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Computed tomographic analysis of the prevalence of International Frontal Sinus Anatomy Classification cells and their association with frontal sinusitis

N Seth[1], J Kumar[1], A Garg[1], I Singh[2] and R Meher[2]

Departments of [1]Radiodiagnosis and [2]Otorhinolaryngology, Maulana Azad Medical College and Associated Lok Nayak Hospital, Govind Ballabh Pant Institute of Postgraduate Medical Education and Research ('GIPMER') and Guru Nanak Eye Centre ('GNEC') Hospitals, New Delhi, India

Main Article

Dr J Kumar takes responsibility for the integrity of the content of the paper

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Author for correspondence:
Dr Jyoti Kumar,
Department of Radiodiagnosis,
Maulana Azad Medical College and Associated Lok Nayak Hospital,
GIPMER and GNEC Hospitals, New Delhi,
Delhi-110002, India
E-mail: drjyotikumar@gmail.com

Abstract

Objectives. To determine the radiological prevalence of frontal cells according to the International Frontal Sinus Anatomy Classification in patients undergoing computed tomography of the paranasal sinuses for clinical symptoms of chronic rhinosinusitis, and to examine the association between cell classification and frontal sinusitis development.

Methods. A total of 180 (left and right) sides of 90 patients were analysed. The prevalence of each International Frontal Sinus Anatomy Classification cell was assessed. Logistic regression analysis was used to compare the distribution of various cells in patients with and without frontal sinusitis.

Results. The agger nasi cell was the most commonly occurring cell, seen in 95.5 per cent of patients. The prevalence rates for supra agger cells, supra agger frontal cells, supra bullar frontal cells, supra bullar cells, supra-orbital ethmoid cells and frontal septal cells were 33.3 per cent, 22.2 per cent, 21.1 per cent, 36.1 per cent, 39.4 per cent and 21.1 per cent, respectively. There was no significant difference in the occurrence of any of the cell types in patients with frontal sinusitis compared to those without ($p > 0.05$).

Conclusion. The presence of any of the International Frontal Sinus Anatomy Classification cells was not significantly associated with frontal sinusitis.

Introduction

The frontal sinus is described as the most difficult sinus to access surgically, given its challenging and variable anatomy, as well as its proximity to the cribriform plate, orbit and anterior ethmoidal artery. This complex space may be pneumatised by various surrounding cells. Although it is observed as a normal variant in much of the population, these cells may have the potential to cause frontal sinusitis, possibly due to obstruction of the frontal sinus outflow tract.

Various classifications have been given for frontal recess cells. In 1994, Bent, Kuhn and colleagues identified four frontal cell variations and classified them as type I–IV cells.[1] In 1996, Kuhn described the modified Kuhn classification of fronto-ethmoidal cells.[2] In 2004, the Kuhn–Citardi–Lee classification was described by Lee *et al.*[3] The recent International Frontal Sinus Anatomy Classification was proposed in 2016.[4] This latter consensus document was developed to provide a better description of frontal cells in relation to the frontal sinus drainage pathway, and to improve the surgeon's ability to: understand various possible variations, plan surgery, and communicate these complexities when teaching or reporting outcomes.

Many previous studies have investigated the clinical significance of fronto-ethmoidal cells described using older classification systems. Various studies have shown that the resultant narrowing of the frontal recess by Kuhn cells is associated with frontal sinusitis.[5–7] In addition, the presence of a fronto-ethmoidal cell (types 3–4), supra bullar cell and frontal bullar cell has been reported to significantly influence frontal sinusitis development.[6,7]

This study aimed to determine the prevalence of frontal cells according to the International Frontal Sinus Anatomy Classification, and to examine the association between cells classified via this system and frontal sinusitis by determining the frequency of different cell types in those with and without frontal sinusitis. We also studied the association between the different cell classifications and gender. In addition, the relationships between International Frontal Sinus Anatomy Classification cells and frontal sinus ostium and frontal recess diameters were explored.

Materials and methods

Ninety adults of either sex, with a clinical suspicion of rhinosinusitis, who had undergone a computed tomography (CT) scan of the paranasal sinuses, were included in the study.

Table 1. International Frontal Sinus Anatomy Classification cell types

Anterior cells	Posterior cells	Medial cells
Agger nasi cell – anterior most ethmoid cell	Supra bullar cell – cell above bulla ethmoidalis that does not enter frontal sinus	Frontal septal cell – medially based cell, attached to inter-frontal sinus septum
Supra agger cell – antero-lateral ethmoid cell that does not pneumatise into frontal sinus	Supra bullar frontal cell – cell above bulla ethmoidalis extending into frontal sinus	
Supra agger frontal cell – antero-lateral ethmoid cell that extends into frontal sinus	Supra-orbital ethmoidal cell – cell that pneumatises around, anterior to, or posterior to anterior ethmoidal artery	

Ethical clearance was obtained from the institutional ethics committee (approval code: F No 17/IEC/MAMC/2017-Radio D-10).

