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PAN-IMMUNE INFLAMMATION VALUE (PIV) AS A PREDICTOR OF DISEASE SEVERITY IN ADULT APPENDICITIS: A COMPARATIVE RETROSPECTIVE STUDY

--Manuscript Draft--

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Abstract:	Purpose The primary objective of this study is to evaluate the predictive value of pan-immune inflammation value (PIV) in determining the pathological severity in patients undergoing appendectomy for acute appendicitis. Secondary objective is to compare the predictive performance with other inflammatory markers such as neutrophil-to-lymphocyte ratio (NLR), platelet-lymphocyte ratio (PLR), systemic immune-inflammation index (SII) and systemic inflammation response index (SIRI), Methods This retrospective observational study included 2334 adult patients who underwent appendectomy between 2012 and 2024. Patients were classified into non-complicated (lymphoid hyperplasia, acute appendicitis) and complicated (phlegmonous, perforated, gangrenous appendicitis) groups based on postoperative histopathological findings. Preoperative hematological and biochemical data were collected to calculate inflammatory indices including NLR, PLR, SII, SIRI and PIV. Receiver Operating Characteristics (ROC) analysis and logistic regression were performed to evaluate diagnostic performance and independent predictors of complicated appendicitis. Results Of the 2334 patients, 1574 (67.4%) patients had non-complicated and 760 (32.6%) had complicated appendicitis. Neutrophil count had the highest AUC (0.655), followed by WBC (0.651), SIRI (0.631), NLR (0.619), and PIV (0.615). The optimal PIV cut-off of 643.2 showed a sensitivity of 70% and specificity of 48%. In multivariate logistic regression, PIV was significantly associated with complicated appendicitis (OR = 2.32; 95% CI: 1.72–3.16; $p < 0.001$). Conclusion

	PIV is a novel and independent marker with moderate predictive value for predicting pathological severity of acute appendicitis in adults. Clinical utility should be supported with prospective studies.

Title: Pan-Immune Inflammation Value (PIV) as A Predictor of Disease Severity in Adult Appendicitis: A Comparative Retrospective Study

Short Title: PIV and Acute Appendicitis

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Table 1. Statistical findings for the comprasion of demographic and hematological values bewtwwen non-complicated and complicated appendicitis groups.

	Non-Complicated	**Complicated**	***P* values**
	n=1574	***n=760***	
Age	32.92 ± 11.79	35.22 ± 13.18	**<0.001**[a]
Sex*			**<0.001**[b]
Male	635 (40.3%)	245 (32.2%)	
Female	939 (59.7%)	515 (67.8%)	
WBC, *median (IQR)*	11.82 (5.87)	14.25 (5.75)	**<0.001**[c]
Neutrophil count, *median (IQR)*	8.48 (6.04)	11.00 (5.37)	**<0.001**[c]
Lymphocyte count, *median (IQR)*	2.15 (1.19)	2.06 (1.25)	0.109[c]
Monocyte count, *median (IQR)*	0.72 (0.41)	0.82 (0.49)	**<0.001**[c]
Platelet count, *median (IQR)*	246.0 (79.0)	238.0 (79.5)	**0.002**[c]
NLR, *median (IQR)*	3.81 (3.95)	4.96 (4.72)	**<0.001**[c]
PLR, *median (IQR)*	116.07 (72.71)	116.85 (78.25)	0.880[c]
SII, *median (IQR)*	942.68 (1028.1)	1194.5 (1277.9)	**<0.001**[c]
SIRI, *median (IQR)*	2.76 (4.05)	4.44 (5.34)	**<0.001**[c]
PIV, *median (IQR)*	681.80 (1023.37)	1018.99 (1441.87)	**<0.001**[c]
CRP, *median (IQR)*	4.80 (18.60)	5.71 (21.74)	0.124[c]

[a]Student's test
[b]Chi-square test
[c]Mann-Whitney U test
WBC: White Blood Count, NLR: Neutrophil-to-Lymphocyte Ratio, PLR: Platelet-to-Lymphocyte Ratio, SII: Systemic Immune-Inflammation Index, SIRI:Systemic Inflammatory Response Index, PIV: Pan-Immune-Inflammation Value.

Table 1. Sensitivity and specificity values according to cut-off values calculated by ROC analysis.

