The Influence of Allergic Biomarkers in Chronic Rhinosinusitis Patients who Underwent Functional Endoscopic Sinus Surgery

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Introduction

Chronic rhinosinusitis (CRS) is a persistent inflammatory disease of the sinonasal mucosa. Traditionally, CRS has been classified based on the presence (CRS with nasal polyps, CRSwNP) or absence of nasal polyps (CRS without nasal polyps, CRSsNP).

In recent decades, the role of endotypes has gained increasing importance. Type 2 endotypes, also known as eosinophilic CRS (ECRS), are characterized by eosinophilic infiltration into the paranasal sinusavailable. Studies have demonstrated that one's serum eosinophil count can predict high tissue eosinophilia.

Regarding IgE, Baba et al. reported significantly higher IgE levels in eosinophilic CRSwNP patients when compared to non-eosinophilic cases Allergy and CRS frequently co-occur, with the role of allergy in CRS having long been a topic of debate. Given that IgE and eosinophils are essential components of allergic inflammation, the purpose of this study is to investigate the roles of allergy, total IgE levels, serum eosinophil and tissue eosinophil in CRS patients who underwent functional endoscopic sinus surgery (FESS).

Methods

We enrolled consecutively CRS patients who failed maximal medical treatment and subsequently underwent bilateral primary FESS from June 2019 to October 2023 at Taichung Veterans General Hospital.
The day before FESS, all eligible patients underwent blood examinations, including allergy testing, serum total IgE levels, serum eosinophil counts, and CRS severity assessment using sinus CT Lund-Mackay score, endoscopic Lund-Kennedy score, traditional Chinese version of the University of Pennsylvania smell identification test (UPSIT-TC), phenyl ethyl alcohol (PEA) odor detection threshold test, the second minimal cross-sectional area (MCA2) of acoustic rhinometry, saccharine transit time test and nasal culture score. Each patient also completed the Taiwanese version of the 22-item Sino-Nasal Outcome Test (TWSNOT-22) questionnaire. The tissues obtained during FESS were examined to count eosinophils. Three months after FESS, all patients repeated the CRS severity assessments, except for sinus CT, in order to evaluate the effectiveness of the surgery.

Results

A total of 96 patients were enrolled in this study, comprising 57 males (59.4%) and 39 females (40.6%). Their ages ranged from 21 to 80 years, with a median age of 49.5 years . The preoperative and postoperative severity of chronic rhinosinusitis (CRS) was evaluated using various measures, with results being summarized in Table 1.

Table 1. Evaluation of CRS Severity

	Preoperation		Postoperation	
	Median	IQR	Median	IQR
Sinus CT	14.0	12-15		
Endoscopic score	5.0	4-6	4.0	3-5
UPSIT-TC	21.0	13.3-28	25.0	20-30
PEA threshold test	−3.25	−6.3 to −1	−4.25	−6.8 to −2.5
Mean MCA2	0.4	0.3-0.6	0.5	0.4-0.6
Saccharine transit time	13.0	9.20.8	14.0	10.3-20
Nasal culture score	0.0	0-1	1.0	0-2
TWSNOT-22	34.5	26.3-56	17.5	8.3-30.5
Item 5 of TWSNOT-22	4.0	2-5	1.0	0-2.8

Table 2 compares the allergy-negative and positive. No significant differences were observed between the allergy-negative and positive groups across both preoperative and postoperative parameters.