With patients in the supine position, all patients underwent high-resolution CT of the paranasal sinuses and nasal cavity using a 128-slice single-source CT scanner (Somatom® Definition Adaptive Scanning (AS+) equipment; Siemens Healthineers, Erlangen, Germany). The following scanning parameters were used: 120 kVp, 80 mAs, 128×0.6 mm detector collimation, and matrix of 512×512. Thin axial sections of 0.6 mm thickness were obtained for each patient. Thin multiplanar images along coronal and sagittal planes were reconstructed from these axial images.

All patients in the study were aged over 18 years, as the size of the frontal sinus becomes stable after 18 years of age. Exclusion criteria included patients who had a previous history of sinus surgery, a maxillofacial fracture, sinonasal malignancy, fungal sinusitis or congenital anomalies, as these disrupt the frontal recess anatomy, hindering cell identification.

A total of 180 (left and right) sides of 90 patients were evaluated. Each scan was evaluated by two radiologists, one with 25 years of experience and another with 15 years of experience. In cases of discrepancy, a consensus was reached.

Fronto-ethmoidal cells were categorised according to the International Frontal Sinus Anatomy Classification, and the prevalence of each cell type was evaluated (Table 1).[4] The frontal ostium diameter was measured in the sagittal plane between the frontal beak and the anterior skull base (Figure 1a). The frontal recess diameter was measured in the sagittal plane from the agger nasi cell and nasofrontal beak anteriorly, to the ethmoid bulla, bulla lamella, supra bullar frontal cells and supra bullar cells posteriorly (Figure 1b).[8] The right and left sides of each scan were evaluated for evidence of frontal sinusitis. Frontal sinusitis was evaluated on CT; it was defined as more than 3 mm of mucosal thickening involving the frontal sinus or the dependent portions of the frontal sinus.

Statistical analysis

Data were analysed and statistically evaluated using SPSS software, version 17 (SPSS, Chicago, Illinois, USA). Quantitative data were expressed in terms of means and standard deviations, and differences between two comparable groups were tested using the student's *t*-test. Qualitative data were expressed in percentages. For quantitative data, analysis of variance was used to compare more than two groups, followed by a post-hoc test. For qualitative variables, the chi-square test was used. A *p*-value of less than 0.05 was considered statistically significant. Odds ratio and 95 per cent confidences were used to quantify the risk factors. A univariate analysis was conducted and the factors that were found to be significant with a *p*-value of 0.1 or less were entered in multivariate analysis.

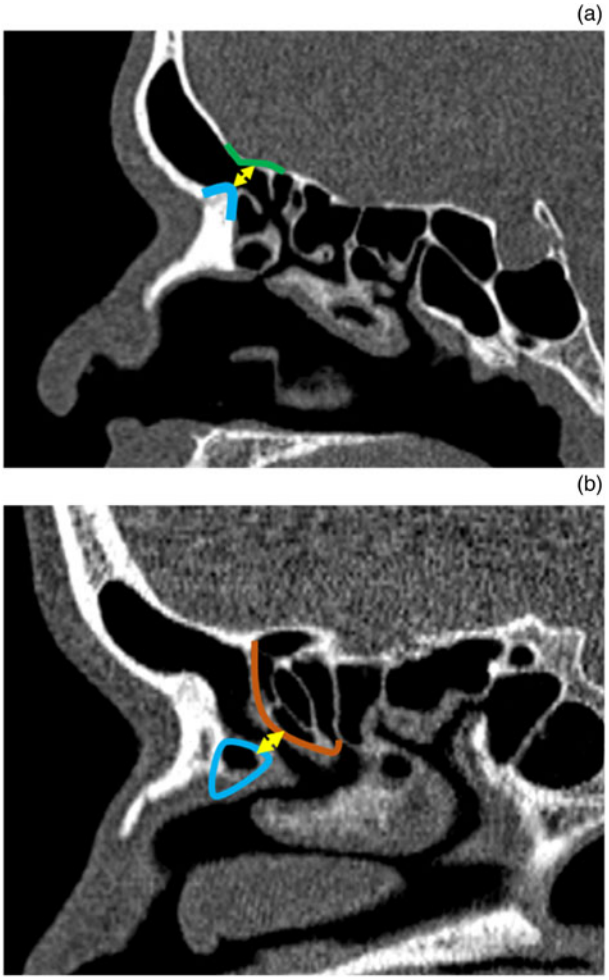

Fig. 1. (a) Non-contrast parasagittal computed tomography (CT) images of the paranasal sinus, showing the frontal sinus ostium (yellow double-headed arrow) located at the level of frontal beak (blue solid line), measured from frontal beak anteriorly to the skull base posteriorly (green solid line). (b) Non-contrast parasagittal CT images of the paranasal sinus, showing the frontal recess (yellow double-headed arrow), measured from posterior wall of the agger nasi anteriorly (blue solid line) to the ethmoidal bulla posteriorly (orange solid line).

