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ROLE OF ABSOLUTE EOSINOPHIL COUNT AND OLFACTORY FUNCTION BEFORE AND AFTER ENDOSCOPIC SINUS SURGERY

Original Research

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ABSTRACT

Background: Chronic rhinosinusitis (CRS), with or without nasal polyps (CRSwNP/CRSsNP), is a persistent inflammatory condition of the sinonasal mucosa that significantly impairs olfactory function. Olfactory loss, often resistant to medical therapy, profoundly affects quality of life and reflects underlying disease severity. Endoscopic sinus surgery (ESS) is frequently considered when conservative treatments fail, aiming to restore sinus ventilation and reduce inflammatory burden, particularly in eosinophilic CRS.

Objective: To evaluate the effect of endoscopic sinus surgery on olfactory function and systemic inflammation in patients with chronic rhinosinusitis by comparing preoperative and postoperative Sniffin' Sticks scores and absolute eosinophil counts.

Methods: A prospective observational study was conducted at the Department of Otolaryngology, Combined Military Hospital, Sialkot, from July to December 2024. Sixty adult patients aged 18–70 years with CRS unresponsive to three months of optimized medical therapy were enrolled. Preoperative and three-month postoperative assessments included peripheral blood absolute eosinophil count (AEC) and olfactory evaluation using the Sniffin' Sticks test (threshold, discrimination, identification; TDI). Surgical intervention was standardized, and postoperative care included nasal corticosteroids and saline irrigation. Data were analyzed using SPSS version 26.0, with statistical significance set at $p < 0.05$.

Results: The mean age of participants was 46.4 ± 14.1 years with a mean BMI of 24.4 ± 3.4 kg/m². Preoperative AEC was 0.7793 ± 0.3638 ×10⁹/L, decreasing significantly to 0.4677 ± 0.2184 ×10⁹/L postoperatively ($p < 0.05$). Sniffin' Sticks TDI scores improved from 18.26 ± 4.92 to 27.93 ± 8.53 ($p < 0.05$). Anosmia decreased from 36.7% to 13.3%, while normosmia increased from 0% to 40%. Olfactory function improved in 47 patients (78.3%), with 13 patients (21.7%) showing no significant change.

Conclusion: ESS significantly improves olfactory function and reduces systemic eosinophilic inflammation in CRS patients, supporting its role as a beneficial intervention in refractory cases.

Keywords: Chronic rhinosinusitis, endoscopic sinus surgery, eosinophilia, inflammation, olfaction disorders, quality of life, Sniffin' Sticks test.

INTRODUCTION

Chronic rhinosinusitis (CRS), whether with or without nasal polyps, is a prevalent condition frequently encountered in otolaryngological practice, characterized by prolonged inflammation of the nasal and paranasal sinus mucosa. One of its most distressing symptoms, particularly in individuals with nasal polyps (CRSwNP), is olfactory dysfunction—a deficit that extends beyond sensory loss to significantly impair daily living and emotional well-being (1). Impaired olfaction in CRS is not only a quality-of-life issue but also serves as a reliable marker of disease severity and responsiveness to therapy. Globally, CRS affects approximately 10–12% of the adult population, with some epidemiological studies indicating even higher prevalence rates in Western countries—estimated at 14% in the United States and 10.9% across Europe. Among these cases, CRS without nasal polyps (CRSsNP) is more commonly reported, while CRSwNP has a prevalence ranging from 2% to 4% (2,3). The underlying mechanisms of olfactory dysfunction in CRS are multifactorial, involving both conductive and sensorineural components. Conductive loss arises primarily from obstruction of airflow to the olfactory cleft due to mucosal swelling, polyp formation, and accumulation of secretions. Conversely, sensorineural impairment stems from chronic inflammation-induced damage to the olfactory epithelium and receptor neurons, potentially resulting in long-term or even irreversible loss of smell (4). A growing body of evidence underscores the pivotal role of eosinophilic inflammation, especially in CRSwNP, in mediating this dysfunction. Eosinophils, through the release of cytotoxic granules such as major basic protein, eosinophilic cationic protein, and reactive oxygen species, contribute to mucosal injury, neurotoxicity, and structural remodeling of the olfactory region (5). Clinical studies have demonstrated that higher tissue and nasal secretion eosinophil counts are significantly associated with diminished olfactory capacity and poorer postoperative recovery following surgical intervention (6,7). For instance, a study found that patients with elevated eosinophilic infiltration had significantly lower preoperative olfactory scores and experienced limited improvement after surgery (8).