Table 2. Comparison of Allergy Test-Negative and -Positive Groups

	Negative (n = 56)		Positive (n = 40)		
	Median	IQR	Median	IQR	P value
Age	51.0	40-60.8	47.0	36.5-55.8	.248
Sex					.171
Female	26 (46.4%)		13 (32.5%)		
Male	30 (53.6%)		27 (67.5%)		
Asthma	10 (58.8%)		7 (41.2%)		.964
Preoperation					
Sinus CT	14.0	13-15	14.0	11.3-14.8	.174
Endoscopic score	5.0	4-6.8	4.0	3.3-6	.345
UPSIT-TC	21.0	13.3-28	20.5	13.3-25.8	.710
PEA threshold test	−3.25	6.4 to −1	−3.5	−6.3 to −1	.800
Mean MCA2	0.4	0.3-0.5	0.5	0.3-0.6	.087
Saccharine transit time	13.5	10-21	12.5	8-18.8	.434
Nasal culture score	0.0	0-1	0.0	0-1	.559
TWSNOT-22	36.0	26.3-55.8	34.0	26.3-57.5	.815
Item 5 of TWSNOT-22	4.0	2-5	4.0	2-5	.750
Postoperation					
Endoscopic score	4.0	3-5.8	4.0	2.3-4.8	.338
UPSIT-TC	27.0	20.3-30	25.0	18-29.8	.390
PEA threshold test	−4.75	−7.5 to −2.8	−3.8	−6.7 to −2.3	.392
Mean MCA2	0.5	0.4-0.6	0.5	0.3-0.7	.780
Saccharine transit time	14.0	9.3-18	14.0	11-28	.251
Nasal culture score	1.0	0-1	1.0	0-2	.217
TWSNOT-22	18.0	9.3-28.8	13.5	8-39	.730
Item 5 of TWSNOT-22	1.0	0-2	1.0	0-3	.097
Postoperative change					
Endoscopic score	−1.0	−3 to 0	−1.0	−2 to 0	.883
UPSIT-TC	4.0	−2 to 9	2.5	−1 to 8.5	.595
PEA threshold test	−1.38	−3.6 to 0.7	0.0	−2.3 to 1.4	.170
Mean MCA2	0.1	0-0.2	0.0	−0.1 to 0.1	.052
Saccharine transit time	−1.0	−8.5 to 5.8	1.0	−1 to 6	.051
Nasal culture score	0.0	0-1	1.0	0-1.8	.114
TWSNOT-22	−16.5	−32.5 to −7.3	−15.0	−23 to −6	.325
Item 5 of TWSNOT-22	−2.0	−4 to −1	−1.5	−3.8 to 0	.200

Table 3 compares the serum IgE-negative and positive groups across baseline characteristics and various clinical parameters indicating preoperative and postoperative CRS severity. Significant differences were noticed in postoperative improvements in the PEA threshold test and the 5th item score of the TWSNOT-22.

Table 3. Comparison of Serum IgE-Negative and -Positive Groups

	Negative (n = 59)		Positive (n = 37)		
	Median	IQR	Median	IQR	P value
Age	50.0	38-58	48.0	43.5-60	.500
Sex					.660
Female	25 (42.4%)		14 (37.8%)		
Male	34 (57.6%)		23 (62.2%)		
Asthma	8 (47.1%)		9 (52.9%)		.179
Preoperation					
Sinus CT	14.0	12-15	14.0	12.5-15	.456
Endoscopic score	5.0	4-6	5.0	4-7	.433
UPSIT-TC	19.0	13-28	22.0	13.5-27.5	.958
PEA threshold test	−2.4	−5.6 to −1	−4.8	−7 to −1	.110
Mean MCA2	0.4	0.3-0.5	0.5	0.3-0.6	.134
Saccharine transit time	13.0	9-19	15.0	8.5-25.5	.321
Nasal culture score	0.0	0-1	0.0	0-1	.933
TWSNOT-22	41.0	25-61	34.0	27-46.5	.646
Item 5 of TWSNOT-22	4.0	3-5	3.0	2-5	.024
Postoperation					
Endoscopic score	4.0	3-5	4.0	2-5	.300
UPSIT-TC	25.0	20-28	25.0	18-31	.766
PEA threshold test	−4.8	−7.8 to −2.4	−3.9	−6.5 to −2.8	.774
Mean MCA2	0.5	0.4-0.6	0.5	0.4-0.6	.769
Saccharine transit time	13.0	9-18	16.0	11.5-30	.007
Nasal culture score	1.0	0-2	1.0	0-2	.674
TWSNOT-22	16.0	9-29	18.0	8-33	.670
Item 5 of TWSNOT-22	1.0	0-2	1.0	0-3	.346
Postoperative change					
Endoscopic score	−1.0	−2 to 0	−1.0	−3 to 0	.201
UPSIT-TC	4.0	−2 to 10	3.0	−0.5 to 6.5	.871
PEA threshold test	−1.3	−4.1 to 0.8	0.0	−1.8 to 1.8	.046
Mean MCA2	0.1	0-0.2	0.1	−0.1 to 0.1	.267
Saccharine transit time	0.0	−7 to 5	0.0	−2.5 to 8	.181
Nasal culture score	0.0	0-1	0.0	0-1	.921
TWSNOT-22	−17.0	−33 to −7	−14.0	−22.5 to −4.5	.185
Item 5 of TWSNOT-22	−2.0	−4 to −1	−1.0	−2 to 0	.006

