Original Article

Cukurova Anestezi ve Cerrahi Bilimler Dergisi

Predictive Value of Systemic Immune-Inflammation Index for Infectious Complications Following Transrectal Ultrasound-Guided Prostate Biopsy

Ahmet Emin Dogan[1], *Muhammed Yusuf Aydin*[1], *Kadri Sergen Akca*[1], *Mehmet Altan*[2], *Gorkem Ozenc*[1], *Arif Huseynli*[1]

[1] Department of Urology, Ankara Etlik City Hospital, Ankara, Türkiye
[2] Republic of Türkiye Ministry of Health, Etimesgut State Hospital, Department of Urology, Ankara, Türkiye
***Correspondence:** Ahmet Emin Dogan, ahmetemindogan@gmail.com
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Abstract

Aim: This study aimed to evaluate the predictive value of the systemic immune-inflammation index (SII) for infectious complications following transrectal ultrasound-guided prostate biopsy. **Materials and Methods:** This retrospective study included 342 patients who underwent transrectal ultrasound-guided prostate biopsy. Inflammatory indices were calculated prior to biopsy using complete blood count parameters. In addition to the SII, neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and monocyte-to-lymphocyte ratio (MLR) were also evaluated. Inflammatory indices were compared between patients with and without post-biopsy infection using nonparametric statistical tests. Receiver operating characteristic (ROC) curve analysis was applied to evaluate predictive performance. **Results:** Post-biopsy infection occurred in 33 patients (9.6%). No statistically significant differences were observed in SII, NLR, PLR, or MLR values between patients with and without post-biopsy infection (all $p > 0.05$). While SII values showed a tendency to be higher in the group of patients experiencing post-biopsy infection, these differences were not statistically significant ($p = 0.069$). ROC analysis revealed poor discriminatory performance for all inflammatory indices, with area under the curve values of 0.596 for SII, 0.585 for NLR, 0.558 for PLR, and 0.522 for MLR. **Conclusion:** Pre-biopsy inflammatory indices demonstrated limited predictive performance for post-biopsy infectious complications. Future prospective multicenter studies integrating inflammatory, clinical, and microbiological parameters are needed.

Keywords: Biomarkers; biopsy; inflammation; prostate; sepsis.

1. Introduction

Prostate cancer (PC) is the second most common malignancy among men worldwide and the fifth leading cause of cancer-related mortality. According to GLOBOCAN 2020 statistical data, the number of newly diagnosed cases of prostate PC is steadily increasing each year—exceeding 1.4 million—driven by population aging and widespread prostate-specific antigen (PSA) screening[1]. Although PSA screening is widely used, prostate biopsy

is still the gold standard diagnostic procedure for patients with elevated PSA levels or an abnormal digital rectal examination[2].

Although prostate biopsy is considered to be a simple and safe procedure, there are many complications that can occur following biopsy, from mild events such as bleeding to more dangerous infections. Some complications that occur frequently include hematuria, hematospermia, rectal bleeding, and urinary retention. However, among all complications of prostate biopsy, infections post-procedure are one of the most life-threatening complications[3]. Recently, increased rates of post-biopsy infection complications have been reported, partly caused by antimicrobial resistance and changes in the rectal flora[4]. Therefore, identifying high-risk patients prior to biopsy is a critical clinical need.

The role of systemic inflammatory response is crucial in the pathogenesis of infection-related complications and sepsis. In this regard, a number of indices combining inflammatory markers measured in the complete blood count have been suggested as independent predictors of poor patient prognosis[5,6]. One of them, termed the systemic immune-inflammation index (SII), calculated as(neutrophil count × platelet count) / lymphocyte count, has been extensively studied in various clinical conditions, including cardiac disorders and cancers[5,7]; nevertheless, its potential to predict post-biopsy infections remains unclear. Previous studies have revealed that indices such as neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and SII are associated with infections and sepsis following endourological treatments[8,9]. Likewise, elevated NLR and PLR values have been observed in patients who had surgical site infections following cesarean operations[10]. Nevertheless, the predictive role of SII in post-biopsy infections has not been sufficiently evaluated, and existing guidelines do not provide for the inclusion of systemic inflammatory indices in pre-biopsy risk stratification models. Considering the simplicity, low cost, and widespread availability of the SII, this represents a significant gap in the literature. Of the different inflammatory parameters that were assessed, the SII index was chosen to be the main index of interest due to its combination of neutrophils, platelets, and lymphocytes into a single composite index, which may give a better representation of the interplay of systemic inflammation and immune status compared to those using only two cell populations (5). NLR, PLR, and MLR indexes were also assessed for comparison purposes.