Reliable evaluation of olfactory function in CRS patients is critical for both clinical management and research. Among the validated tools, the Sniffin' Sticks test remains widely used for its accuracy and reproducibility. When medical management fails, endoscopic sinus surgery (ESS) is often indicated to restore sinus drainage, remove obstructive tissue, and enhance mucociliary clearance. In selected patients, ESS has been shown to alleviate symptoms and improve olfactory function, particularly in those with a lower eosinophilic load (9,10). However, outcomes in eosinophilic CRS (ECRS) are less favorable, with studies revealing that olfactory improvements post-ESS are frequently transient, deteriorating within a year due to persistent inflammation (11). Similarly, a study observed that, although 70% of patients reported postoperative improvement, the rates of complete olfactory recovery were modest, especially among those with severe baseline dysfunction (12). Despite these insights, the predictive utility of absolute eosinophil count in determining postoperative olfactory outcomes remains underexplored. The current study seeks to bridge this gap by evaluating the association between preoperative and postoperative absolute eosinophil counts and olfactory performance as measured by the Sniffin' Sticks test. Through this investigation, the study aims to enhance prognostic accuracy and inform clinical decision-making in the surgical management of CRS patients.

METHODS

A prospective observational study was conducted at the Department of Otolaryngology, Combined Military Hospital, Sialkot, from July 2024 to December 2024, enrolling a total of sixty adult patients diagnosed with chronic rhinosinusitis (CRS) with or without nasal polyps (CRSwNP or CRSsNP) who were scheduled for endoscopic sinus surgery (ESS). Ethical approval for the study was obtained from the Institutional Ethical Review Committee and informed written consent was obtained from all participants prior to their inclusion. Eligible participants included adults aged 18 to 70 years with a clinical diagnosis of CRS based on established diagnostic criteria, including the presence of persistent symptoms for 12 weeks or longer despite at least three months of optimized medical management with intranasal corticosteroids and saline irrigation. All participants exhibited confirmed olfactory dysfunction on baseline Sniffin' Sticks testing and were deemed fit for elective ESS under general anesthesia. Both male and female patients were included. Exclusion criteria comprised any history of prior sinonasal surgery, significant head trauma affecting olfaction, isolated septal deviation requiring septoplasty alone, or the use of systemic corticosteroids or immunosuppressants within four weeks prior to enrollment. Patients were

also excluded if they had underlying neurological disorders, active sinonasal malignancy, fungal sinusitis, or concurrent respiratory tract infections (13).

Comprehensive demographic and clinical information, including age, gender, body mass index (BMI), smoking history, comorbid asthma, allergic rhinitis, and duration of olfactory dysfunction, was collected using a structured data collection form. Patients were categorized into CRSwNP or CRSsNP groups based on endoscopic and clinical findings. Baseline olfactory function was assessed using the Sniffin' Sticks test, which comprised three components: odor threshold (T), discrimination (D), and identification (I). The threshold component measured the lowest detectable odor concentration using a staircase paradigm, with the final score calculated as the mean of the last four out of seven reversal points. The discrimination task required patients to identify one differing odor among triplets of pens, with each correct response scoring one point (maximum 16). The identification test involved the recognition of 16 distinct odors, each with four options, and one point was awarded for each correct answer. The cumulative TDI score (range: 0–48) was used to classify olfactory function into anosmia (<16), hyposmia (16–30), and normosmia (>30). Peripheral blood samples were collected preoperatively to measure the absolute eosinophil count (AEC) using an automated hematology analyzer as part of the complete blood count (CBC). All patients underwent standardized bilateral ESS under general anesthesia, performed by an experienced otolaryngologist. The surgical protocol included uncinectomy, middle meatal antrostomy, anterior and posterior ethmoidectomy, sphenoidotomy, and frontal sinusotomy when indicated. In patients with CRSwNP, particular attention was given to clearing the olfactory cleft of obstructing polypoid tissue to facilitate postoperative olfactory recovery.

