

Article

Association Between Systemic Inflammatory Indices and Lund–Mackay Score in Chronic Rhinosinusitis with Nasal Polyps

Yusuf Aydın *  and Fatma Atalay

Department of Otorhinolaryngology, Faculty of Medicine, Kastamonu University, Kastamonu 37200, Türkiye; fatalay@kastamonu.edu.tr

* Correspondence: yusufaydin@kastamonu.edu.tr

Abstract

Chronic rhinosinusitis with nasal polyps (CRSwNP) is a heterogeneous inflammatory disease in which identifying simple biomarkers reflecting disease severity remains challenging. This study aimed to evaluate the relationship between systemic inflammatory indices and radiological disease severity assessed by the Lund–Mackay (LM) score. This retrospective study included 90 adult patients with CRSwNP who underwent endoscopic sinus surgery. Preoperative computed tomography findings were scored using the LM system, and systemic inflammatory indices, including neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), monocyte-to-lymphocyte ratio (MLR), eosinophil-to-lymphocyte ratio (ELR), neutrophil-to-monocyte ratio (NMR), systemic immune-inflammatory index (SII), systemic inflammation response index (SIRI), and eosinophil/leukocyte ratio, were calculated from complete blood count parameters. Spearman correlation and univariate logistic regression analyses were performed. ELR ($r = 0.49$, $p < 0.001$) and eosinophil/leukocyte ratio ($r = 0.46$, $p < 0.001$) showed moderate positive correlations with LM score, whereas other indices were not significantly associated. In logistic regression analysis, both ELR ($OR = 5.44 \times 10^4$, $p < 0.001$) and eosinophil/leukocyte ratio ($OR = 4.99 \times 10^{12}$, $p = 0.001$) were significantly associated with high disease burden ($LM \geq 15$). These findings suggest that eosinophil-based inflammatory indices may better reflect radiological disease severity in CRSwNP compared to traditional systemic inflammatory markers.

Keywords: chronic rhinosinusitis; nasal polyps; Lund–Mackay score; systemic inflammatory indices; eosinophil; eosinophil-to-lymphocyte ratio



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1. Introduction

Chronic rhinosinusitis (CRS) is the most common chronic inflammatory disease of the upper respiratory tract that affects 5–12% of adults worldwide and causes a significant decline in quality of life [1,2]. CRS is divided into two subtypes based on the presence of nasal polyps: with nasal polyposis (CRSwNP) and without nasal polyposis (CRSsNP) [2]. Of these two phenotypes, CRSwNP is more resistant to treatment and has higher relapse rates and more severe symptoms. Therefore, it is attracting more attention from researchers and clinicians [3]. The prevalence of CRSwNP ranges from 1–4%, with a significant portion of the patient group (approximately 45%) having concomitant asthma and 8–26% having NSAID-negative respiratory disease as comorbidities [4,5].

Pathophysiologically, the inflammatory profile of CRSwNP is quite heterogeneous. The Lund–Mackay (LM) scoring system is currently one of the most widely used objective

methods for demonstrating CRS inflammation [6,7]. Because of its simplicity, ease of use, and low inter-observer variability, this system is widely accepted and used to grade the radiological severity of CRS [8]. However, previous studies in heterogeneous patient groups have failed to establish a significant relationship between subjective symptom burden and objective computed tomography (CT) findings [6,9]. As an important point for clinical practice, it should be noted that CT scanning is the most popular imaging approach frequently used in the diagnosis of CRS, in determining the scope of endoscopic sinus surgery, and in predicting treatment response [10,11].

