



Relationship Between Anatomical Variations in the Frontal Recess Area and the Incidence Rate of Frontal Rhinosinusitis

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ABSTRACT:

Introduction: The most prevalent cause of rhinosinusitis is abnormalities in the nose and paranasal sinuses. Obstacles to frontal sinus flow can arise due to variations in the anatomy of the frontal sinus, where the drainage system is linked to the frontal recess.

Objectives: Determine the relationship between anatomical variations in the frontal recess and the incidence rate of chronic rhinosinusitis..

Methods: A cross-sectional study was conducted between March and September 2023 at Central General Hospital Dr. Wahidin Sudirohusodo and Hasanuddin Faculty Teaching Hospitals in Makassar, including patients with chronic rhinosinusitis (CRS) symptoms who underwent paranasal sinus CT scans and met the inclusion criteria. Patients were categorized into CRS with and without frontal sinus involvement. An assessment of anatomical variations in the frontal recess area was conducted in each group, and their relationship with the incidence rate of frontal rhinosinusitis was analyzed using the SPSS application.

Results: The supra agger nasi anatomical variant showed a significant association with the incidence of right frontal rhinosinusitis ($p=0.042$). On the left side, supra agger and supra bulla cells were associated with the incidence of rhinosinusitis involving anterior ethmoid sinusitis ($p=0.006$ and 0.015 , respectively), as well as posterior ethmoid sinusitis ($p=0.027$ and 0.042 , respectively). There was no significant relationship found between variations in the anterosuperior uncinate process attachment and the incidence of right ($p=0.990$) or left frontal rhinosinusitis ($p=0.999$). The type of drainage did not exhibit a statistically significant association with the incidence of left and right frontal rhinosinusitis ($p>0.05$).

Conclusions: The frequency of frontal rhinosinusitis is significantly correlated with anatomical abnormalities in the anterior frontal recess area (supra agger nasi).

1. Introduction

Rhinosinusitis is a condition frequently encountered in regular medical practice, considered one of the most common health issues globally. The rate of new cases of rhinosinusitis among adult patients presenting to the ENT Department at Dr. Wahidin Sudirohusodo Hospital was reported to be 41.5% of all cases managed by the Rhinology Sub-Section, which were chronic rhinosinusitis cases. The most prevalent causes of rhinosinusitis are anatomical anomalies in the nose and paranasal sinuses. One common cause is a problem with the patency of the ostiomeatal complex (OMC), which comprises physical elements such as the uncinate process, ethmoid infundibulum, hiatus semilunaris, ethmoid bulla, agger nasi, and frontal recess. The osteometal complex functions as a unit facilitating

ventilation and drainage from the anterior sinuses, particularly the maxillary, anterior ethmoid, and frontal sinuses.

Apart from structural blockage, mucosal obstruction to the frontal recess significantly contributes to the development of chronic frontal rhinosinusitis. Infections, foreign bodies, irritants, environmental contaminants, trauma, tumors, and allergens can all affect the physiology of the frontal sinus by disrupting mucociliary clearance function. Azis Rola et al.'s 2017 study found a strong association between the superior attachment of the uncinate process and the Lund Mackay score, as well as the number of sinuses involved, although no significant relationship was observed with the involvement of specific sinuses. However, this relationship remains controversial and rare. Therefore, the purpose of this



study was to confirm a link between structural abnormalities in the frontal recess area and the occurrence of chronic rhinosinusitis.

2. Methods

Research design

This is a cross-sectional study with an analytical observational component.

Place and time

This study was conducted at the Radiology Installation of Central General Hospital Dr. Wahidin Sudirohusodo and Hasanuddin Faculty Teaching Hospital Makassar from March to September 2023.

Research Sample

The sample taken for this study used a consecutive sampling technique, with patients suspected of suffering from chronic rhinosinusitis based on clinical symptoms based on the 2020 European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS) with CT scan results of the paranasal sinuses showing frontal recess cells and the type of superior uncinate processus attachment. Patients with sinonasal tumors, nasal polyps, nasal trauma, previous history of nasal or sinus surgery, invasive fungal sinusitis were excluded from this study.

Research Permit

Before conducting this research, we submitted a research permit to the Health Research Ethics Committee in Faculty of Medicine of Hasanuddin University with recommendation for approbation number 168/UN4.6.4.5.3.1/PP36/2023.