Postoperative management was standardized across all patients and included weekly nasal endoscopic debridement for four weeks, topical intranasal corticosteroid spray (fluticasone twice daily), and saline nasal irrigation (three times daily) for three months. Additionally, a 7-day course of oral antibiotics was prescribed immediately following surgery. The primary outcome was defined as an improvement of at least five points in the Sniffin' Sticks TDI score at three months postoperatively. Both AEC and olfactory function were reassessed at the three-month follow-up visit. Statistical analysis was performed using SPSS version 26.0. Continuous variables such as age, BMI, duration of olfactory dysfunction, absolute eosinophil count, and TDI scores were expressed as means and standard deviations. Categorical variables, including gender, smoking status, asthma, allergic rhinitis, and olfactory classification (anosmic, hyposmic, normosmic), were presented as frequencies and percentages. The Chi-square test was employed to evaluate associations between CRS phenotype (CRSwNP vs. CRSsNP) and categorical variables. Pre- and postoperative differences in AEC and TDI scores were analyzed using paired t-tests, with a p-value of less than 0.05 considered statistically significant.

RESULTS

The study population had a mean age of 46.4 ± 14.1 years and an average BMI of 24.4 ± 3.4 kg/m². The mean duration of olfactory dysfunction was 3.2 ± 1.3 years. Among patients with CRSwNP, 15.8% were in the 18–30 years age group, 47.4% in the 31–50 years group, and 36.8% in the 51–70 years group. The CRSsNP group had 9.1%, 45.5%, and 45.5% patients in the same respective age categories ($p = 0.691$). Gender distribution showed that 63.2% of CRSwNP and 72.7% of CRSsNP patients were male ($p = 0.449$). Smoking history was reported in 36.8% of CRSwNP and 45.5% of CRSsNP patients ($p = 0.512$). A history of asthma was more frequent among CRSwNP patients (31.6%) compared to CRSsNP patients (18.2%) ($p = 0.258$). Allergic rhinitis was present in 36.8% of CRSwNP and 45.5% of CRSsNP patients ($p = 0.512$). The preoperative absolute eosinophil count averaged 0.7793 ± 0.36376 $\times 10^9$/L, which significantly decreased to 0.4677 ± 0.21837 $\times 10^9$/L postoperatively ($r = 0.450$, $p < 0.05$). A corresponding and statistically significant improvement was noted in olfactory function, as assessed by Sniffin' Sticks scores, which rose from a preoperative mean of 18.26 ± 4.923 to a postoperative mean of 27.93 ± 8.525 ($r = 0.853$, $p < 0.05$).

Olfactory classification prior to surgery indicated that 36.7% of patients were anosmic and 63.3% were hyposmic, with none categorized as normosmic. After surgery, the proportion of anosmic patients reduced to 13.3%, hyposmic to 46.7%, while 40.0% of patients achieved normosmia, demonstrating a significant overall shift in olfactory status following ESS. A total of 78.3% of patients showed an improvement of at least five points in their TDI scores, meeting the study's primary outcome criteria. The remaining 21.7% exhibited no clinically meaningful change in olfactory function at the three-month follow-up. The subgroup analysis comparing absolute eosinophil counts between patients who showed olfactory improvement and those who did not revealed notable differences. Patients who demonstrated olfactory function improvement following ESS had a lower mean preoperative eosinophil count (0.7431 ± 0.3069 $\times 10^9$/L) compared to those who did not improve (1.0019 ± 0.3010 $\times 10^9$/L). Similarly, the postoperative eosinophil count was also lower in the improved group (0.4421 ± 0.3265 $\times 10^9$/L) than in the non-improved group (0.6815 ± 0.2811 $\times 10^9$/L). These findings suggest that

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a higher eosinophilic burden may negatively impact olfactory recovery outcomes after ESS, supporting the hypothesis that absolute eosinophil count is a potential prognostic marker in chronic rhinosinusitis management.

Table 1: Baseline and Clinical Characteristics of the Study Participants

Characteristics	CRSwNP (n=38)	CRSsNP (n=22)	P-value
Age Group			0.691
18-30 years	6 (15.8%)	2 (9.1%)	
31-50 years	18 (47.4%)	10 (45.5%)	
51-70 years	14 (36.8%)	10 (45.5%)	
Gender			0.449
Male	24 (63.2%)	16 (72.7%)	
Female	14 (36.8%)	6 (27.3%)	
Smoking			0.512
Yes	14 (36.8%)	10 (45.5%)	
No	24 (63.2%)	12 (54.5%)	
Asthma			0.258
Yes	12 (31.6%)	4 (18.2%)	
No	26 (68.4%)	18 (81.8%)	
Allergic Rhinitis			0.512
Yes	14 (36.8%)	10 (45.5%)	
No	24 (63.2%)	12 (54.5%)	