Results

Demographics

The study group consisted of 90 patients (45 males (50 per cent) and 45 females (50 per cent)), with a male to female ratio of 1:1. The majority of patients (20 per cent) were in the age group of 26–30 years. As patients aged less than 18 years were excluded from the study, the youngest patient was 18 years old and the oldest was 62 years old. The mean age of the patients was 38 years.

Cell prevalence

The prevalence of frontal cells (Table 2) was described, according to the new International Frontal Sinus Anatomy

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Table 2. Prevalence of IFAC cell types

IFAC cell type	Total*	Males†	Females‡	*P*-value
Anterior cells				
– Agger nasi cell	172 (95.5)	86 (95.5)	86 (95.5)	0.94
– Supra agger cell	60 (33.3)	25 (27.7)	35 (38.8)	0.07
– Supra agger frontal cell	40 (22.2)	26 (28.8)	14 (15.5)	0.04
Posterior cells				
– Supra bullar cell	65 (36.1)	30 (33.3)	35 (38.8)	0.31
– Supra bullar frontal cell	38 (21.1)	23 (25.5)	15 (16.6)	0.19
– Supra-orbital ethmoidal cell	71 (39.4)	36 (40)	35 (38.8)	0.93
Medial cells				
– Frontal septal cell	38 (21.1)	22 (24.4)	16 (17.7)	0.34

Data represent numbers (and percentages) of International Frontal Sinus Anatomy Classification cells, unless indicated otherwise. *$n = 180$; †$n = 90$; ‡$n = 90$. IFAC = International Frontal Sinus Anatomy Classification

Classification system, in terms of anterior (Figure 2), posterior and medial cells (Figure 3). The agger nasi cell was the most commonly occurring cell, seen in 95.5 per cent of the patients. The prevalence of frontal septal cells and supra bullar frontal cells was lowest, with each cell type seen in 21.1 per cent of patients. The prevalence of supra agger cells, supra agger frontal cells, supra bullar cells and supra-orbital ethmoid cells was 33.3 per cent, 22.2 per cent, 36.1 per cent and 39.4 per cent, respectively.

Gender-based cell prevalence

The prevalence of the different International Frontal Sinus Anatomy Classification cells in males and females was also studied (Table 2). The occurrence of different cells varied in males and females. In our study, agger nasi cells had the highest prevalence, in both males and females, of 95.5 per cent. The prevalence rates of supra agger cells, supra agger frontal cells, supra bullar cells, supra bullar frontal cells, supra-orbital ethmoidal cells and frontal septal cells in males were 27.7 per cent, 28.8 per cent, 33.3 per cent, 25.5 per cent, 40 per cent and 24.4 per cent, respectively. In females, the prevalence rates were 38.8 per cent, 15.5 per cent, 38.8 per cent, 16.6 per cent, 38.8 per cent and 17.7 per cent, respectively. The supra agger frontal cells were found to be significantly more prevalent in males (28.8 per cent) than in females (15.5 per cent) ($p < 0.04$). There were no statistically significant differences between males and females in terms of the occurrence of the remaining International Frontal Sinus Anatomy Classification cells.

Associations with frontal ostium and recess diameters

The mean (± standard deviation) diameter of the frontal sinus ostium was 5.46 ± 2.11 mm and the mean diameter of the frontal recess was 1.94 ± 1.08 mm. The patients with supra bullar frontal cells had a significantly ($p < 0.05$) shorter anteroposterior diameter of the frontal ostium (4.81 ± 2.12 mm) compared to those without supra bullar frontal cells (5.60 ± 2.18 mm) (Table 3). However, there were no statistically significant differences in the anteroposterior diameters of the frontal ostium and frontal recess regarding the presence or absence of any other International Frontal Sinus Anatomy Classification cells.

Association with frontal sinusitis

In our study, frontal sinusitis was seen in 33.9 per cent of cases (61 out of 180) and absent in 66.1 per cent of cases (119 out of 180). The incidence of supra bullar cells and supra bullar frontal cells was greater in patients with frontal sinusitis (44.3 per cent and 26.2 per cent respectively) than in those without (31.9 per cent and 18.5 per cent respectively) (Table 4). However, there were no significant differences in the incidence rates of any of the International Frontal Sinus Anatomy Classification cells in patients with frontal sinusitis compared to those without frontal sinusitis (all $p > 0.05$).

