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Original Research Article

A prospective study of the prevalence of Kuhn's frontal cells and their relation to frontal sinus disease

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ABSTRACT

Background: The involvement of frontal cells in the frontal sinus disease pathology remains an understudied area. There are very few reports on the prevalence of frontal recess cells in India. In this context the present study was designed to determine the frequency of occurrence of Kuhn frontal cells and to determine whether the size of the frontal isthmus or the presence of frontal cells is related to the presence of frontal sinus disease.
Methods: This study included 80 patients who presented with signs and symptoms of chronic rhino-sinusitis after satisfying the inclusion criteria to the Department of ENT in a tertiary care centre (Mahatma Gandhi Medical College and Research Institute) in Pondicherry from January 2017 to April 2018. The patients were subjected to detailed clinical history, basic preoperative blood investigations, diagnostic nasal endoscopy and High Resolution Computed Tomography of nose and para-nasal sinuses after which the diagnosis was established.
Results: Out of the 80 study participants subjected to our study the number of individuals who had frontal sinusitis was 50%. The association between frontal sinusitis and Kuhn cells was insignificant. The mean value of anteroposterior diameter of the naso-frontal isthmus in case of patients with and without frontal sinusitis was 0.705-0.735. In case of transverse diameter it was 0.725-0.720 and in case of the area of the frontal isthmus it was 30.86-31.12 which had a p value of 0.49
Conclusions: Therefore in our study we concluded that there is no significant relation for any particular frontal recess cell or the size of the nasofrontal isthmus for being the sole cause for chronic frontal sinusitis.

Keywords: Frontal sinus, Kuhn cells, Computerised tomography, Chronic-sinusitis

INTRODUCTION

The frontal recess is bound medially by the middle turbinate, laterally by the lamina papyracea. Bulla lamella forms the posterior wall of the frontal recess and the process of the maxilla and the frontal bone forms the anterior wall, which anterosuperiorly thickens to form the frontal beak.[1] This area was briefed as the nasofrontal region in 1916, which was later known as the frontal recess.[2] Mucociliary clearance mechanics help keep the sinus aerated and prevent airborne particulate contamination and fluid collection.[3] An acute infection of the frontal sinus may easily turn into a chronic disease if various types of frontal cells pneumatising along the nasofrontal isthmus.[4] Previous studies have looked at a number of cells which include the aggernasi cell (ANC), inter-frontal sinus septal cell (IFSSC), frontal cell (FC), frontal bullar cell (FBC), suprabullar cell (SBC) and supraorbital ethmoidal cell (SOEC) and have found a significant relation of these cells in the pathogenesis of chronic frontal sinusitis.[5-13]

Kuhn classified frontal cells into 4 types. Type I (Figure 1a) is a single frontal cell above an aggernasi cell, type II (Figure 1b) is a tier of cells in the frontal recess above the aggernasi cell, type III (Figure 1c) is a large cell

pneumatizing from the frontal recess into the frontal sinus, type IV (Figure 1d) is a cell totally isolated within the frontal sinus.[14] The involvement of frontal cells in the frontal sinus disease pathology remains an understudied area. Most previous studies of the pneumatization pattern of the frontal recess have focused on Caucasian population whereas there are very few reports on the prevalence of frontal recess cells and their relation with frontal sinusitis in India. In this context the present study was designed to determine the frequency of occurrence of Kuhn frontal cells and to determine whether the size of the frontal isthmus or the presence of frontal cells is related to the presence of frontal sinus disease.

METHODS

This study includes 80 patients who presented with signs and symptoms of chronic rhino-sinusitis after satisfying the inclusion criteria, to the Department of ENT in a tertiary care centre (Mahatma Gandhi Medical College and Research Institute) in Pondicherry from January 2017 to April 2018. Ethical committee clearance was obtained and informed consent was taken, the selected patients underwent a thorough history taking and clinical examination which was recorded in a proforma. Further, the patients were subjected to basic blood investigations, plain X-ray nose and paranasal sinuses Water's view, diagnostic nasal endoscopy and high resolution computed tomography (HRCT) of nose and paranasal sinuses (axial, coronal and sagittal views), and all findings were documented. The diagnosis was established by detailed clinical history, diagnostic nasal endoscopy and CT scan findings.