Parameter	AUC	95% CI Lower Bound	95% CI Upper Bound	Cut-off	Sensitivity	Specificity
CRP	0.524	0.493	0.555	4.4	57% (56–58%)	48% (47–49%)
WBC	0.651	0.627	0.676	12.21	69% (68–70%)	54% (53–55%)
Neutrophil count	0.655	0.631	0.680	9.99	61% (60–62%)	64% (63–65%)
Lymphocyte count	0.479	0.454	0.504	3.95	6% (5–6%)	96% (96–97%)
Monocyte count	0.587	0.562	0.612	0.724	62% (61–63%)	51% (50–52%)
NLR	0.619	0.594	0.644	3.016	82% (81–82%)	38% (37–39%)
PLR	0.502	0.477	0.527	185.31	20% (19–21%)	83% (82–84%)
SII	0.600	0.575	0.625	805.07	75% (74–75%)	42% (41–43%)
SIRI	0.631	0.606	0.656	2.821	68% (67–69%)	51% (50–52%)
PIV	0.615	0.590	0.640	643.24	70% (69–71%)	48% (47–49%)

WBC: White Blood Count, NLR: Neutrophil-to-Lymphocyte Ratio, PLR: Platelet-to-Lymphocyte Ratio, SII: Systemic Immune-Inflammation Index, SIRI: Systemic Inflammatory Response Index, PIV: Pan-Immune-Inflammation Value, AUC: Area Under Curve, CI: Confidence Interval

Table 1 Univariate and multivariate logistic regression analyses to determine independent predictive risk factor for acute appendicitis

Variable	Univariant			Multivariant		
	OR	**95 % CI**	***p***	**OR**	**95 % CI**	***p***
Age	1.67	1.29-2.16	**<0.001**	1.78	1.36-2.33	**<0.001**
Gender	0.70	0.59-0.84	**<0.001**	0.73	0.61-0.89	**0.001**
CRP	0.98	0.82-1.17	0.832	-	-	-
PLR	1.06	0.89-1.26	0.535	-	-	-
NLR	2.60	1.99-3.40	**<0.001**	-	-	-
SII	1.57	1.32-1.87	**<0.001**	-	-	-
SIRI	2.53	1.97-3.25	**<0.001**	-	-	-
PIV	2.36	1.74-3.21	**<0.001**	2.32	1.71-3.16	**<0.001**

CRP: C-Reactive protein, NLR: Neutrophil-to-Lymphocyte Ratio, PLR: Platelet-to-Lymphocyte Ratio, SII: Systemic Immune-Inflammation Index, SIRI: Systemic Inflammatory Response Index, PIV: Pan-Immune-Inflammation Value, OR: Odds Ratio, CI: Confidence Interval

Table 1. Comparison of PIV between groups according to Kruskal-Wallis test following Dunn-Bonferroni post-hoc analysis.

	Group 1	Group 2	Group 3	*P*	Post-hoc *P*
PIV, *median (IQR)*	460.34 (692.49)	901.53 (1144.85)	1125.81 (1410.30)	<0.001[a]	1-2: <0.001[b] 1-3: <0.001[b] 2-3: <0.001[b]

PIV: Pan-Immune-Inflammation Value, Group 1 (lymphoid hyperplasia), Group 2 (acute appendicitis), and Group 3 (phlegmonous, perforated and gangrenous appendicitis).