Discussion

The frontal sinus is described as the most difficult sinus to access surgically because of its challenging and variable anatomy, as well as its proximity to the cribriform plate, orbit and anterior ethmoidal artery. The frontal sinus drains into the frontal recess through the frontal ostium. The frontal recess is a complex space, with the approximate shape of an inverted funnel or cone whose apex is at the frontal ostium. This complex space may be pneumatised by various surrounding cells. Although it is observed as a normal variant in much of the population, these cells may have the potential to cause frontal sinusitis, possibly due to obstruction of the frontal sinus outflow tract.

During functional endoscopic sinus surgery (FESS), complete removal of these frontal cells is necessary to ensure adequate opening of the frontal sinus, and to enable proper physiological drainage and ventilation. Incomplete removal of the cells in the frontal recess is one of the most common causes of FESS failure.

The pathophysiology of frontal sinusitis is associated with disturbance of its drainage and ventilation of the sinus via the ostium. Numerous studies have documented the prevalence of frontal cells, using the various frontal sinus classification systems, and examined their association with frontal sinusitis development. However, only one study in the literature investigated the association of International Frontal Sinus Anatomy Classification cells with frontal sinusitis.[9]

Cell prevalence findings

The agger nasi cell, which is the anterior most ethmoid cell, was documented in 95.5 per cent of the frontal sinuses in our Indian population. This is comparable to published findings, which range from 89 per cent to 94 per cent.[3,9] In a study by Choby *et al.*[10] on a North American population and a study by Tran *et al.*[11] on a Vietnamese population, where the fronto-ethmoidal cells were categorised according to the International Frontal Sinus Anatomy Classification, the prevalence rates of agger nasi cells were 96.5 per cent and 95.7 per cent respectively. The consistent presence of agger nasi cell is the primary reason why this cell is used as a reference cell for all the anteriorly based cells in the International Frontal Sinus Anatomy Classification system.

In our study, the prevalence rates of supra agger cells and supra agger frontal cells were 33.3 per cent and 22.2 per cent respectively, which are closer to the rates reported for the North American population, of 30 per cent and 20 per cent respectively.[10] The prevalence rates for supra agger cells and supra agger frontal cells were 16.3 per cent and 13 per cent

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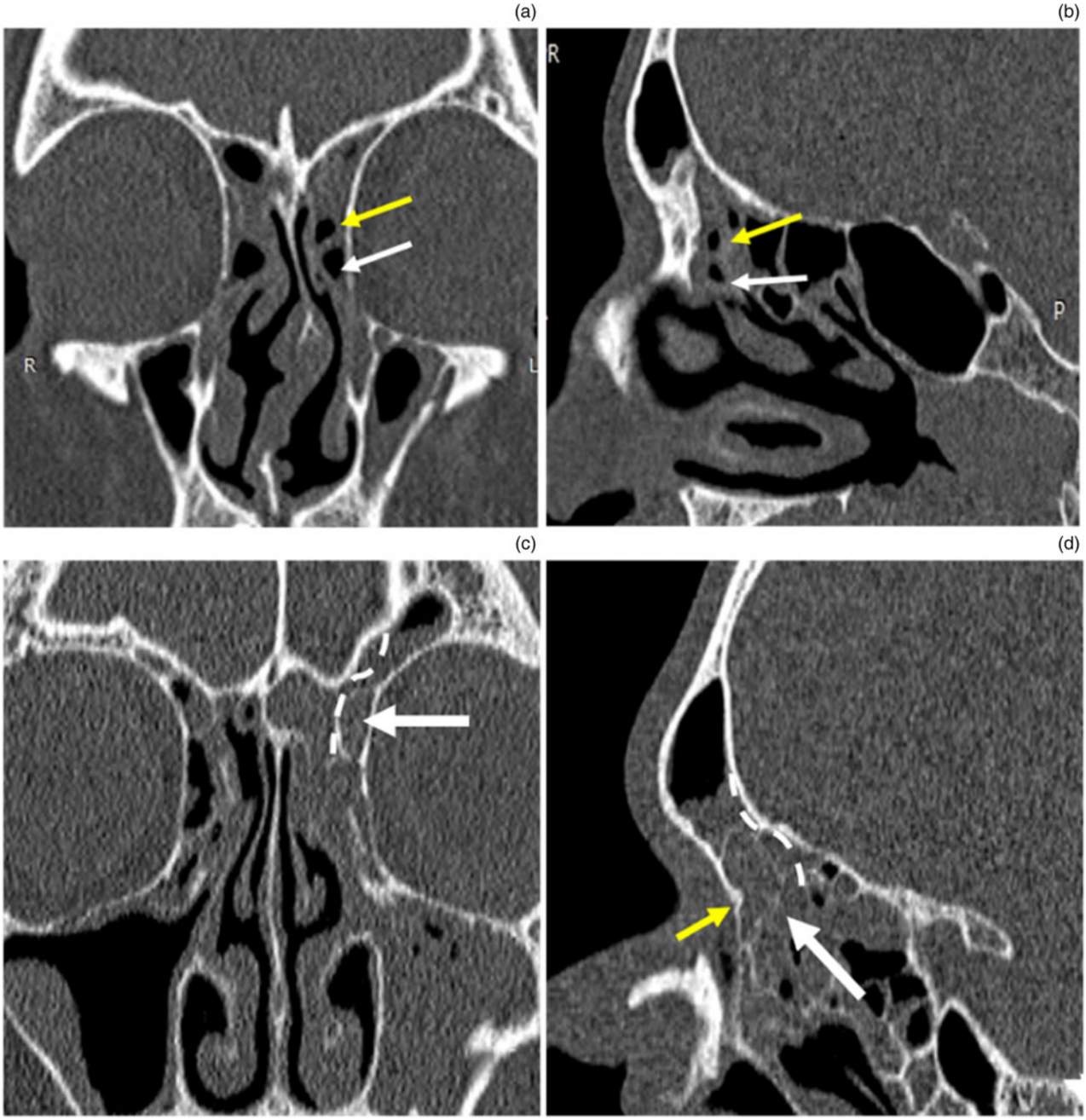