In recent years, increasing attention has been directed toward identifying simple, reproducible, and cost-effective biomarkers that can reflect disease activity and severity in CRS. Among these, eosinophil-related markers have attracted particular interest because eosinophilic inflammation plays a central role in the pathophysiology of CRSwNP. Blood-derived indices such as the eosinophil-to-lymphocyte ratio (ELR) have therefore been proposed as potential surrogate markers of disease burden [12,13]. Although several systemic inflammatory indices, including the systemic immune-inflammatory index (SII) and systemic inflammation response index (SIRI), have also been investigated in CRSwNP, their clinical relevance remains uncertain and the available evidence remains limited [13,14]. However, the relationship between these biomarkers and objective measures of disease severity in CRSwNP remains incompletely understood.

This study aims to gain a clearer understanding of the value and limitations of systemic inflammatory indices in CRSwNP by directly comparing their evaluation with a standard radiological measurement such as the LM score.

2. Materials and Methods

This study is based on a retrospective review of medical records of patients diagnosed with CRSwNP who underwent endoscopic sinus surgery at the Department of Otolaryngology at Kastamonu Training and Research Hospital between 15 June 2022 and 15 November 2024. The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Kastamonu University Ethics Committee for Non-Interventional Clinical Research (protocol code: 2025-83; approval date: 18 December 2025).

The study included patients aged 18 years and older who had undergone endoscopic sinus surgery for CRSwNP and for whom preoperative CT scans of the paranasal sinuses and complete blood count (CBC) results were available. Patients with incomplete clinical or laboratory data, those with acute infections, those with systemic inflammatory or hematological diseases, those receiving systemic corticosteroid treatment at the time of blood sampling, and individuals under the age of 18 were excluded from the study.

The patients' demographic characteristics (age and gender), clinical data, and laboratory results were obtained retrospectively through the hospital information management system. The severity of the disease was assessed using the LM scoring system based on preoperative CT images of the paranasal sinuses [7]. Each sinus (maxillary, frontal, sphenoid, anterior, and posterior ethmoid) was scored on a scale of 0–2, and the ostiomeatal complex patency was also evaluated. The maximum score was calculated as 24 based on the sum of both sides.

Neutrophil, lymphocyte, monocyte, platelet, and eosinophil counts were recorded from routine preoperative complete blood count results obtained before surgery. Systemic inflammatory indices derived from these parameters were calculated. These indices include NLR (neutrophil-to-lymphocyte ratio), PLR (platelet-to-lymphocyte ratio), MLR (monocyte-to-lymphocyte ratio), ELR (eosinophil-to-lymphocyte ratio), NMR (neutrophil-to-monocyte ratio), SII (systemic immune-inflammation index), SIRI (systemic inflammation response index), and the eosinophil-to-leukocyte ratio. The SII was calculated as platelet count $\times$ neutrophil count/lymphocyte

count, and the SIRI was calculated as neutrophil count $\times$ monocyte count/lymphocyte count. Definitions and calculation formulas for all inflammatory indices included in the study are provided in Table 1.

Table 1. Definitions and calculation formulas of the inflammatory indices used in the study.

Index	Formula
NLR	Neutrophils/Lymphocytes
PLR	Platelets/Lymphocytes
MLR	Monocytes/Lymphocytes
ELR	Eosinophils/Lymphocytes
NMR	Neutrophils/Monocytes
SII	Platelets $\times$ Neutrophils/Lymphocytes
SIRI	Neutrophils $\times$ Monocytes/Lymphocytes
Eosinophil/Leukocyte ratio	Eosinophils/Leukocytes

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Shapiro–Wilk test. The relationship between the LM score and systemic inflammatory indices was evaluated using Spearman correlation analysis. In addition, logistic regression analysis was performed to identify factors associated with high radiological disease burden. For this purpose, patients with an LM score ≥ 15 were defined as having a high disease burden, as previous studies have demonstrated that higher LM scores are associated with more severe disease and poorer clinical outcomes [5,10]. A binary outcome variable was then created for logistic regression analysis. The association between systemic inflammatory indices and high LM score was evaluated using univariate logistic regression analysis. The results were reported as odds ratios (OR) with 95% confidence intervals (CI). A p value < 0.05 was considered statistically significant.