[a] Kruskal-Wallis

[b] Dunn-Bonferroni post-hoc test

Figure

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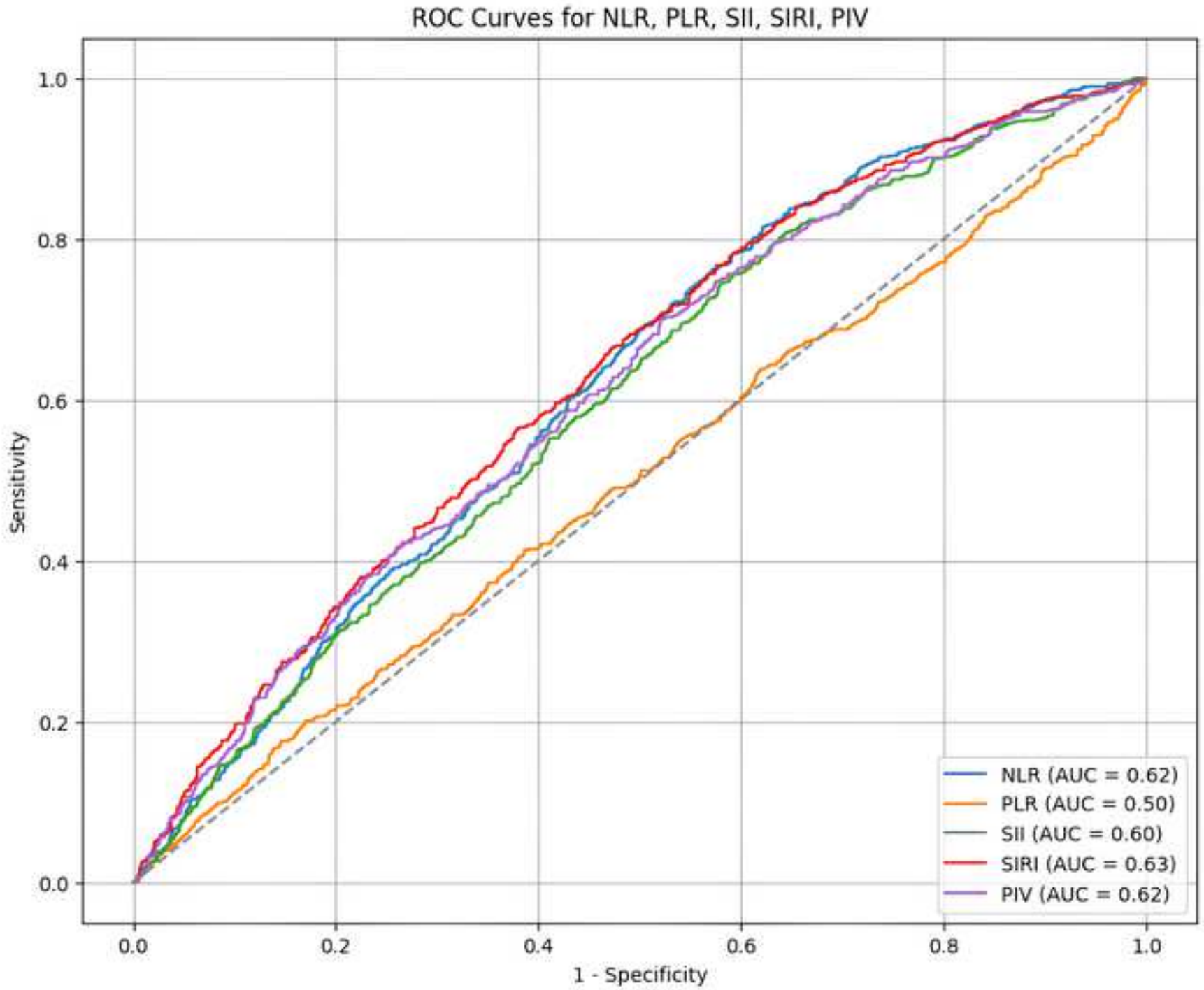

Figure

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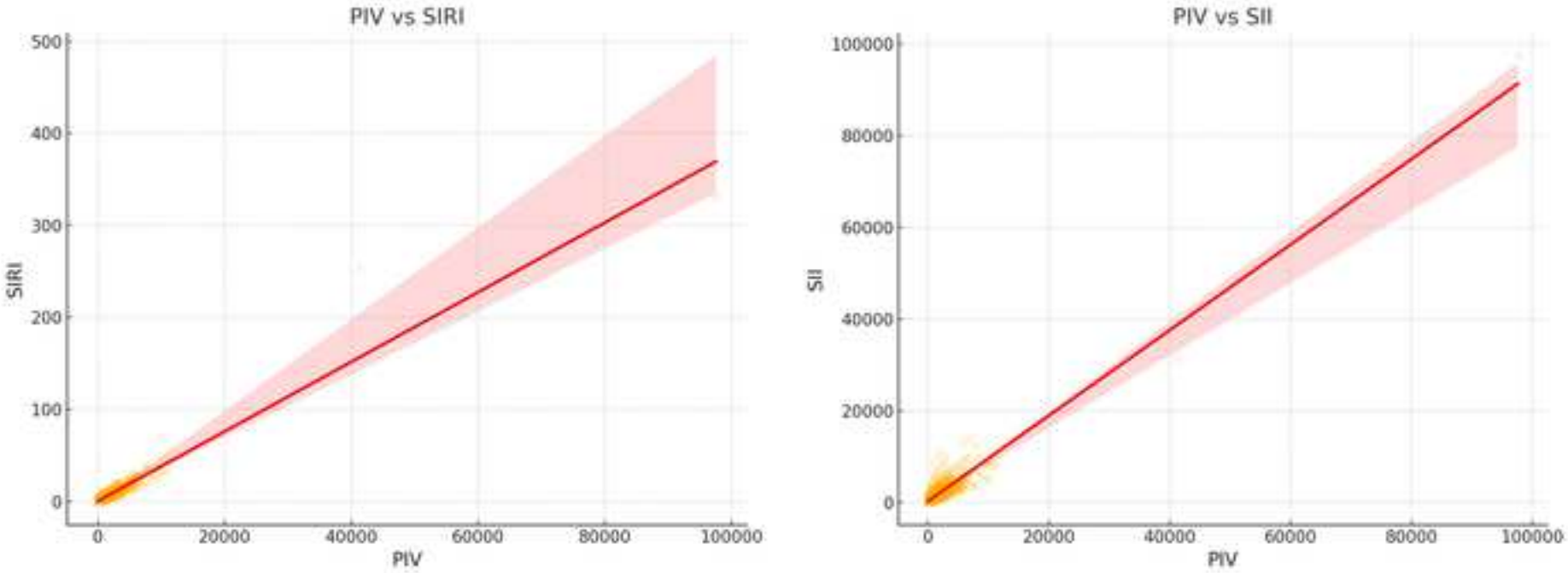