Paranasal Sinus CT Scan Assessment

The frontal recess is assessed with a CT scan of the paranasal sinuses. We assessment the anterior cells, like agger nasi cells, supra agger cells, and frontal supra agger cells and also the posterior cells, like ethmoid bulla cells, supra bulla cells, frontal supra bulla cells, and ethmoid supraorbital cells. Anterosuperior uncinate process (UP) adhesions were also evaluated and classified into six different categories (types 1-6). It is said to be type 1 if the UP attachment is on the lamina papyracea. Type 2 if the UP attachment is on the posterior wall of the agger nasi cells and also the lamina papyracea. It is said to be type 3 if the UP attachment is on the lamina papyracea, as is the connection between the middle turbine and the cribriform plate. It is said to be type 4 if the UP attachment is at the middle turbine joint with the cribriform plate. Type 5 is where the UP attachment is at the base of the skull, and finally, Type 6 is where the UP attachment is to the medial turbinate

Data analysis

The acquired data were analyzed using SPSS version 25. Descriptive statistical computations and frequency distribution were employed in the statistical study. The Chi-square, Fisher, and Kolmogorov-Smirnov statistical tests were utilized in this investigation to explore the connection between anatomical changes in the frontal recess area and the type of uncinate process attachment with the incidence of frontal rhinosinusitis. Statistical test findings are deemed significant if the p-value is less than 0.05. The outcomes are presented in the form of narratives, tables, or graphs.

3. Results

The Research Sample's Characteristics

This study included 70 research samples. According to Table 1, the research sample was mostly female, with 38 people (54.3%). This study's largest age group was 36 to 45 years old (19 people (27.1%)).

Table 2 displays characteristics based on the location of frontal rhinosinusitis, changes in the frontal recess anatomy, attachment types of the anterosuperior uncinate process, and the type of drainage. CRS is more common in people who do not have frontal sinusitis than in those who do (left=74.3%; right=68.6%). When compared to other changes in the anterior cells, anatomical variations in the frontal recess of the agger nasi cells are the most variable (left=92.9%; right=98.6%). The most prevalent anatomical variant of the posterior cell frontal recess (left=92.9%; right=92.9%) is the ethmoid bulla).

Relationship Between Anatomical Variations in The Frontal Recess Area and Frontal Rhinosinusitis's Incidence

Only the supra agger nasi anatomical variant was associated with right frontal rhinosinusitis's incidence ($p=0.042$); and none of the variations were associated with left frontal rhinosinusitis's incidence (Table 3).

Relationship between Variations in Anterosuperior UP Attachment Type and Drainage Type on the Occurrence of Frontal Rhinosinusitis

In table 4, there is no relationship between variations in the anterosuperior UP attachment and the incidence of right ($p=0.990$) and left frontal rhinosinusitis ($p=0.999$). Based on table 5, there is no significant relationship between variations in drainage type and the incidence of left and right frontal rhinosinusitis ($p>0.05$)

4. Discussion



Sensory olfactory disorders are caused by the release of inflammatory mediators by lymphocytes, macrophages and eosinophils, which are toxic to olfactory neuroepithelial receptors, causing damage to the olfactory neuroepithelium (Cho, Seok Hyun, 2014). Anosmia and hyposmia are symptoms of Covid-19 infection. COVID-19-related olfactory dysfunction may occur due to several pathophysiologicals, including obstruction of airflow to the receptors due to local inflammation and mucus changes in the *olfactory cleft*, downregulation of olfactory receptor proteins, damage to the olfactory neuroepithelium, and changes in central brain structures related to smell, especially in the *olfactory bulb* (Doty RL, 2016).

There is a new classification of frontal cells, divided into anterior, posterior, and medial cells based on their position in the frontal recess. Anterior cells comprise agger nasi cells, supra agger cells, and frontal supra agger cells, while posterior cells include ethmoid bulla cells, supra bulla cells, frontal supra bulla cells, ethmoidal supraorbital cells, and frontal septal cells. Only the supra agger nasi anatomical variant was found to be associated with the prevalence of right frontal rhinosinusitis ($p=0.042$), with a higher occurrence of rhinosinusitis and frontal sinusitis among participants lacking supra agger nasi cells compared to those who did. This finding is consistent with Howser LA et al.'s study (2023), which investigated differences in frontal sinus morphology between control and rhinosinusitis groups with frontal sinusitis. The incidence of rhinosinusitis and frontal sinusitis was significantly associated with supra agger cells ($p=0.006$). According to the study, participants in the rhinosinusitis group with frontal sinusitis were more likely to lack supra agger nasi cells compared to those in the control group, which had more supra agger cells than the frontal rhinosinusitis group. Additionally, Nofal AB et al.'s study (2022) found that patients without agger nasi cells were more prone to developing frontal rhinosinusitis than those with them (77.4% vs 22.6%).

Anterolateral ethmoid cells situated above agger nasi cells are termed supra agger nasi cells. We observed that individuals without frontal sinus mucosal thickening had more supra agger cells. This may suggest that the presence of supra agger cells diminishes the agger nasi, acting as a septation and division of the agger nasi, or that supra agger cells replace the agger nasi, leading to an enlargement of the infundibulum. However, the findings of this study contradict those of Fawzi NE et al. (2021), who investigated the occurrence of frontal cell variations

and their association with frontal sinusitis. Supraorbital ethmoidal cells and frontal septal cells were found to have a significant association with the occurrence of frontal sinusitis in this study ($p=0.001$ and 0.044 , respectively). However, supra agger cells showed no significant association with the incidence of frontal sinusitis ($p=0.156$).