Table 2: Preoperative and Postoperative Changes in Absolute Eosinophil Count and Olfactory Function

Variable	Preoperative Value	Postoperative Value	Correlation (r) & P-value
Absolute Eosinophil Count (10^9/L)	0.7793 ± 0.36376	0.4677 ± 0.21837	0.450, $p < 0.05$
Sniffin' Sticks Score	18.26 ± 4.923	27.93 ± 8.525	0.853, $p < 0.05$

Table 3: Subgroup Analysis of Eosinophil Counts

Olfactory Outcome	Preoperative AEC (10^9/L)	Postoperative AEC (10^9/L)
Improved	0.743 ± 0.307	0.442 ± 0.327
Not Improved	1.002 ± 0.301	0.682 ± 0.281

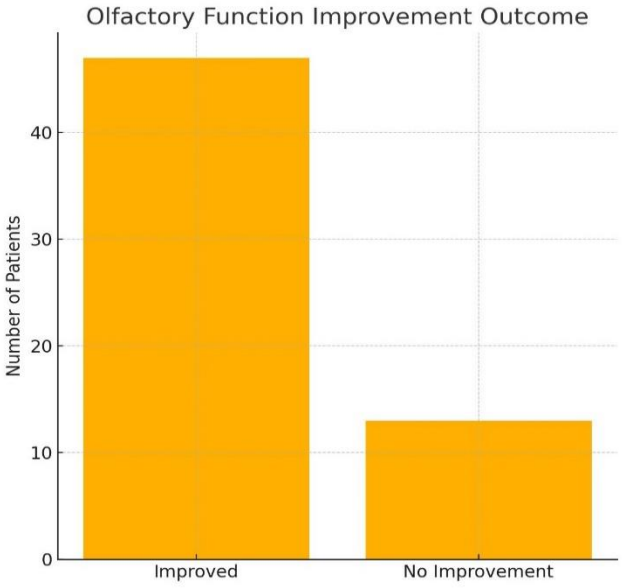

Figure 1 Olfactory Function Improvement Outcome

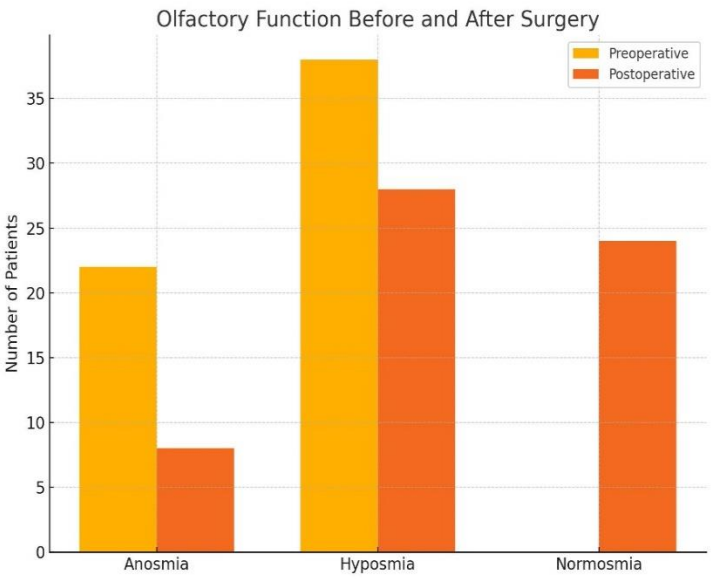

Figure 2 Olfactory Function Before and After Surgery

DISCUSSION

This study assessed the impact of endoscopic sinus surgery (ESS) on olfactory function in patients with chronic rhinosinusitis (CRS), including both phenotypes with and without nasal polyps (CRSwNP and CRSsNP). The findings demonstrated a significant postoperative improvement in olfactory function, evidenced by a notable increase in Sniffin' Sticks test scores and a concurrent reduction in absolute eosinophil counts. These outcomes not only validate the clinical benefit of ESS in enhancing olfaction but also emphasize the potential role of eosinophilic inflammation as a modifiable determinant of postoperative sensory recovery (14,15). The demographic characteristics of the study population were consistent with prior research, with a mean age of 46.4 years and BMI closely aligning with earlier reported cohorts. The average duration of olfactory dysfunction was slightly shorter than that in some referenced studies, suggesting potential variability in the timing of surgical intervention across clinical settings. Notably, the mean peripheral absolute eosinophil count decreased by approximately 40% following surgery, a finding congruent with earlier investigations which have linked systemic eosinophilic burden with disease severity and poorer surgical outcomes in CRS (16,17). The reduction in eosinophil levels observed here supports the hypothesis that ESS contributes to a broader immunologic modulation, particularly by attenuating type 2 inflammation, which in turn facilitates olfactory epithelial recovery. In addition to biochemical markers, objective olfactory testing revealed substantial improvements. The Sniffin' Sticks total score increased from a baseline value indicative of functional anosmia to a postoperative mean consistent with hyposmia, with nearly 10-point gains observed (18).