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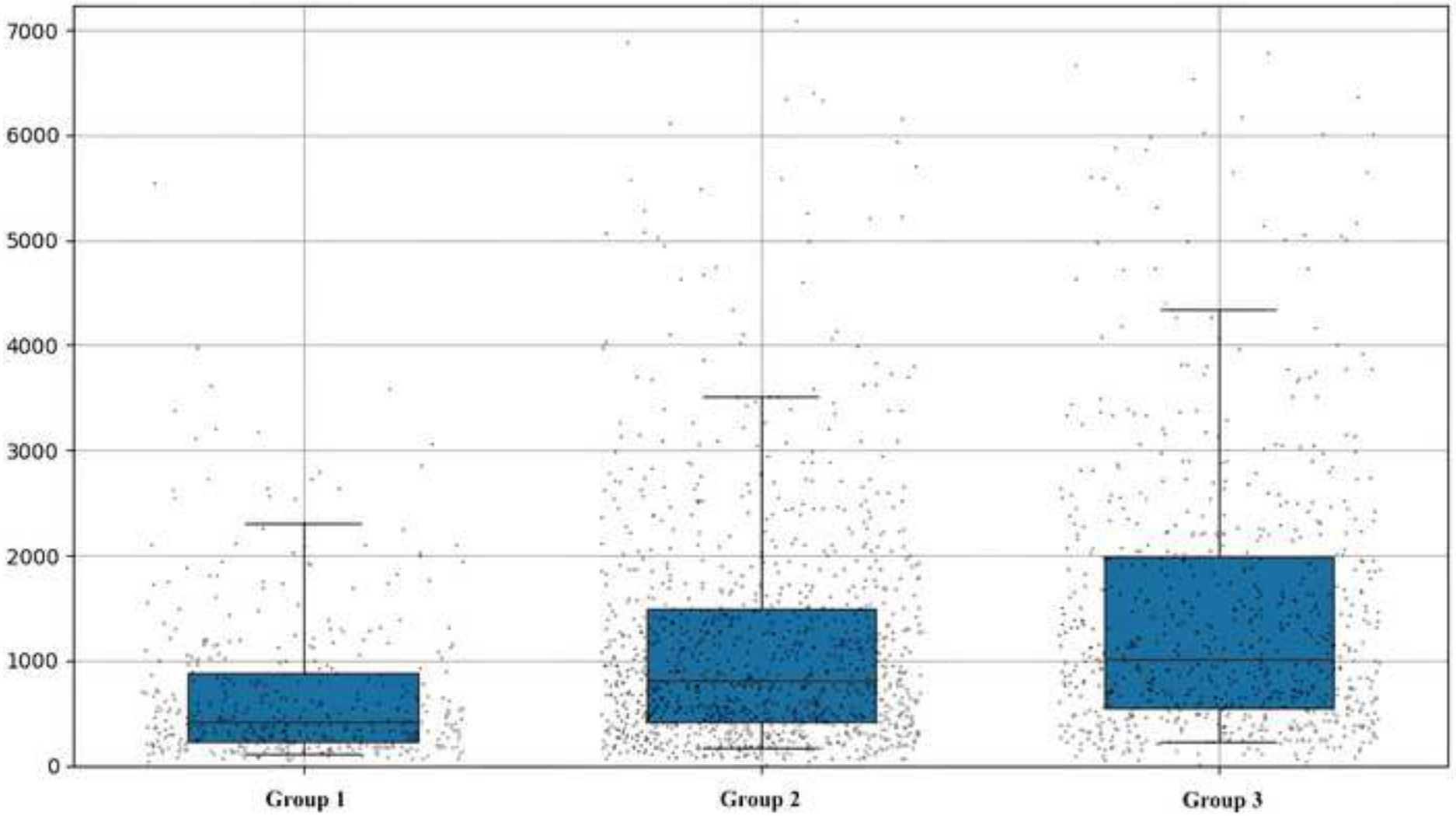