This discrepancy could be attributed to anatomical characteristics such as race, gender, and ethnicity. Although no specific research has been conducted on the relationship of supra agger cells, it has been discovered that ethmoid supraorbital cells are more prevalent in Caucasians, while suprabullar cells are more common in Asian populations (specifically Koreans, Taiwanese, Chinese, and Japanese). Previous research has also found virtually universal agger nasi cells in 95.5% to 97% of patients, demonstrating their value as an effective radiographic and surgical marker. Furthermore, the prevalence of supra agger cells and frontal supra agger cells varies, ranging from 16.3% to 50% and 11% to 36% of patients, respectively. The presence of suprabulla cells ranged from 46.2% to 89% in posterior cells, 4.3% to 53% in frontal suprabulla cells, and 5.5% to 42% in supraorbital ethmoid cells. Genetic differences influence cranial bone structure development and, consequently, the formation of the frontal sinus, leading to discrepancies in the findings of this study.

The uncinate process (UP) is a slender bone constituting the medial wall of the ostiomeatal complex and is positioned on the lateral wall of the nose, medial to the ethmoid infundibulum, divided into six varieties (types 1-6). This study found no association between variations in anterosuperior UP attachment and the occurrence of frontal rhinosinusitis, whereas type I UP superior attachment appears to be more common in frontal sinusitis. These findings are consistent with those of Rijal AS et al. (2022), who found that type I superior attachment UP were more prevalent in patients with chronic frontal sinusitis. Chronic right frontal sinusitis affected up to 75% of patients with type I superior attachment UP, and chronic left frontal sinusitis affected up to 73.6% of patients with type I superior attachment UP. These results are also supported by research by Srivastava M et al. (2016), where patients with frontal rhinosinusitis had more superior UP type I attachments (57.8%) compared to types II, III, IV, V, and VI.

According to the findings of this study, there is no association between the type of frontal sinus outflow and the occurrence of frontal rhinosinusitis. However, this



study may explain why type 1 drainage is more common in frontal rhinosinusitis. This is consistent with the findings of Turgut S et al. (2005), where out of 243 people with frontal sinusitis, 97 had type 1 drainage and 28 had type 2 drainage. The frontal recess extends to the middle meatus, limited laterally and medially by the UP and laterally by the middle turbinate. This frontal recess empties into the middle meatus when the UP inserts into the base of the skull, middle turbinate, or middle turbinate junction. This concept indicates that the superior attachment of the UP clearly influences the frontal sinus drainage pattern. There are two types of drainage, namely type 1 which is frontal sinus drainage towards the medial meatus and type 2 is frontal drainage to the ethmoid infundibulum. As known, many studies report that UP attachment types 1-3 are more common than UP attachment types 4-6, so that drainage type 1 can be seen more often than drainage type 2

5. Conclusion

The frequency of frontal rhinosinusitis is significantly related to anatomical abnormalities in the anterior frontal recess area (supra agger nasi). Variations in the attachment of the anterosuperior uncinat process and the incidence of frontal rhinosinusitis have no meaningful association

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Attachment

Table 1. CRS Sample Characteristics

Variable	Frequency (n)	Percentage (%)
Gender		
Female	38	54,3
Male	32	45,7
Age		
<=25 years	18	25,7
26 - 35 years	18	25,7
36 - 45 years	19	27,1
> 46 years	15	21,4
(Mean±SD(min-max))	35,1±12,7 years (14-70 years)	

Table 2. Characteristics Based on the Distribution of Frontal Rhinosinusitis, Frontal Recess Variations and Attachment Types of the Anterosuperior Uncinate Process and Type of Drainage

Characteristics		Left		Right	
		n	%	n	%
CRS With Frontal Sinusitis					
	Exist	18	25,7	22	31,4
	Doesn't exist	52	74,3	48	68,6
Anatomical Variations of the Frontal Recessus					
Anterior					
Agger Nasi Cell	Exist	65	92,9	69	98,6
	Doesn't exist	5	7,1	1	1,4
Supra Agger Cell	Exist	39	55,7	41	58,6
	Doesn't exist	31	44,3	29	41,4
Supra Agger Frontal Cell	Exist	5	7,1	6	8,6
	Doesn't exist	65	92,9	64	91,4
Posterior					
Bulla Ethmoid	Exist	65	92,9	65	92,9
	Doesn't exist	5	7,1	5	7,1
Supra Bulla Cell	Exist	45	64,3	46	65,7
	Doesn't exist	25	35,7	24	34,3
Supra Bulla Frontal Cell	Exist	3	4,3	2	2,9
	Doesn't exist	67	95,7	68	97,1
Supraorbital Ethmoid Cell	Exist	14	20,0	17	24,3
	Doesn't exist	56	80,0	53	75,7
Anterosuperior UP Attachment Types					
Attachment Type	1	53	75,7	50	71,4
	2	5	7,1	5	7,1
	3	1	1,4	3	4,3



