The Role of Immature Granulocytes in Predicting Complicated Appendicitis: A Retrospective Observational Study

Ann. Ital. Chir., 2025 96, 10: 1349–1356
https://doi.org/10.62713/aic.4013

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AIM: Differentiating complicated appendicitis (CA) from uncomplicated appendicitis (UA) is a critical aspect of preoperative evaluation that influences surgical planning and patient outcomes. This study explored the role of the immature granulocyte count (IG#) and percentage (IG%) as accessible and reliable biomarkers to enhance the diagnostic precision of CA.

METHODS: This retrospective observational study analyzed 482 emergency appendectomies performed at a single tertiary hospital between January 2020 and June 2023. After excluding 23 cases due to haematological disorders, malignancies, additional procedures, or incomplete data, 459 patients were included in the final analysis. Patients were categorized into the UA and CA groups based on histopathological examination. CA was defined as a perforation or gangrene. Laboratory parameters, including IG#, IG%, and inflammatory markers, were compared between groups.

RESULTS: Among the 459 patients, 386 (84.1%) had UA and 73 (15.9%) had CA. The median age of CA patients was significantly higher than that of UA patients (36 vs. 33 years, $p = 0.016$). CA patients also demonstrated significantly elevated levels of C-reactive protein (CRP), direct bilirubin, white blood cell count (WBC), IG#, IG%, and neutrophil-to-lymphocyte ratio (NLR) compared to UA patients ($p < 0.001$). Receiver operating characteristic (ROC) analysis identified an IG# cut-off of 0.06 (area under the ROC curve [AUROC] = 0.699, sensitivity = 68.5%, specificity = 65.2%) and an IG% cut-off of 0.35 (AUROC = 0.663, sensitivity = 75.3%, specificity = 49.6%). In the multivariable logistic regression analysis, none of the evaluated laboratory parameters, including WBC count (Odds ratio (OR): 1.133, 95% Confidence interval (CI): 0.979–1.313, $p = 0.095$), IG# (OR: 0.000, 95% CI: 0.000–1.595, $p = 0.056$), IG% (OR: 6.740, 95% CI: 0.873–52.064, $p = 0.067$), and NLR (OR: 1.070, 95% CI: 0.980–1.169, $p = 0.131$), remained significant independent predictors of CA.

CONCLUSIONS: Elevated IG# and IG% levels were associated with CA in univariate analysis; however, they did not remain significant independent predictors in the multivariable model. Although the potential of these markers may still provide complementary information in certain clinical scenarios, further large-scale prospective studies are needed to better define their role in clinical practice.

Keywords: CA; immature granulocyte count; immature granulocyte percentage; inflammatory markers; predictive markers

Introduction

Acute Appendicitis (AA) can be categorized into two groups: uncomplicated appendicitis (UA) and complicated appendicitis (CA) [1]. While most cases of AA are UA, it remains crucial in current surgical practice to promptly detect and manage cases of CA [2]. Predicting CA is essential, as these cases constitute a significant proportion of emergency surgical procedures and directly influence the choice of surgical approach, including laparoscopic or open appendectomy. An accurate preoperative distinction between UA and CA not only facilitates timely and appropriate surgical decision-making but also optimizes patient outcomes by minimizing complications [3–5].

Radiological and laboratory tests were performed to differentiate between UA and CA. Radiological assessments require specialized equipment and skilled staff. At this point, laboratory testing is more useful [6]. Various markers, such as white blood cell (WBC) count, C-reactive protein (CRP) levels, bilirubin levels, and neutrophil-lymphocyte ratio (NLR), have been identified in the literature as linked to CA [7].

Premature granulocytes are produced in the bone marrow, and their levels increase in the blood under inflammatory conditions. The immature granulocyte count (IG#) and percentage (IG%) of immature granulocytes have been linked to several conditions, including pancreatitis [8], Coronavirus Disease 2019 (COVID-19) [9], and liver abscesses [10,11].