PAN-IMMUNE INFLAMMATION VALUE (PIV) AS A PREDICTOR OF DISEASE SEVERITY IN ADULT APPENDICITIS: A COMPARATIVE RETROSPECTIVE STUDY

Abstract

Purpose: The primary objective of this study is to evaluate the predictive value of pan-immune inflammation value (PIV) in determining the pathological severity in patients undergoing appendectomy for acute appendicitis. Secondary objective is to compare the predictive performance with other inflammatory markers such as neutrophil-to-lymphocyte ratio (NLR), platelet-lymphocyte ratio (PLR), systemic immune-inflammation index (SII) and systemic inflammation response index (SIRI).

Methods: This retrospective observational study included 2334 adult patients who underwent appendectomy between 2012 and 2024. Patients were classified into non-complicated (lymphoid hyperplasia, acute appendicitis) and complicated (phlegmonous, perforated, gangrenous appendicitis) groups based on postoperative histopathological findings. Preoperative hematological and biochemical data were collected to calculate inflammatory indices including NLR, PLR, SII, SIRI and PIV. Receiver Operating Characteristics (ROC) analysis and logistic regression were performed to evaluate diagnostic performance and independent predictors of complicated appendicitis.

Results: Of the 2334 patients, 1574 (67.4%) patients had non-complicated and 760 (32.6%) had complicated appendicitis. Neutrophil count had the highest AUC (0.655), followed by WBC (0.651), SIRI (0.631), NLR (0.619), and PIV (0.615). The optimal PIV cut-off of 643.2 showed a sensitivity of 70% and specificity of 48%. In multivariate logistic regression, PIV was significantly associated with complicated appendicitis (OR = 2.32; 95% CI: 1.72–3.16; $p < 0.001$).

Conclusion: PIV is a novel and independent marker with moderate predictive value for predicting pathological severity of acute appendicitis in adults. Clinical utility should be supported with prospective studies.

Keywords: Pan-Immune-Inflammation Value; PIV; appendicitis; prediction

Introduction

Acute appendicitis is one of the most common surgical emergencies worldwide, yet accurately distinguishing between non-complicated and complicated forms remains a diagnostic challenge (1–4). Traditionally, diagnosis and severity assessment have relied on clinical evaluation, imaging, and standard laboratory markers such as white blood cell (WBC) count and C-reactive protein (CRP) (2,5–7). However, these parameters often lack specificity and may not adequately reflect the systemic inflammatory burden or immune response in all patients.

In recent years, composite inflammatory indices derived from routine blood tests have gained interest as potential diagnostic and prognostic tools. These indices, such as the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), systemic immune-inflammation index (SII), and systemic inflammation response index (SIRI), integrate multiple immune cell components to provide a broader reflection of the host response to inflammation (8–10).

The pan-immune-inflammation value (PIV) is a relatively new index that combines neutrophil, monocyte, platelet, and lymphocyte counts into a single measure, potentially capturing both innate and adaptive immune responses more comprehensively (11–14). While PIV has been studied in oncology and chronic inflammatory conditions, its application in acute surgical pathologies such as appendicitis is still limited. To date, only a few studies have explored the utility of PIV in adult patients with appendicitis, and in a recent study, PIV was reported to predict complicated appendicitis with a sensitivity of up to 78%, suggesting its potential value in early risk stratification (14)

The primary objective of this study is to evaluate the predictive value of PIV in determining the pathological severity in patients undergoing appendectomy for acute appendicitis. Secondary objective is to compare the predictive performance with other inflammatory markers such as NLR, PLR, SII and SIRI.

Methods

Patients

This study was designed as a retrospective comparative observational study. Data from 2334 patients aged ≥ 18 years, underwent appendectomy for acute appendicitis in XXX between XXX were analyzed. Inclusion criteria were: Being ≥ 18 years old, histopathological diagnosis after appendectomy, hematological and biochemical data

availability prior to surgery. Exclusion criteria were: Missing pathological, hematological or biochemical data, a history of inflammatory bowel disease, corticosteroid usage.

Data collection

Patients with histopathological diagnosis for acute appendicitis were investigated for enrollment. All patients were classified into groups based on definitive histopathological diagnoses obtained after appendectomy. After reviewing the postoperative pathology reports we noted five different pathological diagnoses: 1) Lymphoid hyperplasia (n = 434, 18.5%), 2) Acute appendicitis (n = 1140, 48.8%), 3) Phlegmonous appendicitis (n = 684, 29.3%), 4) Perforated appendicitis (n = 66, 2.8%), and 5) Gangrenous appendicitis (n = 10, 0.6%). Initially patients were divided into two main groups: Lymphoid hyperplasia and acute appendicitis were included in non-complicated appendicitis group; and phlegmonous, perforated and gangrenous appendicitis were included in complicated appendicitis group. For post-hoc analyses patients were divided into three group as follows: 1) Group 1 (lymphoid hyperplasia), 2) Group 2 (acute appendicitis), and 3) Group 3 (phlegmonous, perforated and gangrenous appendicitis).