Table 4 compares the serum eosinophil-negative and positive groups The postoperative UPSIT-TC score showed a significantly greater improvement in the serum eosinophil-positive group. The 5th item score of the TWSNOT-22 was also significantly worse in the serum eosinophil-positive.

Table 4. Comparison of Serum Eosinophil-Negative and -Positive Groups

	Negative (n = 50)		Positive (n = 46)		
	Median	IQR	Median	IQR	P value
Age	51.0	36-59	48.0	40.5-59	.857
Sex					.897
Female	20 (40.0%)		19 (41.3%)		
Male	30 (60.0%)		27 (58.7%)		
Asthma	8 (47.1%)		9 (52.9%)		.648
Preoperation					
Sinus CT	14.0	11-15	14.5	13-15	.691
Endoscopic score	5.0	4-6	4.5	4-6	.517
UPSIT-TC	23.0	17-28	15.0	11.8-27.3	.006
PEA threshold test	−3.8	−6.8 to −1	−1.0	−5.8 to −1	.067
Mean MCA2	0.4	0.3-0.6	0.4	0.3-0.5	.507
Saccharine transit time	15.0	9-25	12.0	8-18.3	.147
Nasal culture score	0.0	0-1	0.0	0-0.3	.216
TWSNOT-22	42.0	29-57.3	32.0	24-50.5	.075
Item 5 of TWSNOT-22	3.0	1.8-5	5.0	3.8-5	.001
Postoperation					
Endoscopic score	4.0	3-6	4.0	2-4.3	.100
UPSIT-TC	25.0	20-28	25.5	18-30.3	.630
PEA threshold test	−4.2	−7 to −2.8	−4.5	−6.6 to −2.3	.608
Mean MCA2	0.5	0.4-0.7	0.5	0.3-0.6	.170
Saccharine transit time	14.0	9-21.5	14.0	11-19.3	.985
Nasal culture score	1.0	0-2	1.0	0-1.3	.606
TWSNOT-22	19.5	9-29	13.0	6.5-37.5	.379
Item 5 of TWSNOT-22	1.0	0-2	1.0	0-3	.422
Postoperative change					
Endoscopic score	−1.0	−2 to 0	−1.0	−3 to 0	.490
UPSIT-TC	2.0	−3.3 to 5.3	6.0	1-11	.001
PEA threshold test	−0.9	−2.3 to 1.4	−0.8	−3.8 to 0.9	.334
Mean MCA2	0.1	0-0.2	0.1	0-0.1	.446
Saccharine transit time	0.0	−6.8 to 5.3	0.0	−4 to 6	.266
Nasal culture score	0.0	0-1	1.0	0-1	.574
TWSNOT-22	−18.0	−31.5 to −7.8	−12.5	−27.3 to −4.3	.103
Item 5 of TWSNOT-22	−1.0	−3 to 0	−2.0	−4 to −1	.028

Table 5 compares the tissue eosinophil-negative and positive groups. No significant differences were observed between groups in postoperative results. The UPSIT-TC score and fifth item score of the TWSNOT-22 showed significantly greater improvement in the tissue eosinophil-positive group.

