranial complications. A prospective study was done on 75 patients of clinically and diagnostically proven chronic rhinosinusits. The coronal CT scan was evaluated with special attention to anatomical variations of anterior skull base including ethmoid fovea, olfactory fossa, lateral lamella and course of anterior ethmoid artery. The endoscopic surgeon's awareness of these variations and its role in preventing complications are highlighted.*

Key Words: *Anterior skull base, Anatomical variations, CT scan, Chronic rhinosinusitis*

INTRODUCTION

Endoscopic sinus surgery has become an extremely popular technique for refractory rhinosinusitis. Mosher in 1912 stated that intranasal ethmoidectomy is "the blindest and most dangerous operation in all surgery".[1] Understanding the complex anatomy of anterior skull base and its relationship including fovea ethmoidalis, olfactory fossa, lateral lamella and course of anterior ethmoid ethmoid artery, is important to avoid dangerous complications during ESS. Inadvertent violation of fovea ethmoidalis or cribriform plate may cause CSF leak, direct penetration trauma to the dura, serious intracranial and intracerebral complications.[2,3] Preoperative evaluation of patients undergoing ESS by both radiologists and endoscopic surgeon is crucial. Radiological reports of CT scans of the sinuses often omit the necessary information of anatomical radiological variations which is necessary for the surgeons to take adequate precautions for the procedure.

We conducted a prospective study on patients who were clinically and endoscopically proven to have chronic rhinosinusitis to identify the high risk areas of anterior skull base by radiological analysis and to determine the prevalence of its variations.

MATERIALS AND METHODS

This prospective study was done over one year period in 75 patients with age ranging from 15 to 45 years who were clinically diagnosed as chronic rhinosinusitis based on the Task Force criteria.[4] Patients with acute rhinosinusitis, clinically proven allergy, extensive nasal polyposis, previous history of sinonasal surgeries (except antral washout), and age less than 15 years were excluded from the study.

Patients underwent detailed clinical and physical examination followed by diagnostic nasal endoscopy using 30 degree 2.7 mm diameter rigid nasal endoscope to confirm the diagnosis of rhinsosinusitis. All patients with clinically and endoscopically proven rhinosinusitis had coronal CT scanning done with Siemens somatosom DRH (Single slice helical CT scanner). A direct coronal positioning was done with the patient prone or supine with the chin extended (neck hyper extended). The slice thickness was 3 mm with 3 mm increments, and a bone algorithm was used for acquisition. The images were sent to PACS (GE) and interpreted in bone windows.

The CT scans were interpreted in detail with special emphasis on anatomical variations, anatomical boundaries and the extent of mucosal disease by ENT surgeon and the radiologist. The various radiological features of anterior skull base structures were analysed in detail. The frequency distributions of various findings were determined by descriptive statistics.

RESULTS

Of the 75 patients, 64 patients (85.4%) and 11 patients (14.6%) were noted to have symmetric and asymmetric ethmoid fovea respectively (Figure 1). Among the 11

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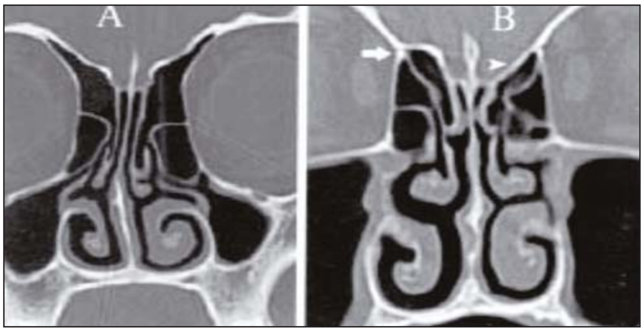

Figure 1: Coronal CT sinus scan showing A) symmetric ethmoid fovea on both sides and B) asymmetry of ethmoid fovea with low lying fovea on left side (arrow head)

patients, 7 (63.6%) showed low fovea on right side and 4 (36.4%) showed low fovea on left side. Eight patients (72.7%) showed contour asymmetry with flattening of fovea on one side. Two patients (18.2%) showed asymmetry in height while maintaining same contour on both sides and 1 patient (9.1%) showed both height and contour asymmetry (Figure 2, Table 1)

The olfactory fossa was type I in 15 patients (20%), type II in 59 patients (78.7%) patients and type III in 1 patient (1.3%) (Figure 3). Anterior ethmoid artery was seen coursing through ethmoidal air cells in 31 patients (41.3%) and running along anterior skull base in 44 patients (58.7%) (Figure 4). In 6 patients (8%) the lateral lamella was noted laterally placed or protruded into ethmoid cells (Figure 5, Table 1).