For each patient, age, gender and laboratory findings were collected. Hematological parameters including WBC, neutrophil, lymphocyte, monocyte and platelet counts; biochemical parameters including CRP and indirect bilirubin were recorded. From these data SII [(Platelet x Neutrophil] / Lymphocyte], SIRI [(Neutrophil x Monocyte) / Lymphocyte], PIV [(Neutrophil x Monocyte x Platelet) / Lymphocyte], NLR and PLR were calculated.

Outcomes

The primary outcomes of this study were to determine independent predictors of complicated appendicitis and predictive role of the PIV. Secondary outcomes were comparing PIV, SII, NLR, PLR, and CRP levels across histopathological groups, establishing optimal cut-off values for these inflammatory markers by using ROC curve analysis, and assessing the discriminative ability of PIV compared to traditional markers in predicting the severity of appendicitis.

Statistical Analyses

Continuous variables were assessed for normality and summarized as mean ± standard deviation (SD) and median with interquartile range (IQR). Categorical variables were expressed as numbers and percentages. Differences between two groups (noncomplicated and complicated appendicitis) were evaluated using Student's t-test for normally distributed continuous variables (e.g., age), and Mann-Whitney U test for non-normally distributed continuous variables (e.g., WBC, neutrophil count, lymphocyte count, monocyte count, platelet count, NLR, PLR, SII, SIRI, PIV, and CRP). Categorical variables (e.g., gender) were compared using the Chi-square test. Receiver operating characteristic (ROC) curve analysis was performed for NLR, PLR, SII, SIRI, and PIV to evaluate their diagnostic performance in predicting complicated appendicitis. For each parameter, the area under the curve (AUC) and the corresponding 95% confidence interval (CI) were calculated. Optimal cut-off values were determined using the Youden index. Sensitivity and specificity values at the optimal cut-off point were reported along with standard error–based ranges. Logistic regression analysis was conducted to identify independent predictors of complicated appendicitis. Initially, univariate logistic regression was performed for each parameter, and odds ratios (OR) with 95% confidence intervals (CI) were calculated. Variables showing statistical significance in univariate analysis were subsequently entered into a multivariate logistic regression model to determine independent risk factors. Cut-off values derived from receiver operating characteristic (ROC) analysis were used to dichotomize continuous variables before logistic modeling. For comparisons across three groups (lymphoid hyperplasia, acute appendicitis, and phlegmonous appendicitis), non-parametric Kruskal-Wallis tests were employed. When significant differences were found, pairwise post-hoc analyses were conducted using the Mann-Whitney U test with Bonferroni correction for multiple comparisons. Statistical analyses were performed using Python version 3.11 (Python Software Foundation, USA) and R version 4.2.1 (https://www.r-project.org/)., where appropriate. A two-sided p-value < 0.05 was considered statistically significant.

Results

A total of 2334 patients were included to the study for comparative analyses. There were 1574 (67.4%) patients in non-complicated and 760 (32.6%) patients in complicated groups. Among the patients, there were 1454 (62.3%) were female and 880 (37.7%) male patients. The mean age was 33.67 ± 12.27 years (18-74).

Comparative statistics of age, gender and laboratory findings are demonstrated in Table 1. between the groups. The distribution of male and female patients were significantly different between groups ($P < 0.001$). The ratio of 67.8% females in complicated group was significantly higher compared to the complicated group. The mean age of the patients was also significantly higher in the complicated group ($P < 0.001$). WBC, neutrophil count,

monocyte count, platelet count, NLR, SII, SIRI and PIV values were also significantly higher in complicated group ($P < 0.005$ for all parameters). Lymphocyte, PLR and CRP values did not show statistical significance between groups (P values, 0.109, 0.88, 0.12, respectively).