Submitted: 20 February 2025 Revised: 22 May 2025 Accepted: 30 May 2025 Published: 13 August 2025
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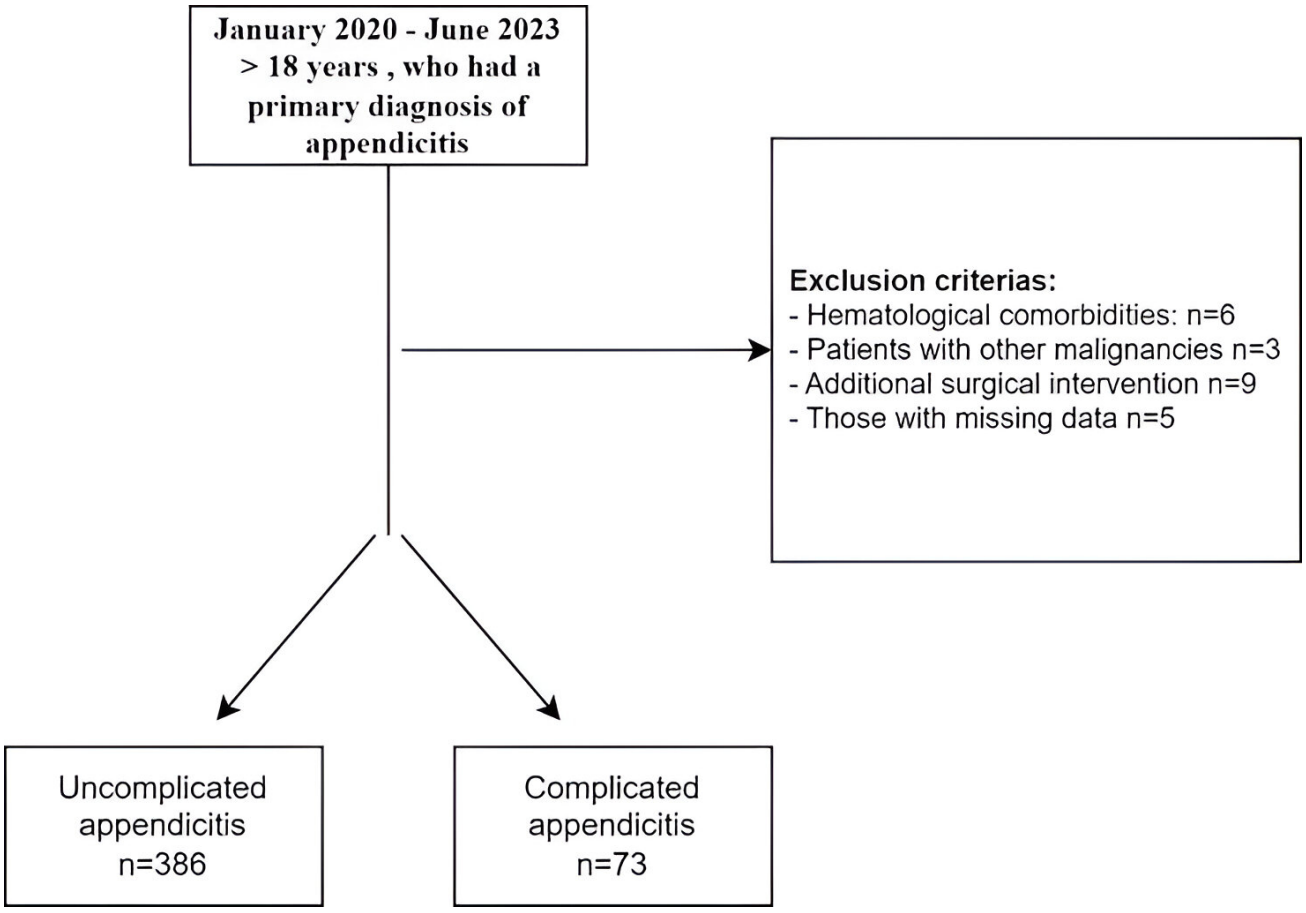

Fig. 1. Flowchart for the explanation of patient categorization and study planning. This flowchart was created using draw.io (diagrams.net), desktop version 20.8.16 (JGraph Ltd., London, UK).

The objective of this study was to examine whether the quantity and percentage of IG can be used to predict the occurrence of CA and to compare these findings with existing literature. Our hypothesis proposes that the quantity and percentage of IG are indicative of CA.

Materials and Methods

This study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the Clinical Research Ethics Committee of Bursa City Hospital (Decision Number: 2023-12/7). Written consent was obtained from patients admitted to the clinic, where their data could be used for academic purposes.

