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Original Research Article

Radiological study of the myriad variations in frontal sinus anatomy: an institutional study

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ABSTRACT

Background: The frontal sinus is a challenging area for endoscopic surgeons. The variations in the frontal sinus differs so much among individuals that there are forensic applications. A detailed radiological study of the sinus is important for understanding the pathophysiology of sinusitis and as a prerequisite for frontal sinus drainage procedures. Aims and objectives were to document the anatomical variations of the frontal sinus (radiological) and to correlate the variations with the signs and symptoms of sinusitis.
Methods: Coronal and axial CT paranasal sinuses scans of 30 consecutive patients who attended the Otolaryngology clinic OPD in St. John's medical college and hospital, Bangalore, India with signs/symptoms of chronic sinusitis were evaluated between January to July 2018.
Results: The average frontal sinus diameter in patients with sinusitis was 6.65 mm. The prevalence of frontal cells in our study was 48%. Agger nasi cells were the most common cells seen. Frontal sinus disease was found in 72% of the studied sides in the scans.
Conclusions: Frontal sinus anatomy varies with different ethnicities. It is very important to study the frontal sinus anatomy before exploring the sinus for disease clearance and avoid surgical complications.

Keywords: Frontal sinus, CT scan of paranasal sinuses, Agger nasi, Frontal cells, Frontal recess

INTRODUCTION

In recent years endoscopic sinus surgery is used to treat sinus disease but still frontal sinus disease is very challenging to treat. The frontal sinus anatomy is very complex and varies because of the anatomical variations in the ethmoidal infundibulum and frontal sinus.[1] There are many anatomic features which compromise the frontal sinus drainage. These include the agger nasi cell, the uncinate process attachment, the ethmoidal bulla and concha bullosa. Understanding the anatomy is very important in order to clear the disease, prevent recurrences and avoid complications.[2] The anatomy of the frontal sinus varies between ethnicities and is so unique that it even has forensic applications. A high resolution CT scan with 3mm cuts will help in analysing the anatomy. Both coronal and axial views with sagittal reconstruction help in assessing the frontal recess area. The frontal recess diameter, agger nasi cells, frontal cells are to be studied thoroughly before undertaking surgery.

METHODS

Study design, place and period

This descriptive study was done at the Otolaryngology clinic OPD in St. John's medical college and hospital, Bangalore, India in 30 patients with signs/symptoms of

chronic sinusitis. The study period was between January to July 2018.

Inclusion criteria

Patients who presented to the ENT OPD with signs and symptoms of chronic frontal sinusitis (frontal headache, post nasal drip, recurrent attacks of sinusitis, purulent nasal discharge).

Exclusion criteria

Patients with acute sinusitis and children.

Procedure

Coronal and axial CT paranasal sinuses scans of 30 consecutive patients who attended the oto-laryngology clinic OPD in St. John's medical college and hospital, Bangalore, India with signs/symptoms of chronic sinusitis were evaluated between January to July 2018. All the pre-operative CT scans were done on a 64 slice, high resolution CT machine. 1 mm thin axial scans were taken for each patient, reformed images of 2 mm coronal and few sagittal cuts were finally obtained as CT scan films. The scans were studied to identify the agger nasi and the frontal cells as classified by Kuhn et al. The cells were identified on the right and left sides separately. Other types of frontal recess cells like interfrontal sinus septal cells, supraorbital cells, suprabullar cells, and frontal bulla cells were also studied. Overall the features assessed were,

- Frontal Recess Diameter.
- Type I, II, III, IV frontal sinus cells.
- Agger nasi.
- Supraorbital ethmoid sinus.
- Suprabullar cell.
- Frontal bullar cell.
- Frontal intersinus septal cell.

Statistical analysis

Since this is a descriptive study, paired 't' test was used for statistical analysis. P value of 0.05 was taken to be significant.

Ethical approval

Consent was taken from the patient prior subjecting them to the CT scan. IERB clearance was taken. This was a non-interventional study.

RESULTS

Among the 30 patients involved in the study, there were 17 males and 13 females. The age ranged from 18 to 54 years with a mean age of 37 years.

Our study showed that, the range of the frontal recess diameter varied between 7.8 to 2.4 mm. The average frontal sinus diameter in patients with sinusitis was 6.65 mm and in those without frontal sinusitis was 5.11 mm.