Receiver operating characteristic (ROC) curve analyses were performed to evaluate the predictive performance of various inflammatory markers for complicated appendicitis (Table 2, Fig. 1). Among the evaluated parameters, the neutrophil count demonstrated the highest area under the curve (AUC) value of 0.655 (95% CI: 0.631–0.680), followed by WBC with an AUC of 0.651 (95% CI: 0.627–0.676). SIRI, PIV, and NLR also showed moderate predictive ability with AUC values of 0.631, 0.615, and 0.619, respectively. SII exhibited a lower AUC of 0.600, while CRP and PLR displayed poor discriminatory capacities with AUCs of 0.524 and 0.502, respectively. Lymphocyte count yielded the lowest AUC (0.479; 95% CI: 0.454–0.504), suggesting minimal predictive utility. The optimal cut-off values, along with their respective sensitivities and specificities, were determined for each marker. For example, a neutrophil count cut-off of 9.99 yielded a sensitivity of 61% and a specificity of 64%, whereas a PIV cut-off of 643.246 provided a sensitivity of 70% and a specificity of 48%. Notably, NLR demonstrated a high sensitivity of 82% at a cut-off of 3.016, although with a relatively low specificity of 38%.

Univariate and multivariate logistic regression to determine independent risk factors are presented in Table 3. In the univariate logistic regression analysis, several variables demonstrated significant associations with the outcome. Age was positively associated with increased odds (OR = 1.67, 95% CI: 1.29–2.16, $P < 0.001$), as was male gender, which appeared protective (OR = 0.70, 95% CI: 0.59–0.84, $P < 0.001$). Inflammatory markers such as NLR (OR = 2.60, 95% CI: 1.99–3.40, $P < 0.001$), SII (OR = 1.57, 95% CI: 1.32–1.87, $P < 0.001$), SIRI (OR = 2.53, 95% CI: 1.97–3.25, $P < 0.001$), and PIV (OR = 2.36, 95% CI: 1.74–3.21, $P < 0.001$) were also significantly associated with higher odds of the outcome. In contrast, CRP (OR = 0.98, 95% CI: 0.82–1.17, p = 0.832) and PLR (OR = 1.06, 95% CI: 0.89–1.26, $P = 0.535$) were not significantly associated and were therefore excluded from subsequent multivariate analysis. In the multivariate logistic regression model NLR and PLR were excluded due to being part of PIV calculation. And, SII and SIRI were excluded since they showed strong correlation with PIV (r = 0.901, r = 0.965, $P < 0.001$) (Fig. 2).

In Table 4, PIV values among the lymphoid hyperplasia (Group 1); acute appendicitis (Group 2); and phlegmonous, perforated and gangrenous appendicitis (Group 3) are presented. According to the post-hoc analyses, PIV values in Group 1 were significantly lower than those in the other group ($P < 0.001$ for all comparisons). The PIV values in Group 3 were significantly higher than when compared the other two groups ($P < 0.001$ for all comparisons). In Fig. 3, the distribution of PIV values between research groups are presented.

Discussion

To our knowledge, PIV is a new inflammatory biomarker and there are only a few studies in adult acute appendicitis. Our study shows that PIV is a strong predictive factor for determining the severity of pathological findings in acute appendicitis. Previous studies have demonstrated that PIV is a reliable marker for assessing disease severity and prognosis in chronic inflammatory diseases, various malignancies, and pediatric appendicitis (11–13). Sarıdas et al investigated PIV in adult appendicitis that included 436 patients, and they showed that high PIV values (cut-off, >1179.81) is associated with complicated appendicitis (14). In our study, patients with higher PIV value [> 1125.81 (post-hoc groups)] had complicated appendicitis. Our results showed that PIV has moderate level of predictive success for severity of acute appendicitis [AUC (0.615), 70% sensitivity, 48% specificity]. Additionally, considering the effects of other risk factors, logistic regression analyses showed that patients with high PIV values had 2.32 times more likely to develop complicated acute appendicitis.

Our study also investigated the predictive other inflammatory markers such as: WBC, neutrophil, lymphocyte, monocyte, CRP, NLR, PLR, SII and SIRI. In the literature, high values of WBC, neutrophil and monocyte count are significantly associated with complicated acute appendicitis (6,7). On the other hand, decrease in lymphocyte count has been associated with severe disease (5). A low lymphocyte count is often accompanied by an elevated neutrophil count; thus, it is reasonable to expect an increased neutrophil-to-lymphocyte ratio (NLR) in cases of acute appendicitis. According to a meta-analysis with 17 studies and 8914 patients by Hajibandeh et al., NLR is a strong indicator to predict both for diagnosis and severity of acute appendicitis with acceptable sensitivity and specificity (8). In this meta-analysis, ROC curve analysis identified NLR of 8.8 as cut-off value for complicated appendicitis with sensitivity of 76.92% (95% CI, 46.2% - 95.0%) and specificity 100% (95% CI, 75.3%e100%). AUC was 0.91 (95% CI 0.73 - 0.99, P < 0.0001). In our study, while univariate analysis demonstrated a positive correlation between NLR and the degree of inflammation, this association was not sustained in the multivariate regression analysis.