3. Results

3.1. Patient Characteristics

A total of 90 patients diagnosed with CRSwNP who underwent endoscopic sinus surgery were included in the study. The mean age of the patients was 46.7 ± 14.9 years, and 74.4% were male. The demographic and laboratory characteristics of the patients are summarized in Table 2.

Table 2. Demographic and laboratory characteristics of the study population.

Variable	Value
Age (years), mean $\pm$ SD	46.7 ± 14.9
Sex (male/female), n (%)	67 (74.4%)/23 (25.6%)
Eosinophil count ($\times 10^9/L$), median (IQR)	0.28 (0.16–0.45)
NLR, median (IQR)	1.94 (1.48–2.66)
PLR, median (IQR)	125.62 (101.09–160.77)
MLR, median (IQR)	0.27 (0.22–0.33)
ELR, median (IQR)	0.12 (0.08–0.19)
NMR, median (IQR)	7.49 (6.31–8.63)
SII, median (IQR)	511.11 (376.31–691.55)
SIRI, median (IQR)	1.07 (0.76–1.76)

SD: standard deviation; IQR: interquartile range.

3.2. Correlation Between Lund–Mackay Score and Systemic Inflammatory Indices

The median LM score of the study population was 14 (range: 4–24). Spearman correlation analysis was performed to evaluate the relationship between LM score and

systemic inflammatory indices. No significant correlation was found between LM score and NLR, PLR, MLR, NMR, SII, or SIRI ($p > 0.05$). However, ELR showed a moderate positive correlation with LM score ($r = 0.49$, $p < 0.001$). Similarly, the eosinophil/leukocyte ratio was also positively correlated with LM score ($r = 0.46$, $p < 0.001$). The correlation results are presented in Table 3.

Table 3. Correlation between systemic inflammatory indices and Lund–Mackay score.

Variable	r	p Value
NLR	0.06	0.58
PLR	−0.08	0.44
MLR	0.12	0.26
ELR	0.49	<0.001
NMR	−0.10	0.33
SII	0.05	0.63
SIRI	0.11	0.29
Eosinophil/Leukocyte Ratio	0.46	<0.001

r: Spearman correlation coefficient.

3.3. Logistic Regression Analysis

Logistic regression analysis was performed to determine the association between systemic inflammatory indices and high radiological disease burden. A LM score ≥ 15 was defined as high disease burden. In univariate logistic regression analysis, ELR was significantly associated with high LM score ($OR = 5.44 \times 10^4$, 95% CI: $131.7\text{--}2.25 \times 10^7$, $p < 0.001$). Similarly, the eosinophil/leukocyte ratio was also significantly associated with higher disease burden ($OR = 4.99 \times 10^{12}$, 95% CI: $7.69 \times 10^4\text{--}3.23 \times 10^{20}$, $p = 0.001$). No significant associations were observed for NLR, PLR, MLR, NMR, SII, or SIRI ($p > 0.05$). The results of the logistic regression analysis are shown in Table 4.

Table 4. Logistic regression analysis of factors associated with high Lund–Mackay score (≥ 15).

Variable	OR	95% CI	p Value
NLR	1.04	0.71–1.52	0.846
PLR	0.99	0.99–1.00	0.505
MLR	23.21	0.21–2527.07	0.189
ELR	5.44×10^4	$131.7\text{--}2.25 \times 10^7$	<0.001
NMR	0.94	0.82–1.08	0.382
SII	1.00	0.999–1.001	0.732
SIRI	1.39	0.79–2.44	0.250
Eosinophil/Leukocyte Ratio	4.99×10^{12}	$7.69 \times 10^4\text{--}3.23 \times 10^{20}$	0.001

OR: odds ratio; CI: confidence interval.

Receiver operating characteristic (ROC) analysis was performed to evaluate the discriminatory ability of systemic inflammatory indices for predicting high radiological disease burden (LM score ≥ 15). ELR demonstrated the highest area under the curve (AUC = 0.741), followed by the eosinophil/leukocyte ratio (AUC = 0.702). The remaining indices showed limited discriminatory performance, with AUC values close to 0.50. The ROC curves are presented in Figure 1.