There were 12 suprabullar cells (20%), 8 frontal bullar cells (13.3%), 2 frontal intersinus septal cell (3.3%) and 27 supraorbital cells (45%) among the studied sides. There was a variation in the cells found in the right and left sides. Agger nasi cells were more commonly seen on the right side compared to the left (86% Right side, 76% left side). Supraorbital cells were more common the right than the left (50% right, 40% left). However, suprabullar cells were found more often on the left than the right side (23% left, 16% right).

Frontal sinus disease was found in 72% of the studied sides in the scans.

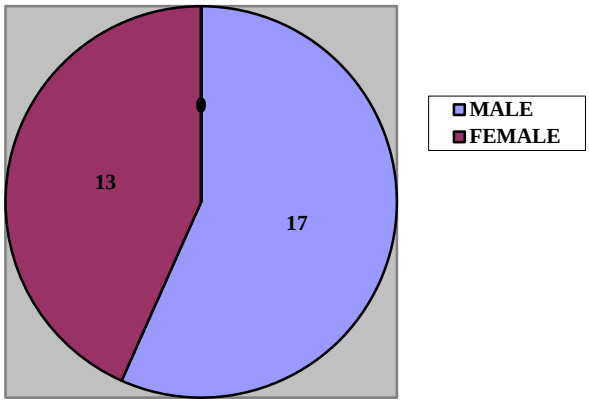

Figure 1: Male to female distribution.

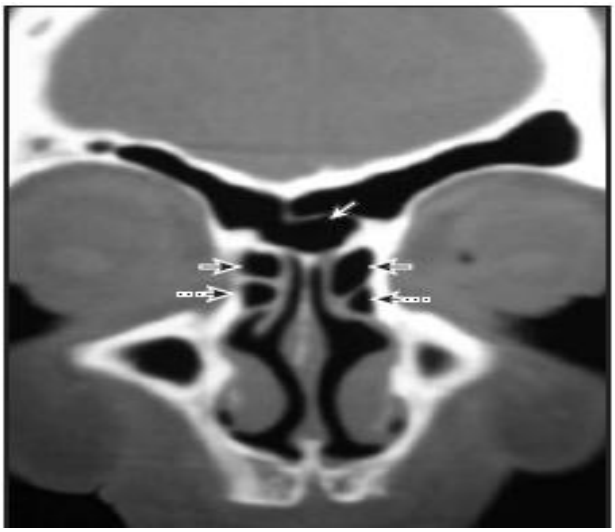

Figure 2: Type I frontal cells were found in 15 of the studied sides (25%).

Figure 3: Type II frontal cells were found in 4 of the studied sides (6%).

Figure 4: Type III frontal cells were found in 31 of the studied sides (15%).

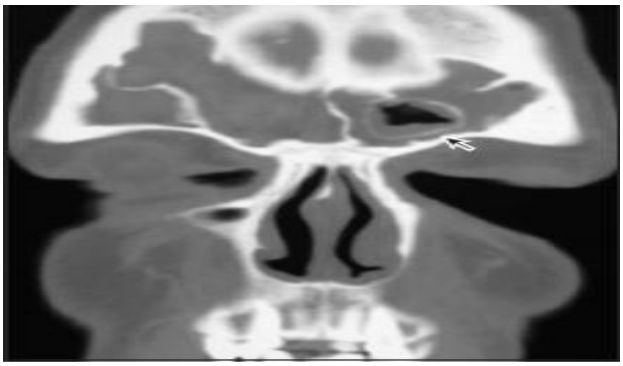

Figure 5: Type IV frontal cells was found in only 1 of the studied sides (1.6%).

Table 1: Distribution of frontal cells.