High values of SIRI and SII are also associated with severity of systemic inflammation, indicate poorer prognosis in colorectal patients (9). In a study by Yildiz et al., SIRI and SII showed significant correlation with complicated acute appendicitis [AUC:0.753 (sensitivity:68%, specificity:60%, P = 0.002); AUC:0.786 (sensitivity:72%, specificity:64%, P < 0.001)] (10). Another study by Aydin et al., including 64 geriatric patients (>65 year old) diagnosed with acute appendicitis that were compared with healthy individuals, showed strong diagnostic accuracy of high SII values [AUC:0.81, sensitivity:78%, specificity:79%, P < 0.001] (15). In our study, both SIRI and SII were found to be significantly higher in patients with complicated appendicitis compared to the non-complicated

group. These findings are consistent with previous studies suggesting that composite inflammatory indices, however, the relatively moderate AUC values observed for both SII (0.600) and SIRI (0.631) suggest that while they may contribute to risk stratification, they are not sufficient as stand-alone diagnostic tools.

C-reactive protein is another widely used serum inflammatory marker and is generally elevated in cases of complicated appendicitis compared to uncomplicated ones (8,13). In our study, CRP levels did not show a statistically significant difference between complicated and non-complicated appendicitis groups, and were not found to be independently associated with complication risk in the logistic regression analysis. Although CRP is widely used as a conventional marker of systemic inflammation, our findings suggest that its diagnostic performance in distinguishing complicated from non-complicated appendicitis may be limited. This was further supported by the ROC analysis, where CRP demonstrated a low AUC value (0.524), indicating poor discriminatory capacity. One possible explanation is that CRP, as a relatively late-phase reactant, may not rise sufficiently in the early stages of inflammation or may vary depending on individual immune responses. Additionally, the inclusion of phlegmonous appendicitis cases within the complicated group may have influenced the discriminatory performance of CRP, as this subtype is considered by some authors to represent an intermediate or transitional inflammatory stage rather than a fully complicated form. Indeed, there is ongoing debate in the literature regarding whether phlegmonous appendicitis should be classified as complicated or non-complicated, which may partly explain the inconsistent diagnostic performance of CRP reported across different studies (2,3).

Our study has several limitations. First, due to its retrospective design some data were missing such as physical examination, complications and course of disease. Second, single center studies limit the applicability of the findings to the general populations. However, large sample size provide valuable outcomes and insight since there are fewer studies on PIV compared to other inflammatory markers. Further multicenter prospective studies are needed to confirm the role of PIV in clinical practice.

In conclusion, our study shows PIV is a promising and independent predictor of complicated appendicitis. While traditional markers such as CRP and PLR showed limited diagnostic value, composite indices like PIV, SII, and SIRI provided a more accurate reflection of the systemic inflammatory response. Notably, PIV was significantly higher in patients with more advanced pathological findings and showed moderate discriminative ability in ROC analysis. Given its simple calculation from routine blood parameters and its ability to integrate multiple aspects of immune activation, PIV may serve as a valuable adjunct in the early identification of complicated appendicitis. However, as PIV has been less extensively studied compared to other markers, further multicenter prospective studies are needed to confirm its clinical utility and establish standardized cut-off values for broader use.

DECLARATIONS:

Each author hereby acknowledges that the final state of this manuscript is prepared and sent with his/her approval having been taken. The authors also confirm that this manuscript has not been published and is not under simultaneous consideration by another journal or electronic publication. All authors have read and complied with the requirements set forth in the Instructions to Authors.

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Data and/or Code availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request. The dataset includes all raw data collected during the research, including participant responses and experimental results

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Figure legends

Figure 1. ROC curves demonstrating the predictive performance of inflammatory parameters.

Figure 2. Scatter plots showing the correlation between the Pan-Immune-Inflammation Value (PIV) and two systemic inflammation indices: (Left) PIV vs. Systemic Inflammation Response Index (SIRI); (Right) PIV vs. Systemic Immune-Inflammation Index (SII). Each plot includes a fitted linear regression line (red) with 95% confidence interval (shaded area). A strong positive correlation is observed in both comparisons, indicating that higher PIV is associated with increased levels of SIRI and SII.

Figure 3. Boxplot with jitter demonstrating the distribution of Pan-immune-inflammation (PIV) among research groups. Each box represents the interquartile range (IQR), with the horizontal line indicating the median. Whiskers denote the 1.5×IQR range, and individual data points are shown as overlaid dots, highlighting the spread and presence of potential outliers.