Table 1: Description and frequencies of variations of anterior skull base (n= 75)

	Number	Percentage
Ethmoid asymmetry	64	85.4
Asymmetry in contour	8	72 .7
Asymmetry in height	2	18.2
Combined	1	9.1
Anterior ethmoid artery		
Course through ethmoid cells	31	41.3
Runs along skull base	44	58.7
Lateral lamella		
Normal	69	92
Lateralised or protruded	6	8
Olfactory fossa		
Type I	15	20
Type II	59	78.7
Type III	1	1.3

DISCUSSION

It has been described in previous literature the prevalence of asymmetric ethmoid fovea and its importance in avoiding complications during surgery. Different studies used different radiological parameters.[2,5,6] The fovea ethmoidalis or ethmoid roof is lowest medially at its articulation with the lateral lamella and rises from medial to lateral in a "gullwing" configuration. The level is a function of vertical height of lateral lamella (height) and the angle at which it articulate with the cribriform plate (contour). The height is considered asymmetric if there is a difference in vertical height of lateral lamella and asymmetry in contour was reported when there is difference in angle between lateral lamella and cribriform plate.[2] Meyers et al[5] used a horizontal or foveal plane to determine the height of which passes medially between the point of junction of fovea to the medial orbital walls, then extending laterally through the orbit. They also measured as angle between medial orbital wall and fovea. The overall prevalence of asymmetric fovea varies in different studies. Dessi et al reported ethmoid asymmetry in 9.8% patients (8.2% on right side was lower and 1.2% cases on left side).[6] Lebowitz et al[2] reported asymmetry in majority of their case (57%). Of these 63.2% showed lower on right side and 36.8% on the left. Meyers et al[5] reported a low fovea in 12% cases

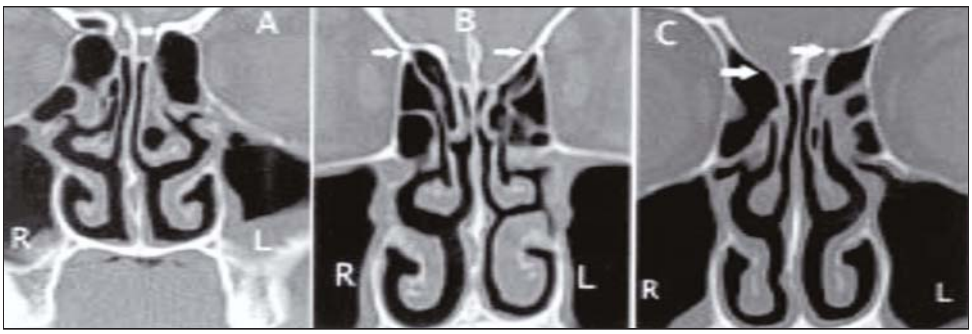

Figure 2: Coronal sinus CT scan showing three patterns of ethmoid asymmetry with A) height asymmetry with low lying fovea on left (arrow), B) contour asymmetry with flattening of fovea on left side (arrows) and C) combined height and contour asymmetry (arrows)

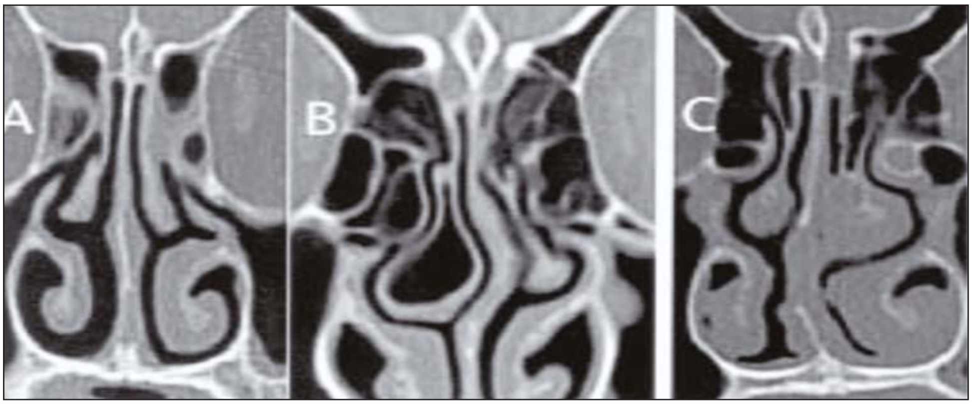

Figure 3: Coronal sinus CT scan with olfactory fossa A) Type I, B) Type II and C) Type III