Frontal cell	Right side	Left side
Type I	9	6
Type II	3	1
Type III	3	6
Type IV	0	1

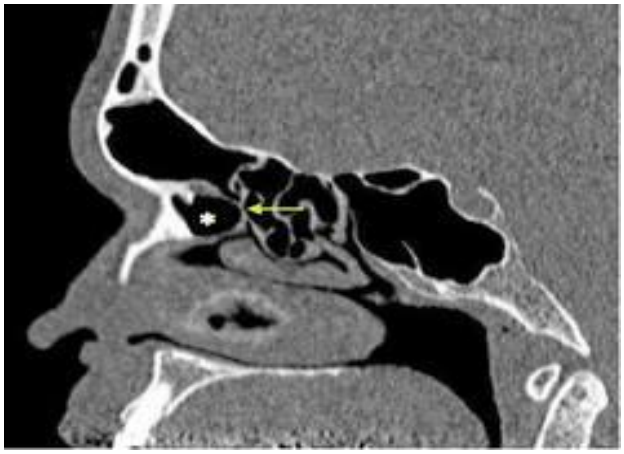

Figure 6: Agger nasi cells were found in 49 of the studied sides (81.6%) (26 on the right and 23 on the left side).

Table 2: Distribution of the agger nasi and other cells.

Type of cell	Right (%)	Left (%)
Agger nasi	26 (53)	23 (47)
Supra orbital cell	12 (44)	15 (55)
Supra bullar cell	7 (58)	5 (42)
Frontal bullar cell	3 (37.5)	5 (62.5)
Frontal intersinus septal cell	2	

DISCUSSION

The "frontal recess" or outflow tract of the frontal sinus is the key area in pathogenesis of frontal sinus disease. Although overall results of surgical treatment of chronic sinus disease has improved a lot in recent years, frontal sinus disease still poses a significant challenge to most of the endoscopic sinus surgeons. This is because frontal recess is a difficult area to operate because of its small size, the sensitive structures nearby, and the awkward angle one must often assume to adequately view and instrument this area.[1] So it is apparent that a thorough knowledge of frontal recess anatomy is important for the surgeon to perform a safe and successful frontal sinus surgery.[2] Anatomically, the frontal recess is bounded medially by the middle turbinate and laterally by the lamina papyracea.[3] The posterior wall of the frontal recess is the bulla lamella. If the latter does not reach the skull base, the frontal recess may open into the suprabullar recess. The anterior wall is formed by the frontal process of the maxilla and the frontal bone, which thickens anterosuperiorly to form the frontal beak. In the posteromedial and superior region of the frontal recess lies the lateral wall of the olfactory fossa, which is the thinnest part of the anterior skull base.[4]

In 1941, van Alyea detected frontal cells in 41% of the specimens during cadaveric dissections.[6] He included not only the frontal cells as classified by Kuhn et al, but also the agger nasi, the supraorbital cells, and the interfrontal

sinus septal cells.[5] Later studies showed the agger nasi on their own to be much commoner than Van Alyea's results.[6]

Krzeski et al identified frontal cells in 23.56% of the studied sides of paranasal sinuses CT scans.[7,8] Meyer et al studied the coronal CT scans of paranasal sinuses in a large population.[9] They detected a prevalence of frontal cells in 20.4% of the studied individuals. Their results showed a significantly higher incidence of frontal sinus disease in presence of types III and IV frontal cells. Han et al detected frontal cells in 39.6% of the paranasal sinuses CT scan sides when studying a Chinese population without frontal sinusitis symptoms.[10] The prevalence of frontal cells in a study by Eweiss et al was 78.571%.[7]

The prevalence of frontal cells in our study was 48%. There is a lot of variation in the prevalence of frontal cells in different studies. This could possibly be as a result of different ethnicity.

According to Wormold, agger nasi cells are the key to understanding the anatomy of frontal recess.[11] In a study by Sagar et al, the prevalence of agger nasi cells was 94 %.[2] In the literature distribution of agger nasi cells are between 78 and 98.5% of the patients. According to Landsberg and Friedman agger nasi cells were found in 78% of scans.[12] Bolger et al has found the prevalence in 98.5% of their cases. Our study showed agger nasi cells in 81.6% of the studied scans.[13]

Sagar et al found the prevalence of supraorbital cells to be 26%.[2] Our study showed the prevalence of these cells to be at 45% as compared to that of 15% in Owen and Khun's study, 62% in Lee et al study.[14,15]

CONCLUSION

Frontal sinus anatomy varies widely with different ethnicities. A good understanding of the frontal sinus anatomy is important to ensure clearance of disease, to prevent recurrence of disease and avoid complications while operating. A high resolution CT scan giving thin coronal and sagittal 'cuts' is important for the surgeon addressing frontal recess area.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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