Fig. 2. Anterior International Frontal Sinus Anatomy Classification cells. Non-contrast coronal (a) and sagittal (b) computed tomography (CT) images of the paranasal sinus, showing a left agger nasi cell (white arrow) and a left supra agger cell (yellow arrow) in a patient with bilateral frontal sinusitis. Non-contrast coronal (c) and sagittal (d) CT images of the paranasal sinus, showing a left supra agger frontal cell (white arrow) in a patient with bilateral frontal sinusitis, which is seen to pneumatise into the frontal sinus through the frontal ostium and to sit above the frontal beak (yellow arrow). The cell pushes the drainage pathway of the frontal sinus posteriorly and medially (white dotted line). R = right; L = left; P = posterior

respectively for the Vietnamese population, which are lower than the rates in our study.[11] Direct comparison of these cells with earlier studies using an older classification system was difficult, because of their different anatomical description. Tran *et al.* assumed that type 1 and type 2 cells (categorised using the Bent and Kuhn classification) likely correspond to supra agger cells, with type 3 and type 4 (Bent and Kuhn classification) likely representing supra agger frontal cells.[1,11] The quoted prevalence rates for these cells were highly variable, ranging from 16.3 per cent to 56 per cent for T1 and T2 cells, and from 5.6 per cent to 13 per cent for T3 and T4 cells, respectively.

The prevalence of supra bullar cells in our study was 36.1 per cent. This prevalence rate is lower than that reported in the study by Choby *et al.*[10] (another International Frontal Sinus Anatomy Classification based study) of a North American population, which reported the prevalence rate of 72 per cent.[10] According to Tran *et al.*, supra bullar cells were noted in 46.2 per cent of patients, which is also higher than in our study.[11] The prevalence of supra bullar frontal cells in our study was 21.1 per cent. This prevalence rate was higher than those in the North American and Vietnamese groups, which were 5.5 per cent and 4.3 per cent respectively.[10,11]

The prevalence of supra-orbital ethmoidal cells varied significantly across studies, when examining the previously published literature. In our study, supra-orbital ethmoidal cells were seen in 39.4 per cent of frontal sinuses, which is a higher rate than that reported for the North American population (28.5 per cent). In the study by Tran *et al.*, the prevalence of