Consequently, the current study aimed to explore the relationship between serum SII before biopsy and post-biopsy infection. In addition, we investigated the predictive utility of SII, in combination with other inflammatory indices, as a potential predictor of post-biopsy infection complications.

2. Materials and Methods

2.1. Study Design and Patient Population:

In this study, 342 patients who underwent transrectal ultrasound-guided prostate biopsy at our institution between 1 October 2022 and 1 October 2025 were retrospectively analysed. The biopsy indications included elevated PSA levels and/or presence of abnormalities during digital rectal examination. Patients with active infection, missing laboratory results, hematological malignancy, or immunosuppressive treatment were excluded.

2.2. Biopsy Procedure:

A standard 12-core biopsy technique was used for all biopsies, conducted under transrectal ultrasound guidance. Biopsies were performed in the left lateral decubitus position using an 18-gauge cut needle. All patients received 500 mg ciprofloxacin and 500 mg ornidazole twice daily for five days following the biopsy.

2.3. Data Collection and Definitions:

Retrospective clinical and laboratory data were collected from the medical records of the patients. The recorded parameters were age, prostate volume, PSA level, hemoglobin, white blood cell count, neutrophil count, lymphocyte count, monocyte count, and platelet count.

Indices for inflammation were computed based on pre-biopsy laboratory values:

NLR = neutrophil count / lymphocyte count

PLR = platelet count / lymphocyte count

MLR = monocyte count / lymphocyte count

SII = (neutrophil × platelet) / lymphocyte count

Since the data was skewed, the SII values were subjected to a logarithmic transformation (logSII) for analysis.

2.4. Outcome Definition

The primary outcome was post-biopsy infection. Consistent with previous studies reporting both early and late post-prostate biopsy infection complications[3,4] , infection was defined as the development of fever (≥38°C) and/or urinary tract symptoms requiring medical treatment (including antibiotic therapy, emergency department visits, or hospitalization) within 7 days following the procedure. Patients were followed for the predefined 7-day period through review of outpatient clinic visits, emergency department presentations, hospitalization records, and electronic medical records to identify infectious complications.

2.5. Ethical approval

The study protocol was approved by the institutional ethics committee and conducted in accordance with the Declaration of Helsinki.

2.6. Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 22 (IBM Corp., Armonk, NY, USA). Data distribution was examined with the help of histograms and tests for skewness. Despite some variables showing a tendency toward symmetry, the majority of parameters were not normally distributed, thus nonparametric tests were employed.

Statistical results were provided as median and interquartile range (IQR). The difference in patients with and without post-biopsy infection was calculated using the Mann-Whitney U test. For the sensitivity analysis, only patients with values of hematological parameters within the reference intervals (platelet 150-450 $\times 10^9$/L, neutrophil 1.5-8 $\times 10^9$/L, lymphocyte 1.0-4.8 $\times 10^9$/L, monocyte 0.2-0.8 $\times 10^9$/L) were included in the study.

A receiver operating characteristic (ROC) curve was generated for all the indices tested for their prediction accuracy. The area under the curve (AUC) was calculated for each index. A p-value < 0.05 was considered as statistically significant.

3. Results

3.1. Patient Characteristics

In total, 342 patients participated in the study. Post-biopsy infection occurred in 33 patients (9.6%), whereas 309 patients (90.4%) did not develop any infectious complications.

The basic demographic and clinical characteristics of the study sample according to post-biopsy infection status are presented in Table 1. There were no statistically significant differences between the groups in terms of age, prostate volume, PSA level, or routine hematological parameters (all $p > 0.05$).

3.2. Inflammatory Markers

Pre-biopsy inflammatory indices, including NLR, PLR, MLR, and SII, were compared between patients with and without post-biopsy infection. No statistically significant differences were observed between the two groups regarding all the evaluated inflammatory indicators ($p > 0.05$).

Nevertheless, SII and logSII showed a tendency to be higher in the patients with infections following biopsy, although this difference did not reach statistical significance ($p = 0.069$ for both).