Patients were informed and explained in detail about the study and procedures involved after which an informed consent was obtained. They were then subject to detailed history taking and clinical examination followed by a diagnostic nasal endoscopy. Subsequently all patients underwent CT scans which was done on a 128-slice, high resolution multiple detector computer tomography (MDCT) machine (GE Optima; GE Medical Systems, Milwaukee, Wis). Imaging was done without gantry tilt with the subjects head in neutral position. The images were forwarded into an imaging laboratory and evaluated using standard "tri-planar reconstruction protocol" over an advantage workstation (ADW; GE Healthcare, Waukesha, Wis). 2 mm thin axial scans were taken for each patient along with reformed images of 0.6 mm coronal and sagittal cuts were finally obtained as CT scan films. Anatomical details of the nasofrontal isthmus including the anteroposterior (Figure 2a), transverse diameter (Figure 2b) and area (Figure 2c) of the frontal isthmus of each side of all the patients were recorded. The scans were then reviewed and the findings were noted, documented, analysed and interpreted. Data were then exported into Microsoft excel 2016 software and analysed using statistical package for social sciences (SPSS) version 16. Mean and standard deviation were calculated to summarize continuous variables such as age. Number and percentage were used to present the categorical data pertaining to the following distribution of the various socio-demographic variables. Independent t test was done to find the factors associated. Statistical significance was set at p value of less than or equal to 0.05.

RESULTS

The study included 80 subjects who presented to the Department of ENT in a tertiary care centre in Pondicherry where 160 frontal sinuses were studied.

Table 1: Distribution of study participants based on left and right Kuhn frontal cells.

	Type cells	Frequency	%
Left Kuhn cells	No cells visualized	65	81.3
	Type 1	11	13.8
	Type 2	1	1.3
	Type 3	2	2.5
	Type 4	1	1.3
	Total	80	100
Right Kuhn cells	No cells visualized	73	91.4
	Type 1	4	5.0
	Type 2	1	1.3
	Type 3	1	1.3
	Type 4	1	1.3
	Total	80	100

Table 2: Association between left and right frontal sinusitis with Kuhn cells.

		Frontal sinusitis present	Frontal sinusitis absent	P value
Left Kuhn cells	Yes	9 (22.5)	6 (85.0)	0.39
	No	31 (77.5)	34 (15.0)	
	Total	40 (100.0)	40 (100.0)	
Right Kuhn cells	Yes	3 (7.5)	4 (10.0)	0.28
	No	37 (92.5)	36 (90.0)	
	Total	40 (100.0)	40 (100.0)	

The distribution of study participants based on age is 23.8% in the age group 15-30, 47.5% in the age group 31-45, 23.8% in the age group 46-60 and 5% in the age group >60 years. Based on gender-52.5% of the study participants were males and 47.5% were females. Kuhn cells were identified in 15 of the left frontal sinuses where type 1 cell were found in 11 individuals, type 2 in 1, type 3 in 2 and type 4 in 1 individual (Table 1).

In another 80 frontal sinuses studied on the right side showed 7 Kuhn cells where type 1 cells were 4, type 2 type 3 and type 4 were 1 each (Table 1). Association between left frontal sinusitis and left Kuhn cells showed a

p value of 0.39 (Table 2) and association between right frontal sinusitis and right Kuhn cells showed a p value of 0.28 (Table 2) both of which were statistically insignificant. The association between the antero-posterior diameter of the left nasofrontal isthmus and left frontal sinusitis showed a p value of 0.36 (Table 3, Figure 3) and that of the right nasofrontal isthmus and right frontal sinusitis showed a p value of 0.06 (Table 3, Figure 3) which were statistically again insignificant. The relation between right and left transverse diameters and their corresponding frontal sinus disease showed p values of 0.18 (Table 3, Figure 4) and 0.26 (Table 3, Figure 4). Finally the association between area of the frontal ostium with their respective frontal sinuses were evaluated which showed a p value of 0.49 (Table 3, Figure 5) which again was statistically insignificant.

Table 3: Association between AP diameter, transverse diameter and area of-frontal isthmus with frontal sinusitis.

Naso-frontal isthmus parameters (in mm)	Frontal sinusitis		No frontal sinusitis		Difference in mean	P value
	Mean	SD	Mean	SD		
Left naso-frontal isthmus AP diameter	0.71	0.10	0.73	0.10	0.02	0.36
Right naso-frontal isthmus AP diameter	0.70	0.11	0.74	0.08	0.04	0.06
Left naso-frontal isthmus transverse diameter	0.74	0.09	0.71	0.11	0.03	0.26
Right naso-frontal isthmus transverse diameter	0.71	0.1	0.73	0.09	0.03	0.18
Area of FO* (in mm^2)	30.86	1.5	31.12	1.87	0.26	0.49