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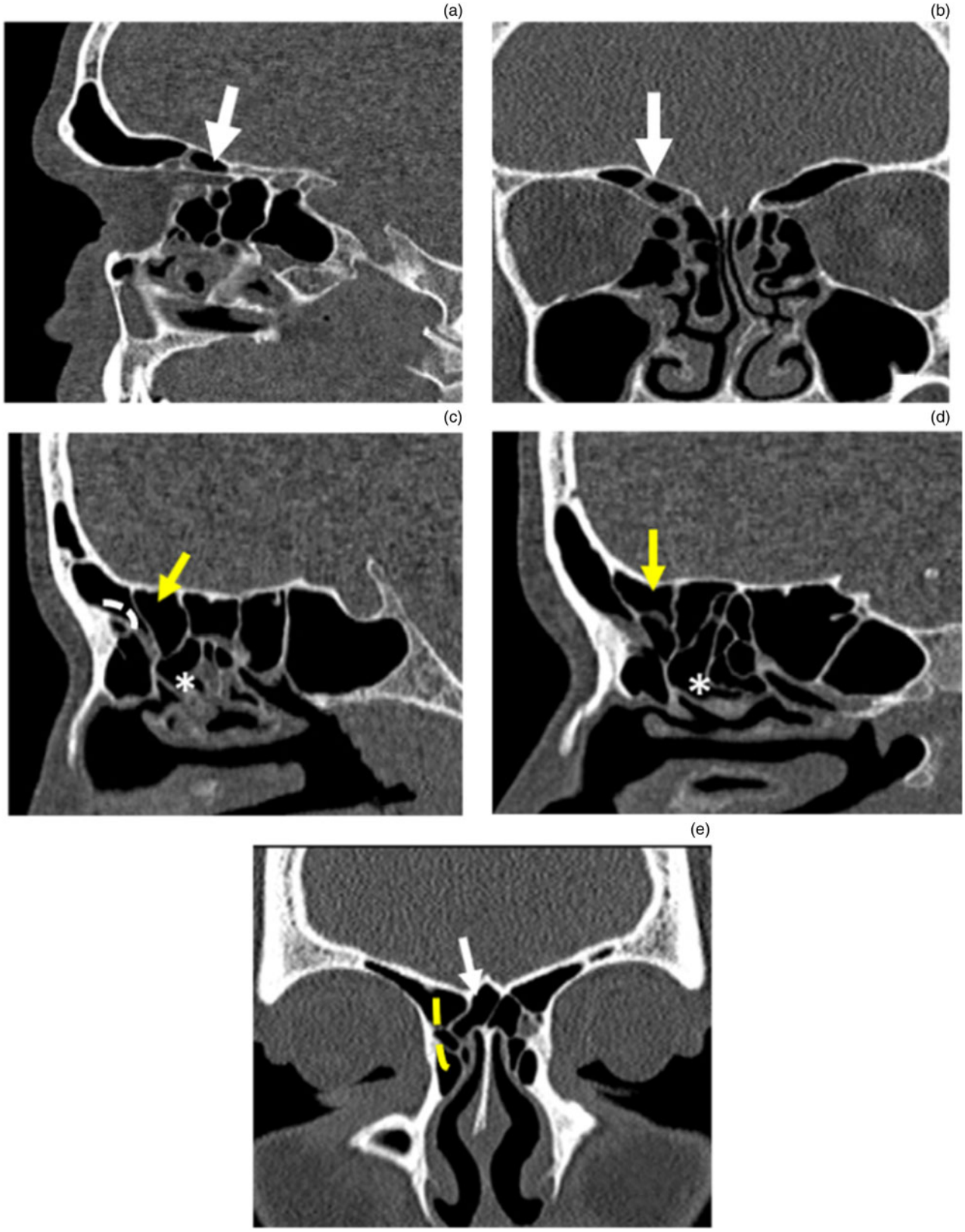

Fig. 3. Posterior and medial International Frontal Sinus Anatomy Classification cells. Non-contrast sagittal (a) and coronal (b) computed tomography (CT) images of the paranasal sinus, showing a supra-orbital ethmoid cell (white arrow) in a patient with bilateral frontal sinusitis, which pneumatises over the orbit. Non-contrast sagittal CT images of the paranasal sinus of a different patient, showing a: (c) supra bullar cell (yellow arrow), which lies above the ethmoid bulla (asterisk) pushing the frontal drainage pathway anteriorly (white dotted line); and (d) a supra bullar frontal cell (yellow arrow), which lies above the ethmoid bulla (asterisk) pneumatising through the frontal ostium. (e) Non-contrast sagittal CT image, showing a right frontal septal cell (white arrow) attached to the inter-frontal sinus septum.

supra-orbital ethmoidal cells was 17.3 per cent, which was lower than in our population.[11] The varying prevalence rates of supra-orbital ethmoidal cells may be a result of its similar radiological appearance to supra bullar cells.

The differences in these posterior cell prevalence rates could also be because of differences in ethnicity. Furthermore, 33 per cent of the patients in our study had frontal sinusitis, which could result in a higher prevalence of posterior cells.