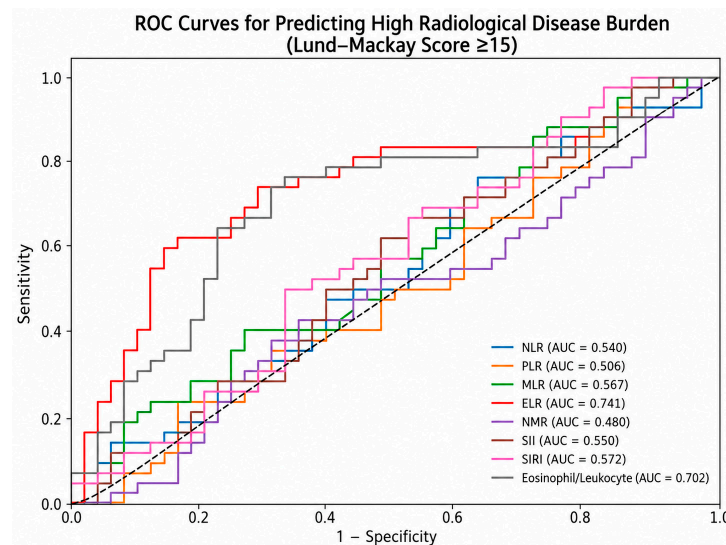


Figure 1. Receiver operating characteristic (ROC) curves of systemic inflammatory indices for predicting high radiological disease burden (Lund–Mackay score ≥ 15). The black dashed diagonal line represents the no-discrimination reference line (AUC = 0.50).

4. Discussion

The main finding of this study is that among the evaluated systemic inflammatory indices, only eosinophil-related parameters, particularly ELR and eosinophil/leukocyte ratio, showed a significant and moderate positive correlation with LM score. In contrast, commonly used indices such as NLR, PLR, MLR, SII, and SIRI did not show a significant correlation with radiological disease severity. These findings suggest that eosinophil-mediated inflammation may significantly influence the disease burden in CRSwNP compared to other systemic inflammatory responses.

The role of eosinophils in the pathophysiology of CRSwNP has been well established. Eosinophilic inflammation is a key feature of type 2 disease [15]. Eosinophilic inflammation has been associated with more severe symptoms, higher recurrence rates, and poorer clinical outcomes in patients with CRSwNP [16–20]. In the present study, both ELR and eosinophil/leukocyte ratio showed significant positive correlations with LM score, supporting the concept that eosinophil-driven inflammation is closely related to radiological disease burden in CRSwNP. Our findings are consistent with these observations and underscore the importance of eosinophil-related markers.

Our results also align with studies reporting that eosinophil-related ratios such as ELR may reflect the inflammatory status more accurately than traditional indices. For example, ELR has been shown to be elevated in CRSwNP patients and associated with disease activity and recurrence [21,22]. Although composite inflammatory indices such as SII and SIRI have been proposed as potential biomarkers in CRS, previous studies have reported inconsistent findings regarding their association with disease severity and clinical outcomes [13,23]. One possible explanation is that CRSwNP is predominantly a type 2 inflammatory disease characterized by eosinophilic infiltration, whereas composite indices such as SII and SIRI are influenced by multiple leukocyte populations and may therefore reflect systemic inflammation rather than eosinophil-driven local disease activity. In our study, neither SII nor SIRI demonstrated a significant relationship with LM score, suggesting that eosinophil-specific markers may better reflect radiological disease burden in CRSwNP than composite systemic inflammatory indices. This may also explain why ELR performed better than the other investigated markers, as it directly incorporates eosinophil counts, which are closely linked to the underlying inflammatory mechanisms of CRSwNP.