*FO-Frontal ostium

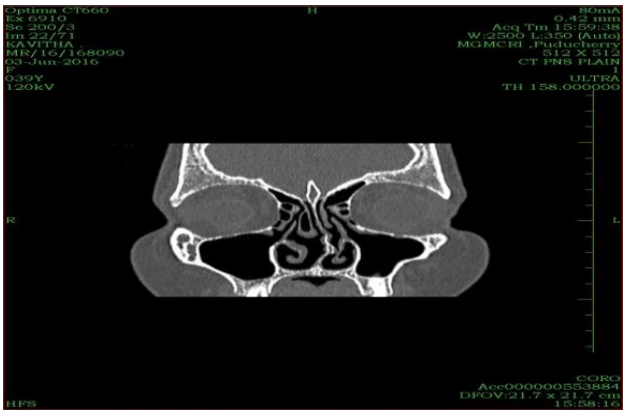

Figure 1a: Kuhn type 1 frontal cell.

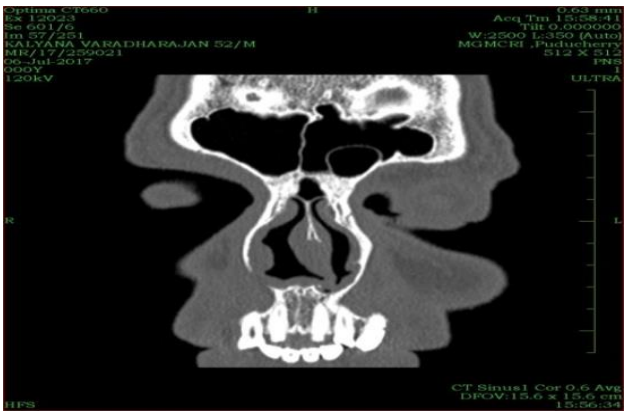

Figure 1c: Kuhn type 3 frontal cell.

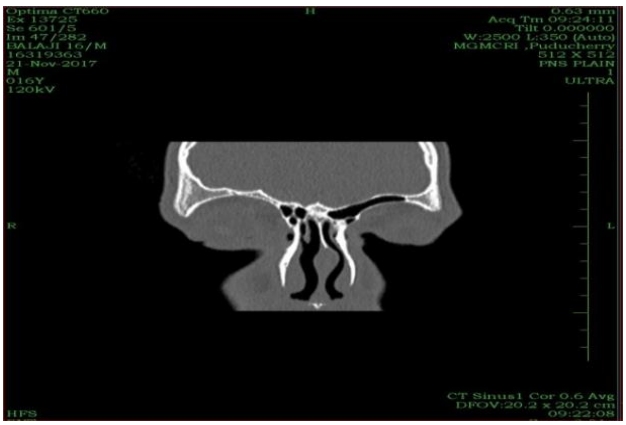

Figure 1b: Kuhn type 2 frontal cell.

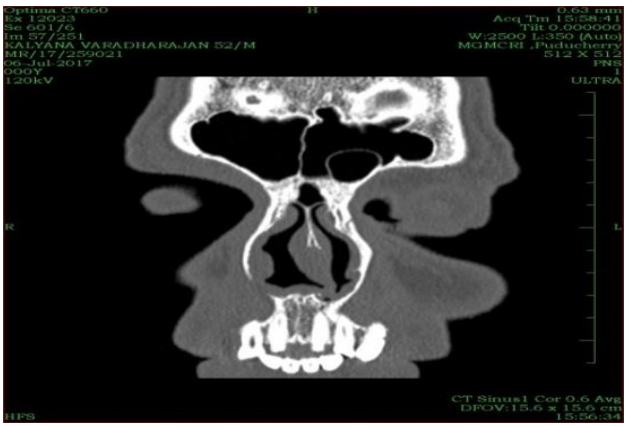

Figure 1d: Kuhn type 4 frontal cell.

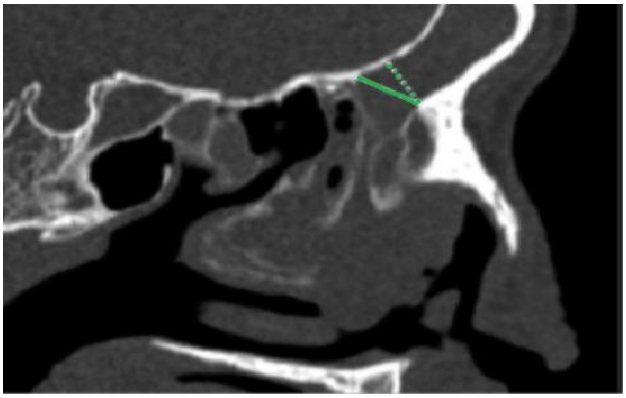

Figure 2a: A-P length-frontal isthmus (FI; dotted line) frontal recess (FR; solid line).