	4	0	0	1	1,4
	5	2	2,9	4	5,7
	6	9	12,9	7	10,0
Drainage	Group 1	59	84,3	58	82,9
	Group 2	11	15,7	12	17,1

Table 3. Relationship Between Frontal Recess Area Variations and The Right and Left Frontal Rhinosinusitis's Incidence

CRS With Frontal Sinusitis					p-value
		Exist	Doesn't Exist		
Right	Agger Nasi Cell	Exist	22 (100,0%)	0 (0,0%)	0,495*
		Doesn't exist	47 (97,9%)	1 (2,1%)	
	Supra Agger Cell	Exist	9 (40,9%)	13 (59,1%)	0,042*
		Doesn't exist	32 (66,7%)	16 (33,3%)	
	Supra Agger Frontal Cell	Exist	1 (4,5%)	21 (95,5%)	0,415*
		Doesn't exist	5 (10,4%)	43 (89,6%)	
	Bulla Ethmoid	Exist	20 (90,9%)	2 (9,1%)	0,646**
		Doesn't exist	45 (93,8%)	3 (6,3%)	
	Supra Bulla	Exist	11 (50,0%)	11 (50,0%)	0,061*
		Doesn't exist	35 (72,9%)	13 (27,1%)	
	Supra Bulla Frontal	Exist	0 (0,0%)	22 (100,0%)	1,000**
		Doesn't exist	2 (4,2%)	46 (95,8%)	
Supraorbital Ethmoid	Exist	4 (18,2%)	18 (81,8%)	0,420*	
	Doesn't exist	13 (27,1%)	35 (72,9%)		
Left	Agger Nasi Cell	Exist	17 (94,4%)	1 (5,6%)	1,000*
		Doesn't exist	48 (92,3%)	4 (7,7%)	
	Supra Agger Cell	Exist	8 (44,4%)	10 (55,6%)	0,264**
		Doesn't exist	31 (59,6%)	21 (40,4%)	
	Supra Agger Frontal Cell	Exist	1 (5,6%)	17 (94,4%)	1,000*
		Doesn't exist	4 (7,7%)	48 (92,3%)	
	Bulla Ethmoid	Exist	17 (94,4%)	1 (5,6%)	1,000*
		Doesn't exist	48 (92,3%)	4 (7,7%)	
	Supra Bulla	Exist	10 (55,6%)	8 (44,4%)	0,370**
		Doesn't exist	35 (67,3%)	17 (32,7%)	
	Supra Bulla Frontal	Exist	0 (0,0%)	18 (100,0%)	0,564*
		Doesn't exist	3 (5,8%)	49 (94,2%)	
	Supraorbital Ethmoid	Exist	3 (16,7%)	15 (83,3%)	1,000**
		Doesn't exist	11 (21,2%)	41 (78,8%)	

*Chi-square

**Fisher

Table 4. Correlation Between Variations in Anterosuperior UP Attachment Types and The Incidence of Right and Left Frontal Rhinosinusitis

		Right UP attachment type						p-value
		I	II	III	IV	V	VI	
Right	Exist	17 (77,3%)	2 (9,1%)	0 (0,0%)	0 (0,0%)	1 (4,5%)	2 (9,1%)	0,990*
	Doesn't exist	33 (68,8%)	3 (6,3%)	3 (6,3%)	1 (2,1%)	3 (6,3%)	5 (10,4%)	
Left	Exist	15 (83,3%)	1 (5,6%)	0 (0,0%)	1 (5,6%)	0 (0,0%)	1 (5,6%)	0,999*
	Doesn't exist	38 (73,1%)	4 (7,7%)	1 (1,9%)	1 (1,9%)	0 (0,0%)	8 (15,4%)	



* Kolmogorov-Smirnov

Table 5. Relationship Between Variations in Drainage Type and The Incidence of Right and Left Frontal Rhinosinusitis

		Drainage Type		p-value
		Group 1	Group 2	
CRS With Frontal Sinusitis				
Right	Exist	19 (86,4%)	3 (13,6%)	0,741*
	Doesn't exist	39 (81,3%)	9 (18,8%)	
Left	Exist	16 (88,9%)	2 (11,1%)	0,716*
	Doesn't exist	43 (82,7%)	9 (17,3%)	

*Fisher