Table 1. Baseline characteristics according to post-biopsy infection

Variable	Infection (+) (n=33) Median (IQR)	Infection (–) (n=309) Median (IQR)	p-value
Age (years)	67 (62–70)	68 (63–73)	0.478
Prostate volume (mL)	67 (55–90)	70 (50–101)	0.764
PSA (ng/mL)	10.3 (5.6–16.2)	8.4 (5.7–14.5)	0.481
Hemoglobin (g/dL)	13.8 (12.2–15.2)	13.7 (12.3–15.3)	0.833
Platelet count (×10⁹/L)	249 (220–302)	242 (205–300)	0.462
White blood cell count (×10⁹/L)	7.13 (6.25–9.21)	7.89 (6.43–9.29)	0.319
Neutrophil count (×10⁹/L)	4.95 (3.99–6.34)	4.79 (3.80–6.07)	0.293
Lymphocyte count (×10⁹/L)	1.85 (1.21–2.48)	1.93 (1.55–2.50)	0.409
Monocyte count (×10⁹/L)	0.62 (0.48–0.77)	0.66 (0.50–0.82)	0.645
NLR	2.72 (1.95–4.37)	2.39 (1.75–3.26)	0.107
PLR	132.3 (110.0–199.3)	126.8 (92.3–168.4)	0.272
MLR	0.30 (0.24–0.53)	0.32 (0.24–0.44)	0.681
SII	657.7 (483.5–1107.3)	564.4 (401.6–906.4)	0.069
logSII	2.82 (2.68–3.04)	2.75 (2.60–2.96)	0.069

Abbreviations: PSA, prostate-specific antigen; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; MLR, monocyte-to-lymphocyte ratio; SII, systemic immune-inflammation index; IQR, interquartile range.

Table 2. Sensitivity analysis according to post-biopsy infection status

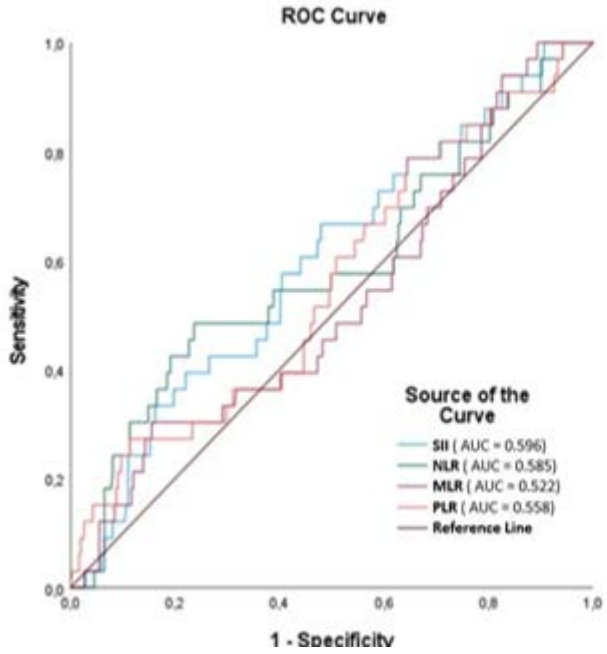
Variable	Infection (+) (n=22) Median (IQR)	Infection (–) (n=184) Median (IQR)	p-value
Age (years)	67.0 (61.0–71.3)	68.0 (62.0–73.0)	0.475
Prostate volume (mL)	77.5 (50.0–100.0)	70.0 (50.0–100.0)	0.820
PSA (ng/mL)	10.0 (6.0–16.7)	8.3 (5.5–13.1)	0.583
Hemoglobin (g/dL)	14.0 (12.6–15.7)	14.1 (12.5–15.3)	0.699
Platelet count (×10⁹/L)	259.5 (220.0–313.0)	243.5 (208.0–291.0)	0.489
White blood cell count (×10⁹/L)	7.1 (6.2–8.1)	7.7 (6.4–8.6)	0.281
Neutrophil count (×10⁹/L)	5.0 (4.1–6.1)	4.5 (3.7–5.5)	0.208
Lymphocyte count (×10⁹/L)	1.9 (1.6–2.4)	1.9 (1.5–2.4)	0.841
Monocyte count (×10⁹/L)	0.60 (0.48–0.69)	0.57 (0.45–0.67)	0.557
NLR	2.63 (1.98–3.53)	2.23 (1.67–3.02)	0.284
PLR	133.4 (103.1–170.6)	127.2 (97.5–156.8)	0.715
MLR	0.32 (0.24–0.41)	0.27 (0.22–0.37)	0.605
SII	620.5 (460.1–897.5)	539.6 (392.4–770.8)	0.192
logSII	2.79 (2.66–2.95)	2.73 (2.59–2.89)	0.192

Abbreviations: PSA, prostate-specific antigen; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; MLR, monocyte-to-lymphocyte ratio; SII, systemic immune-inflammation index; IQR, interquartile range.