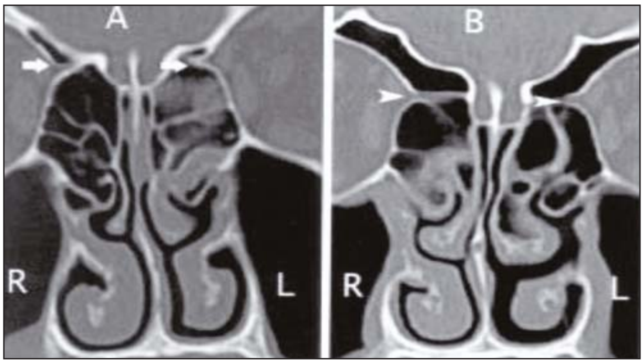

Figure 4: Coronal sinus CT scan showing course of anterior ethmoid artery A) along skull base (arrows) and B) coursing along anterior ethmoid cells (arrow heads)

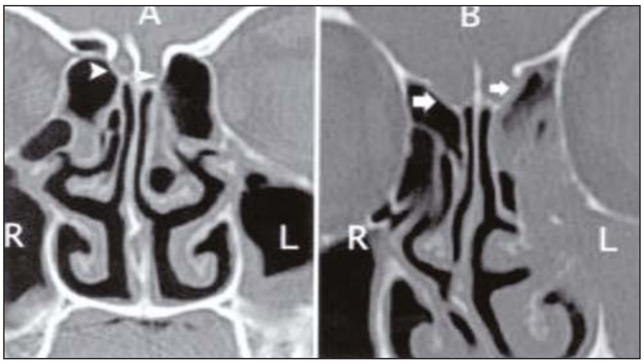

Figure 5: Coronal sinus CT scan showing A) lateral lamella (arrow heads) and B) laterally protruded lateral lamella (arrows)

based on their assessment. In all previous studies including ours the occurrence of low lying fovea is on right side, hence chance of getting complications may be higher on this side. Freedman et al[7] emphasized that the cerebrospinal fluid leak occur more frequently when ethmoidectomy is being performed on the right by right sided surgeon standing on the right side may be attributed to awkward position of surgeon.

Cribriform plate and its lateral lamella are other possible areas of danger. The cribriform plate forms the partition between the nasal chamber and the anterior cranial fossa and is more caudal than the ethmoid roof. The reciprocal arrangement between these structures were investigated by Keros (1962)[10] in his study of 450 skulls and termed as olfactory fossa. He distinguished three types – Type I: the cribriform plate 1-3mm more caudal than ethmoid roof. This is the least common disposition (11.59% of 450 skulls), Type II: the cribriform plate is 4-7mm lower, occurred in 70.16% of cases and Type III: the cribriform plate is from 8-16mm (18.25%). Basak et al[3] in their study of pediatric patients reported the most common type to be type II (53%) followed by type III (38%) and type 1 (9%). In our study on adult patients, type II (78.7%) was the most common followed by type I (20%) and type III (1.3%) (Figure 3). Type III is most dangerous for the surgeon because of the likelihood of a perforation through the lateral lamella of the cribriform plate.

Topographic relationships of the anterior ethmoidal artery are of particular significance since in its course from orbit to the olfactory fossa, it traverses three cavities: orbit, ethmoidal labyrinth and the anterior cranial fossa. The course through the lateral lamella of lamina cribrosa is the most critical area with least resistance.[9] Basak et al highlighted the importance of localization of anterior ethmoidal artery on CT scan. Anterior ethmoid artery enters nasal cavity via anterior ethmoid foramen and courses in the canalis ethmoidalis anterior. A V-shaped notch on CT marks the entry of it through lamina papyracea.[3] Basak et al[3] in their study in pediatric age group noticed anterior ethmoid artery coursing freely in the ethmoidal cells in 67% cases and the rest were along skull base. In our study we noticed anterior ethmoid artery coursing through ethmoidal air cells in 31 patients (41.3%) and along anterior skull base in 44 patients (58.7%) (Figure 4). This is an additional risk in these patients. The chance of coming face to face with the artery and to injure is greater since the upper lateral boundary of ESS is bounded by the anterior ethmoid artery and upper medial border by the lamina cribrosa.[3].Hence this high prevalence of variation in course of anterior ethmoid artery is vital information in patients undergoing ESS to prevent hemorrhage or orbital haematoma due to anterior ethmoid artery injury.

It had been reported earlier that the lateral lamella constitute another potential area vulnerable for iatrogenic trauma and it might bulge into ethmoid cavity.[8] In our study we noticed extreme lateralisation and protrusion of lateral lamella in 6 patients (8%) having a possible risk of getting injury during surgery (Figure 5).

CONCLUSION

Anatomical variations of anterior skull base like asymmetric fovea, lateral lamella, olfactory fossa and change in course of anterior ethmoid artery are high in patients going for endoscopic sinus surgery. A meticulous pre-operative assessment of CT scan by the surgeon is mandatory to avoid serious iatrogenic complications in this endoscopic era.

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