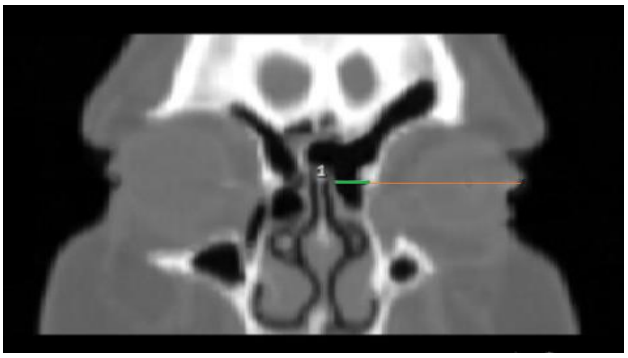

Figure 2b: Transverse diameter of the frontal sinus ostium.

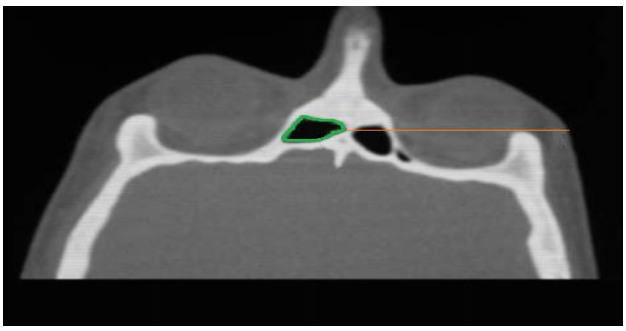

Figure 2c: Area of the naso-frontal isthmus.

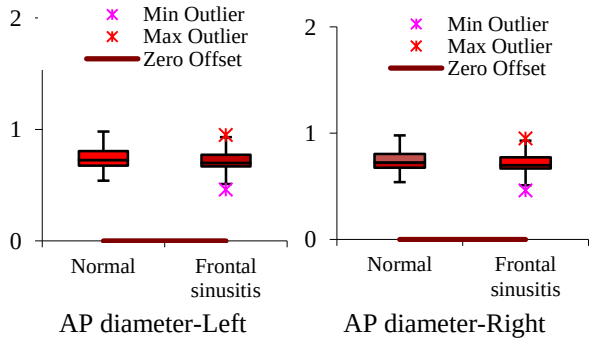

Figure 3: Association between naso-frontal isthmus AP diameter-left/right and frontal sinusitis.

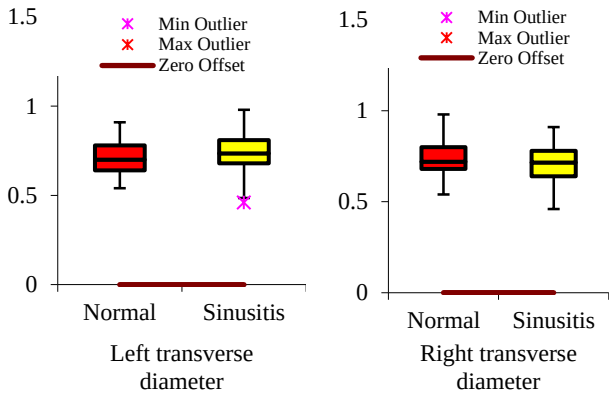

Figure 4: Association of left/right transverse diameter with frontal sinusitis.

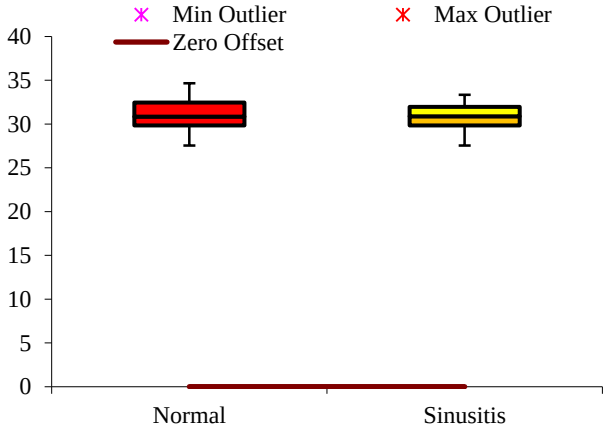

Figure 5: Association of area of frontal ostium with frontal sinusitis.