3.3 ROC Curve Analysis

ROC curve analysis was carried out to evaluate the predictive utility of inflammatory indices in predicting post-biopsy infection (Figure 1). The AUC values were 0.596 for SII, 0.585 for NLR, 0.558 for PLR, and 0.522 for MLR, demonstrating the poor discriminatory ability of these markers.

Overall, none of the inflammatory indices analyzed performed adequately in predicting post-biopsy infection. Likewise, these findings were observed in a sensitivity analysis limited to patients with hematological parameters within the reference ranges. While the median SII values were higher in patients who experienced post-biopsy infection (620.5 vs. 539.6), this difference was not statistically significant (p = 0.192) (Table 2). Similarly, the ROC analysis in the sensitivity cohort revealed consistently low AUC values for SII (0.585), NLR (0.570), PLR (0.524), and MLR (0.534), suggesting limited predictive performance of these biomarkers (Figure 2).



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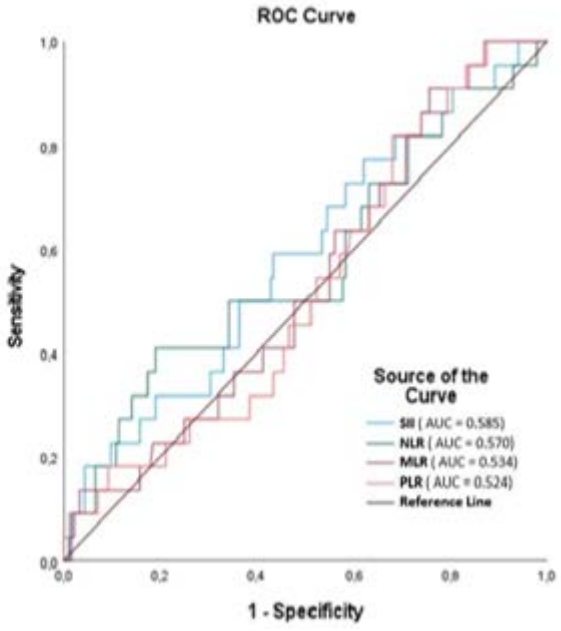

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Figure 1. Receiver operating characteristic (ROC) curves showing the discriminatory ability of the systemic immune-inflammation index (SII), neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and monocyte-to-lymphocyte ratio (MLR) for predicting post-biopsy infectious complications in the overall study cohort.

Figure 2. Receiver operating characteristic (ROC) curves showing the discriminatory ability of the systemic immune-inflammation index (SII), neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and monocyte-to-lymphocyte ratio (MLR) for predicting post-biopsy infectious complications in the sensitivity analysis cohort, including only patients with hematological parameters within the reference ranges.

4. Discussion

The present study investigated whether pre-biopsy inflammatory indices could have any utility in predicting infectious complications occurring after prostate biopsy. While higher levels of inflammatory indices like SII and NLR were observed in patients developing infections after the procedure, the predictive values of these indices were found to be limited. This implies that commonly used inflammatory indices may not reflect adequately the complex and multifactorial nature of post-biopsy infection complications.

The potential role of inflammatory biomarkers in infectious complications may be explained by the complex interplay between systemic inflammation and the host immune response. It is known that neutrophils are important components of the inflammatory response and can suppress immune activity through lymphocyte inhibitory mechanisms[11]. Platelets are rich in pro-inflammatory mediators that enable them to release potent pro-inflammatory metabolites. Monocytes are also critical in the process of regulation of the complicated systemic inflammation[12,13]. Therefore, composite inflammatory indices that integrate multiple immune cell components may more accurately capture the balance between the host's inflammatory and immune states[6,14].