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Table 3. Effect of presence of IFAC cells on mean anteroposterior diameters of frontal ostium and frontal recess*

IFAC cell type	Presence or absence	Frontal ostium		Frontal recess	
		Anteroposterior diameter (mean ± SD; mm)	*P*-value	Anteroposterior diameter (mean ± SD; mm)	*P*-value
Anterior cells					
– Agger nasi cell	Presence	5.41 ± 2.17	0.51	1.93 ± 1.04	0.90
	Absence	5.97 ± 2.20		2.26 ± 1.80	
– Supra agger cell	Presence	5.26 ± 2.16	0.45	1.98 ± 1.35	0.68
	Absence	5.52 ± 2.18		1.92 ± 0.91	
– Supra agger frontal cell	Presence	5.19 ± 2.04	0.39	1.78 ± 0.97	0.20
	Absence	5.51 ± 2.21		1.99 ± 1.10	
Posterior cells					
– Supra bullar frontal cell	Presence	4.81 ± 2.12	<0.05	1.98 ± 0.75	0.28
	Absence	5.60 ± 2.18		1.93 ± 1.15	
– Supra-orbital ethmoidal cell	Presence	5.28 ± 1.98	0.23	2.04 ± 0.90	0.08
	Absence	5.67 ± 2.28		1.88 ± 1.18	
– Supra bullar cell	Presence	5.14 ± 2.22	0.15	2.01 ± 0.88	0.15
	Absence	5.61 ± 2.13		1.90 ± 1.18	
Medial cells					
– Frontal septal cell	Presence	5.25 ± 2.06	0.55	1.95 ± 0.79	0.43
	Absence	5.48 ± 2.21		1.94 ± 1.14	

*n = 180. IFAC = International Frontal Sinus Anatomy Classification; SD = standard deviation

Table 4. Association of various IFAC cells with frontal sinusitis

IFAC cell name	Frontal sinusitis (n (%))		Univariate analysis		
	No*	Yes†	Odds ratio	95% CI	*P*-value
Agger nasi cell	115 (96.6)	57 (93.4)	0.49	0.12–2.05	0.32
Supra agger cell	44 (37.0)	16 (26.2)	0.60	0.30–1.19	0.14
Supra agger frontal cell	25 (21.0)	15 (24.6)	1.22	0.59–2.54	0.58
Supra bullar cell	38 (31.9)	27 (44.3)	1.69	0.89–3.19	0.10
Supra bullar frontal cell	22 (18.5)	16 (26.2)	1.56	0.75–3.26	0.22
Supra-orbital ethmoidal cell	50 (42.0)	21 (34.4)	0.72	0.38–1.37	0.32
Frontal septal cell	25 (21.0)	13 (21.3)	1.01	0.47–2.16	0.96

*n = 119; †n = 61. IFAC = International Frontal Sinus Anatomy Classification; CI = confidence interval

In our study, frontal septal cells were seen in 21.1 per cent of the patients; this rate is closer to the 30 per cent reported for the North American population.[10]

Table 5 shows a comparison of the various studies.

Gender-based cell prevalence findings

To best of our knowledge, no previous study has investigated the association between different International Frontal Sinus Anatomy Classification cells and gender. Gender differences may be important predictors of frontal sinus disease in males versus females. In our study, males had a higher proportion of frontal sinusitis (24.5 per cent) than females (13.3 per cent). Males also had a significantly higher number of supra agger frontal cells (28.8 per cent) than females (15.5 per cent) ($p < 0.05$), which may explain the increased incidence of frontal sinusitis in males. There were no statistically significant differences between males and females in terms of the occurrence of the remaining International Frontal Sinus Anatomy Classification cells. In a study by House *et al.*, males had a significantly higher number of type 4 cells (categorised based on the Bent and Kuhn classification[1]), with a higher incidence of frontal sinusitis in males.[12]

Frontal ostium and recess diameter findings

We studied the associations between anterior, posterior and medial International Frontal Sinus Anatomy Classification cells and the mean diameters of the frontal ostium and frontal recess. In our study, the mean anteroposterior diameter of the frontal ostium in patients with supra bullar frontal cells was 4.81 ± 2.12 mm, whereas the diameter in patients without supra bullar frontal cells was 5.60 ± 2.18 mm; this difference was statistically significant ($p < 0.05$). This result is similar

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Table 5. Comparison of IFAC cell prevalence among various ethnic groups

IFAC cell type	Current study, Indian population, 180 sides (% (*n*))	Choby *et al.*,[10] US population, 200 sides	Tran *et al.*,[11] Vietnamese population, 208 sides	German population
Anterior cells				
– Agger nasi cell	95.5 (172)	96.5 (193)	95.7 (199)	95.2 (237)
– Supra agger cell	33.3 (60)	30 (60)	16.3 (34)	49 (122)
– Supra agger frontal cell	22.2 (40)	20 (40)	13 (27)	24.9 (62)
Posterior cells				
– Supra bullar cell	36.1 (65)	72 (144)	46.2 (96)	88.8 (221)
– Supra bullar frontal cell	21.1 (38)	5 (11)	4.3 (9)	26.5 (66)
– Supra-orbital ethmoidal cell	39.4 (71)	28 (57)	17.3 (36)	9.2 (23)
Medial cells				
– Frontal septal cell	21.1 (38)	30 (30)	10.6 (22)	27.7 (69)

'Sides' refers to patients' left and right sides, subjected to computed tomography scanning. Data represent percentages (and numbers) of International Frontal Sinus Anatomy Classification cells. IFAC = International Frontal Sinus Anatomy Classification

to that of Lien *et al.*, who found that the presence of supra bullar frontal cells was associated with a significantly narrower frontal ostium diameter.[6] Thus, the existence of supra bullar frontal cells might lead to narrowing of the frontal sinus drainage pathway and produce significant obstruction. However, there were no statistically significant associations between the anteroposterior diameters of the frontal ostium and frontal recess and the presence or absence of other International Frontal Sinus Anatomy Classification cells.