The LM score is a widely used measure designed to assess disease severity, but its relationship to symptomatic presentation is debatable. Studies in the literature highlight this discrepancy [5,6,10,13]. However, the LM score is a strong and reliable measure of radiological disease severity [6,17]. Therefore, identifying biomarkers associated with the LM score is important. These markers can support imaging findings and contribute to clinical evaluation.

In logistic regression analysis, ELR and eosinophil/leukocyte ratio were found to be significantly associated with high disease burden ($LM \geq 15$). These findings are clinically significant because high LM scores are known to be associated with worse surgical outcomes and uncontrolled disease [5,10,14]. Therefore, eosinophil-based indices can be used to predict disease severity and in preoperative risk stratification. Consistent with these findings, ROC analysis demonstrated moderate discriminatory performance for ELR (AUC = 0.741) and eosinophil/leukocyte ratio (AUC = 0.702). Although these values do not indicate excellent diagnostic accuracy, they suggest that eosinophil-based indices may serve as useful adjunctive biomarkers for identifying patients with a higher radiological disease burden.

In addition to their potential role in risk stratification, eosinophil-based biomarkers may also have increasing relevance in the era of biologic therapies for CRSwNP. Recent advances in the management of severe CRSwNP have introduced targeted biologic agents directed against key mediators of type 2 inflammation, including anti-IL-4/IL-13 (dupilumab), anti-IL-5 (mepolizumab), and anti-TSLP therapies. These treatments have demonstrated significant benefits in reducing polyp burden, improving symptom control, enhancing quality of life, and decreasing the need for systemic corticosteroids and revision surgery in selected patients with severe eosinophilic disease [24]. Since eosinophilic inflammation is a major determinant of disease severity and treatment response, simple blood-derived eosinophil indices such as ELR may potentially contribute to identifying patients who could benefit from these targeted therapies. Although the present study was not designed to evaluate treatment outcomes, our findings further support the central role of eosinophil-driven inflammation in CRSwNP [16,22].

Despite these findings, this study has several limitations. First, its retrospective design may introduce selection bias. Second, the study was conducted in a single center with a relatively limited sample size. Third, only univariate logistic regression analysis was performed, and potential confounding factors were not fully adjusted. Finally, the study focused on preoperative laboratory parameters and did not include postoperative outcomes or long-term follow-up data. In addition, patient-reported outcome measures, such as the Sinonasal Outcome Test-22 (SNOT-22) and other quality-of-life assessments, were not available and therefore could not be evaluated. Future prospective studies incorporating patient-reported outcomes, tissue eosinophilia, and postoperative follow-up data are warranted to further validate the clinical utility of eosinophil-based inflammatory indices in CRSwNP.

5. Conclusions

In conclusion, eosinophil-based systemic inflammatory indices, particularly ELR and eosinophil/leukocyte ratio, are significantly associated with radiological disease severity in CRSwNP, whereas other commonly used indices such as NLR, PLR, SII, and SIRI appear to have limited utility. These findings suggest that eosinophil-driven inflammation remains the key determinant of disease burden in CRSwNP and highlight the potential role of simple blood-based markers in clinical evaluation and risk stratification.

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Informed Consent Statement: Patient consent was waived due to the retrospective design of the study and the use of anonymized clinical data.

Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

CRS	Chronic rhinosinusitis
CRSwNP	Chronic rhinosinusitis with nasal polyps
CRSSNP	Chronic rhinosinusitis without nasal polyps
LM	Lund–Mackay
CT	Computed tomography
NLR	Neutrophil–lymphocyte ratio
PLR	Platelet–lymphocyte ratio
MLR	Monocyte–lymphocyte ratio
ELR	Eosinophil–lymphocyte ratio
NMR	Neutrophil–monocyte ratio
SII	Systemic immune-inflammatory index
SIRI	Systemic inflammation response index
CBC	Complete blood count
ROC	Receiver operating characteristic
SNOT-22	Sinonasal outcome test-22

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