Previous studies investigating inflammatory biomarkers in postoperative infection complications have demonstrated conflicting results. In endourological procedures such as flexible ureteroscopy and percutaneous nephrolithotomy, various studies have reported associations between preoperative inflammatory indices and postoperative fever, systemic inflammatory response syndrome (SIRS), or infection complications[8,15]. Nevertheless, studies evaluating infections particularly associated with prostate biopsy have yielded inconsistent results. Voyvoda et al. found higher NLR and PLR values in patients who experienced SIRS following biopsy; however, these associations failed to remain statistically significant in multivariable analyses[16]. Likewise, Abou Heidar et al. also observed no association between pre-biopsy NLR or PLR values and sepsis after prostate biopsy[17]. Conversely, a study by Bulut et al. showed that higher pre-biopsy levels of WBC were predictors of biopsy-related sepsis[18]. Consistent with the mixed findings from the literature, the inflammatory biomarkers evaluated in our cohort showed limited predictive performance for post-biopsy infection complications. Thus, the clinical importance of inflammatory markers has already been shown in other urological diseases. While SII has demonstrated prognostic value in urothelial carcinoma, NLR and PLR have shown potential clinical utility in differentiating premature ejaculation subtypes, suggesting that the performance of these indices is highly dependent on the specific disease context and clinical outcome evaluated[19,20].

Several potential reasons could explain the limited predictive performance observed in our study. Post-prostate biopsy infection complications are multifactorial and are influenced not only by the host inflammatory state but also by rectal bacterial flora, antimicrobial resistance patterns, procedural contamination, prophylactic antibiotic regimens, and individual immune responses[3,4]. Hence, isolated pre-biopsy systemic inflammatory biomarkers may be inadequate to fully reflect the complex processes underlying post-biopsy infection complications. From a clinical perspective, our findings indicate that inflammatory indices routinely available may have limited utility when used alone in predicting patients at high risk for post-biopsy infection complications.

While these indices are inexpensive, easily accessible, and reproducible, their predictive performance in our cohort was insufficient for reliable risk stratification. Hence, inflammatory biomarkers such as SII, NLR, PLR, and MLR may be more useful when integrated with other clinical, microbiological, and procedural risk factors rather than when used as standalone predictors.

The present study has several limitations. First, its retrospective and single-center design may limit the generalizability of the findings. Secondly, the comparatively small number of infection cases may have reduced the statistical power of the analyses and limited the ability to detect weaker associations between inflammatory biomarkers and post-biopsy infections. Another limitation is that post-biopsy infection was defined as a composite outcome including fever and/or urinary symptoms requiring medical treatment rather than only severe infectious events such as sepsis. Therefore, the predictive performance of inflammatory biomarkers for severe infections specifically could not be evaluated. Third, inflammatory indices were calculated using single pre-biopsy laboratory

measurements, and dynamic peri-procedural inflammatory changes were not evaluated. Furthermore, detailed microbiological data, such as rectal flora profiles and antimicrobial resistance patterns, were lacking among all patients in this study. Finally, while various commonly used inflammatory biomarkers were assessed, other potentially clinically relevant inflammatory and immune-related markers were not evaluated. However, to minimize potential confounding by underlying hematological abnormalities, we also performed a sensitivity analysis restricted to patients with hematological parameters within reference ranges.

Although these inflammatory indices are inexpensive and readily available, our findings do not support their routine use as standalone tools for pre-biopsy risk stratification of post-biopsy infectious complications. Instead, they should be interpreted alongside established clinical risk factors rather than used in isolation.

5. Conclusion

Pre-biopsy inflammatory biomarkers such as SII, NLR, PLR, and MLR showed limited predictive performance for post-biopsy infection complications in our cohort. While these indices are low-cost, easily accessible, and reproducible, their utility for risk stratification appears insufficient when used alone. Post-biopsy infections are influenced by numerous host, microbial, and procedure-related factors, in addition to systemic inflammatory conditions. To develop more reliable predictive models for post-biopsy infection complications, there is a need for additional prospective multicenter studies that include clinical, microbiological, and inflammatory parameters.

Ethical approval: The study protocol was approved by the institutional ethics committee (Ankara Etlik City Hospital), approval number: AESH-BADEK-2024-1089 and conducted in accordance with the Declaration of Helsinki. Subsequent to the approval process, written informed consent was formally secured from all participating patients.

genAI: ChatGPT (version 5.1, OpenAI) was used to support language editing, improve clarity, and readability of the manuscript. The authors critically reviewed and verified all outputs and take full responsibility for the accuracy, integrity, and originality of the final manuscript.

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Conflict of Interest: The authors declare no conflict of interest.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions: Conceptualization: AED, MA; Methodology: AED, GO; Formal Analysis: AED, MA; Investigation: MYA, KSA; Data Curation: MYA, KSA; Writing – Original Draft: AED; Writing – Review & Editing: AED, MYA, KSA, MA, GO, AH; Supervision: GO, MA; Project Administration: AED, AH.

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