This magnitude of improvement aligns with pooled data from multiple ESS outcome studies, particularly among CRSwNP populations, where olfactory loss is often severe and inflammation-driven. Despite these gains, the average postoperative score did not surpass the normosmic threshold, a trend similarly reported in prior longitudinal evaluations. This persistent sub normality, even after effective surgical intervention, reflects the chronicity and potential irreversibility of structural or neuroepithelial damage induced by longstanding inflammation. Therefore, although ESS substantially improves olfaction in most patients, complete restoration of normal smell may remain elusive for a considerable proportion, underscoring the need for long-term medical management (19).Postoperative categorical analysis of olfactory status also revealed clinically meaningful transitions. A considerable number of patients moved from anosmia or hyposmia toward normosmia following surgery, with nearly 40% achieving normal olfactory function. These findings are supported by similar trends reported in earlier studies, although rates of normosmic recovery have varied across cohorts, likely due to heterogeneity in patient characteristics, follow-up intervals, and definitions of recovery (20). Furthermore, the subgroup analysis comparing patients with and without olfactory improvement revealed that higher baseline eosinophil counts were associated with poorer postoperative outcomes. This observation strengthens the argument for utilizing eosinophilic biomarkers not only as indicators of disease severity but

also as predictors of surgical prognosis. It also reinforces the relevance of incorporating targeted anti-eosinophilic strategies, possibly including biologics, into the treatment algorithm for patients at higher risk of persistent dysfunction (21).

Overall, 78.3% of patients exhibited improved olfactory function postoperatively, which is comparable to previously published improvement rates ranging from 58% to 75%. These consistent outcomes confirm ESS as an effective therapeutic modality for CRS-associated olfactory loss. However, a minority of patients (21.7%) did not experience significant changes in smell despite surgery, highlighting the complexity of olfactory recovery and the multifactorial nature of its impairment. The strengths of this study include its prospective design, the use of a validated olfactory testing tool, and objective quantification of peripheral eosinophil counts both pre- and postoperatively. Furthermore, the inclusion of both CRSwNP and CRSsNP patients allowed for comparative insights into different inflammatory subtypes. Nonetheless, the study had several limitations. The sample size was relatively small, and the follow-up period was limited to three months, precluding assessment of long-term outcomes or delayed deterioration, particularly in eosinophilic CRS cases. Adherence to postoperative medical therapy, although advised, was not actively monitored, and could have influenced the observed results. Additionally, eosinophil counts were measured only in peripheral blood, whereas tissue eosinophilia, which may better correlate with disease activity, was not evaluated. Future studies should incorporate larger, multicenter cohorts with extended follow-up periods to evaluate the sustainability of olfactory improvement over time. Stratification by inflammatory endotype, integration of tissue-level biomarkers, and the role of adjunctive therapies including biologics may further refine patient selection and treatment planning. Understanding the interplay between systemic and local inflammation and their impact on sensory recovery will be critical in optimizing long-term outcomes in CRS patients undergoing ESS.

CONCLUSION

This study concludes that endoscopic sinus surgery serves as an effective intervention for improving olfactory function in patients with chronic rhinosinusitis, particularly in those unresponsive to medical therapy. The observed enhancement in smell perception, along with a reduction in eosinophilic inflammation, underscores the dual therapeutic impact of surgery—both functional and immunological. These findings highlight the importance of timely surgical management in selected CRS patients and support its role in alleviating the inflammatory burden that contributes to sensory impairment. The results contribute to clinical decision-making by reinforcing the predictive value of inflammatory markers and emphasizing the potential for meaningful recovery in olfactory function through surgical care.

AUTHOR CONTRIBUTION

Author	Contribution
Amna Raza*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Sohail Aslam	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Liaquat Ali	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published

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