Frontal sinusitis findings

We studied the association between International Frontal Sinus Anatomy Classification cells and frontal sinusitis. In our study, frontal sinusitis was present in 33.9 per cent of cases and absent in 66.1 per cent of cases. The odds ratio of having supra bullar cells was 1.69 times higher for those with frontal sinusitis than for those without. However, this finding did not reach statistical significance in our study. The incidence rates of supra bullar cells and supra bullar frontal cells were greater in patients with frontal sinusitis (44.3 per cent and 26.2 per cent respectively) than in those without (31.9 per cent and 18.5 per cent respectively). However, there was no significant association between these cells and the presence of frontal sinusitis. On univariate analysis, the prevalence rates of agger nasi cells, supra agger cells, supra agger frontal cells, supra-orbital ethmoidal cells and frontal septal cells also failed to show any association with the presence of frontal sinusitis. Sommer *et al.* demonstrated no increased occurrence of frontal sinus opacification associated with the presence of International Frontal Sinus Anatomy Classification cells ($p > 0.05$).[9]

Meyer *et al.* categorised the cells according to the Bent and Kuhn classification and found a higher incidence of frontal sinusitis in patients with frontal cell types 3 and 4.[7] DelGaudio *et al.* also classified the cells according to the Bent and Kuhn classification[1] and reported no significant difference in the frequency of frontal sinusitis for patients with or without agger nasi cells or frontal cells.[13] A study by Langille *et al.* demonstrated a significant association between frontal sinus mucosal thickening and the presence of frontal cells type 2 and type 3.[14] Eweiss and Khalil demonstrated no significant difference between frontal sinus mucosal disease regarding the presence or absence of agger nasi and frontal cells.[15]

Hashimoto *et al.* classified the cells according to the modified Kuhn classification and found that the presence of frontal recess cells did not influence frontal sinusitis development.[16]

The frontal cells in the following studies were classified according to the Kuhn–Citardi–Lee classification and varying results were reported.[3] Lien *et al.* reported a significant association between the presence of supra bullar cells, frontal bullar cells and supra-orbital ethmoidal cells and the development of frontal sinusitis, owing to significant shortening of the anteroposterior diameters of the frontal ostium and frontal recess.[6] According to Kubota *et al.*, the presence of frontal bullar cells was significantly associated with frontal sinusitis development.[5] Lai *et al.* reported a higher incidence of supra bullar cells and supra bullar frontal cells in patients with frontal sinusitis, but there was no significant association between the presence of various fronto-ethmoidal cells and frontal sinusitis development.[8] These discrepancies can be explained as due to differences in ethnicity between the various studies, different classifications of fronto-ethmoidal cells and our small sample size.

- The agger nasi cell was the most commonly occurring cell, seen in 95.5 per cent of patients
- Occurrence of International Frontal Sinus Anatomy Classification cells varied in males and females
- There was no significant difference in occurrence of any International Frontal Sinus Anatomy Classification cells in patients with frontal sinusitis compared to those without
- High-resolution computed tomography (CT) is the reference standard for evaluation prior to functional endoscopic sinus surgery
- High-resolution CT enables delineation of anatomical details such as frontal recess cell, which is critical for pre-operative evaluation and treatment of frontal sinus pathology

There were a few limitations of our study. The sample size was small because of study time restraints, which may have masked or enhanced the differences observed. In order to obtain more conclusive results, a larger population needs to be studied. Our study included patients clinically suspected of having chronic rhinosinusitis who were referred to our department for CT scanning of the paranasal sinuses; thus, our findings may not be directly applicable to patient populations without chronic frontal sinusitis. Racial differences in frontal anatomy are possible, which makes it difficult to extrapolate the findings to populations of different racial origins.

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Conclusion

This study documents the prevalence of International Frontal Sinus Anatomy Classification cells in patients undergoing CT of the paranasal sinuses for clinically suspected chronic rhinosinusitis. The presence of any of the International Frontal Sinus Anatomy Classification cells was not significantly associated with frontal sinusitis.

Competing interests. None declared

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