Table 5. Comparison of Tissue Eosinophil-Negative and -Positive Groups

	Negative (n = 47)		Positive (n = 49)		
	Median	IQR	Median	IQR	P value
Age	53.0	34-61	46.0	39-56.5	.329
Sex					.969
Female	19 (40.4%)		20 (40.8%)		
Male	28 (59.6%)		29 (59.2%)		
Asthma	6 (35.3%)		11 (64.7%)		.214
Preoperation					
Sinus CT	14.0	11-14	14.0	13-15	.035
Endoscopic score	5.0	4-6	5.0	4-6	.829
UPSIT-TC	22.0	18-28	14.0	11.5-26	.001
PEA threshold test	−4.0	−6.5 to −1	−1.0	−6.3 to −1	.111
Mean MCA2	0.4	0.3-0.6	0.4	0.3-0.6	.655
Saccharine transit time	15.0	10-23	12.0	8-19	.071
Nasal culture score	0.0	0-1	0.0	0-1	.473
TWSNOT-22	41.0	29-58	32.0	25-52	.178
Item 5 of TWSNOT-22	3.0	2-5	5.0	3-5	.003
Postoperation					
Endoscopic score	4.0	3-6	4.0	2-4.5	.064
UPSIT-TC	24.0	20-27	27.0	19.5-30	.354
PEA threshold test	−4.3	−6.8 to −2.8	−4.3	−8 to −2.3	.883
Mean MCA2	0.5	0.4-0.7	0.5	0.3-0.6	.095
Saccharine transit time	14.0	11-21	14.0	8.5-19.5	.605
Nasal culture score	1.0	0-2	1.0	0-2	.734
TWSNOT-22	20.0	11-33	12.0	8-29	.158
Item 5 of TWSNOT-22	1.0	0-2	1.0	0-3	.844
Postoperative change					
Endoscopic score	−1.0	−2 to 0	−1.0	−3 to 0	.094
UPSIT-TC	1.0	−4 to 5	6.0	1.5-11	<.001
PEA threshold test	−2.3 to 1.8		−1.0	−3.4 to 0	.102
Mean MCA2	0.1	0-0.2	0.0	0-0.1	.102
Saccharine transit time	0.0	5-5	0.0	−4.5 to 6	.789
Nasal culture score	0.0	0-1	1.0	0-1	.432
TWSNOT-22	−18.0	−31 to −8	−14.0	−28.5 to −5.5	.431
Item 5 of TWSNOT-22	−1.0	−3 to 0	−2.0	−4 to −1	.018

Moreover, serum eosinophils are highly associated with tissue eosinophil. Serum eosinophils had moderate evidence to rule in as well as rule out .

Discussion

The study explores the debated role of nasal allergies in CRS by comparing the severity and outcomes between the allergy-positive and allergy-negative groups. The results suggest that while allergies and CRS often coexist, their relationship may be complex and does not directly contribute to the pathophysiology of CRS.
IgE plays a key role in allergic inflammation. Our study indicates that ECRS is driven by a TH2 response dominated by eosinophilia rather than IgE.
In our study, serum eosinophil counts and tissue eosinophil presence were significantly associated with worse preoperative olfactory dysfunction. Despite poorer preoperative olfactory function in the serum and tissue eosinophil-positive groups, postoperative olfactory function at three months remained no different between the groups surprisingly. These findings carry important clinical implications. Despite worse baseline olfactory function, patients with ECRS demonstrated comparable postoperative olfactory recovery compared to non-ECRS patients. This suggests that timely surgical intervention can be highly effective in restoring olfaction, a key quality-of-life factor in CRS. Clinicians should consider early surgical management in appropriate candidates to maximize olfactory outcomes and patient satisfaction.
Several limitations must be acknowledged. First, the small sample size with retrospective design at a single institution. Second, a single postoperative follow-up time point at three months.

Conclusion

Our study highlights the significant role of serum and tissue eosinophils, which are associated with worse preoperative CRS severity, particularly in olfactory dysfunction. Elevated serum and tissue eosinophils are also associated with greater postoperative improvements in smell function and symptom scores. Serum eosinophils could serve as a reliable non-invasive biomarker for predicting disease severity and surgical outcomes in CRS patients.