DISCUSSION

In a study by Gaudio et al 33% was the prevalence in his multi-planar CT reconstruction study of 106 patients where type 1-18.4%, type 2-2%, type 3-6.1% and type 4-3.1% .[1]Aalyea et al found 40% frontal cells in his report.[2] The prevalence of frontal cells was 20.4% in 768 coronal CT scans by Meyer et al where, Type 1 was found in 14.9%, Type 2 was found in 3.1%, Type 3 was found in 1.7% and Type 4 were found in 2.1%.[15] Kew et al who assessed the use of reconstructed multi-planar CT images of frontal recess in 43 patients and came to a conclusion that there was no statistical difference between the Bent and Kuhn classification of frontoethmoidal cells on coronal and parasagittal images.[16] According to Lee et al finding type 1-37%, type 2-19%, type 3-8%, type 4-0%.[17] In our study 80 patients frontal recess anatomy who were suffering from chronic rhino-sinusitis were studied and 50% were having either unilateral or bilateral frontal sinusitis. Type 1 frontal cells were the most common type of frontal cell on both sides. In the left side the prevalence of Kuhn frontal cells were type 1 cells: 13.8%, type 2 cells: 1.3%, type 3 cells: 2.5% and type 4 cells: 1.3%. On the right side however the prevalence of Kuhn frontal cells was type 1 cells: 5.0%, type 2 cells:

1.3%, type 3 cells: 1.3%, type 4 cells: 1.3%. Thus coming to the overall prevalence including both sides are type 1 cells: 9.4%, type 2 cells: 1.3%, type 3 cells: 1.9%, type 4 cells: 1.3%.

Gaudio et al reported that there was no significant association between the area of the frontal isthmus and the occurrence of chronic frontal sinusitis.[1] Landsberg et al in their study reported the diameters of the frontal ostium as follows, AP diameter was 7.22 mm with a SD of 2.78 mm and transverse diameter was 8.92 mm with a SD of 2.95 mm. The mean sectional frontal ostium area was 50.5 mm^2.[18] In our study, the mean AP diameter was 7.05 mm, the mean transverse diameter was 7.25 mm and the mean area of frontal ostium was 30.86 mm^2. Thus we did not actually find a significant difference in the antero-posterior diameter, transverse diameter and the area of nasofrontal isthmus of smaller size in the diseased sinuses when compared to normal sides without sinusitis.

A lot of studies on multi-planar computed tomographic analysis of the frontal sinus outflow tract had been done in patients with no sinusitis or in patients with chronic sinusitis and only a few studies gave importance to the prevalence of frontal cells, and very few investigated the relation between frontal sinus disease and frontal cells. A study was done on the relationship of frontal sinusitis to frontal cells was conducted by Gaudio et al in around 106 patients by using multi-planar computerised-tomography scans to determine the presence of frontal cells and frontal sinusitis. They identified that frontal cells were found in 33% of patients and also found that frontal cells was not associated with the frontal sinusitis.[1]

Prevalence of the frontal cells and the other anatomic variants were studied by Meyer et al in about 768 coronal CT nose and paranasal sinus scans. They actually studied the coronal CT scans of paranasal sinuses in a larger population and detected a prevalence of frontal cells in 20.4% of the study participants and their results interpreted a significantly higher incidence of frontal sinus disease in presence of type III and type IV frontal cells.[16] Multi-planar reconstructed computerised tomography in 43 patients was done where the frontal recess were studied by Kew et al in view of deciphering the anatomy in determining the suitable surgical approach.[16] There was another conclusion that even though variations in anatomy were more likely to result in frontal sinusitis other factors which cause mucosal inflammatory process are also to be considered as an essential aetiology. Literature search did not show many studies from health centres in India where research was done regarding frontal sinus outflow tract in patients with sinusitis and in subjects without sinusitis. However in 2013, Sagar et al did a study on the anatomy of the frontal recess in patients having frontal sinus disease. 44% patients had type 1 cells, type 2 in 8% patients, type 3 in 48% patients and type 4 in 2% of patients. They concluded that there is a high prevalence of frontal recess cells in patients suffering from frontal sinus disease, and that the type 3 frontal cell is more common in the Indian population having frontal sinusitis.[19] In our study we did not find a significant relation for Kuhn frontal cells being the sole cause for chronic frontal sinusitis (p=0.28) for the right side and (p=0.39) for the left side.

CONCLUSION

Frontal cells were identified in 13.9% of frontal recesses, and type I cells were the most common type of frontal cell. The incidence of frontal sinusitis was not influenced by the size of the frontal isthmus. Finally in our study, we also didn't find any significant relation for a particular frontal recess cell in being the only reason for chronic frontal sinusitis. Therefore we conclude that even though variations in anatomy were more likely to result in frontal sinusitis other factors which cause mucosal inflammatory processes are also to be considered as an essential aetiology.

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