The diagnosis of AA in our clinic was made by an on-call surgeon who performed the evaluation in the emergency room. Preoperative laboratory tests were performed. Surgery can be performed using either the open or laparoscopic method. The classification of cases as uncomplicated or complicated was determined based on pathology reports. CA is classified as perforated or gangrenous, whereas UA is classified as erectile, catarrhal or suppurative.

Our study data included emergency appendectomy cases performed between January 2020 and June 2023 in patients aged over 18 years with a primary diagnosis of appendicitis. A total of 482 patients were included in this study.

The study excluded patients with haematological comorbidities (n = 6), other malignancies (n = 3), those who underwent additional procedures (n = 9), and those lacking laboratory and clinical data (n = 5) (Fig. 1).

The dataset consists of many different parameters associated with patients, including their age, sex, laboratory measurements [CRP, direct bilirubin, total bilirubin, WBC, immature granulocyte count (IG#), immature granulocyte percentage (IG%), neutrophil percentage (NEUT%), lymphocyte percentage (LYMPH%), neutrophil lymphocyte ratio (NLR)], clinical information (such as duration of hospitalization), and pathological data. Data were obtained from the hospital electronic archives of the patients. Due to the retrospective nature of the study, data on symptom duration, fever and body temperature, and antibiotic use were not consistently available and, therefore, could not be included in the analysis.

Statistical Analysis

Normality of continuous variables was assessed using the Shapiro–Wilk test. Continuous variables are presented as median [interquartile range] or mean ± standard devia-

Table 1. Comparison of demographic data and laboratory findings between uncomplicated appendicitis and complicated appendicitis groups.

Variable	Uncomplicated appendicitis [n = 386]	Complicated appendicitis [n = 73]	Total [n = 459]	*p*-value	Test used
Age	33 [25–44]	36 [28–52]	34 [25–45]	0.016	Mann-Whitney U (Z = –2.414)
Male/Female	229 (59.3)/157 (40.7)	42 (57.5)/31 (42.5)	271 (59)/188 (41)	0.775	Chi-Square (χ^2 = 0.082)
Length of stay (days)	2 [2–3]	3 [2–4]	2 [2–3]	<0.001	Mann-Whitney U (Z = –4.134)
CRP (mg/L)	21.8 [4–85]	94.45 [21.55–188.8]	28.9 [5–99.9]	<0.001	Mann-Whitney U (Z = –4.304)
Bilirubin, direct (mg/dL)	0.16 [0.11–0.24]	0.24 [0.17–0.37]	0.17 [0.11–0.27]	<0.001	Mann-Whitney U (Z = –4.494)
Bilirubin, total (mg/dL)	0.56 [0.38–0.85]	0.84 [0.55–1.17]	0.59 [0.39–0.91]	<0.001	Mann-Whitney U (Z = –3.906)
WBC (10^3/μL)	12.88 [10.16–15.64]	15.5 [12.97–19.09]	13.25 [10.45–16.17]	<0.001	Mann-Whitney U (Z = –4.264)
IG# (10^3/μL)	0.05 [0.03–0.07]	0.07 [0.05–0.1]	0.05 [0.03–0.07]	<0.001	Mann-Whitney U (Z = –5.439)
IG%	0.4 [0.3–0.5]	0.4 [0.4–0.6]	0.4 [0.3–0.5]	<0.001	Mann-Whitney U (Z = –4.526)
NEUT%	75.5 [68.9–83]	83.7 [76.4–87.5]	77.55 [70.1–84.1]	<0.001	Mann-Whitney U (Z = –5.255)
LYMPH%	15.6 [9.8–22.3]	9.3 [5.8–13.9]	14.2 [9–21.5]	<0.001	Mann-Whitney U (Z = –6.046)
NLR	4.82 [3.12–8.44]	9.26 [5.33–14.93]	5.34 [3.23–9.46]	<0.001	Mann-Whitney U (Z = –5.968)

Normality of continuous variables was assessed using the Shapiro-Wilk test. Depending on the distribution, continuous variables were presented as either mean ± standard deviation (SD) or median [interquartile range, IQR]. For inter-group comparisons, the Mann-Whitney U test was used for non-normally distributed data, while the independent samples *t*-test was applied to normally distributed variables. Categorical variables were expressed as numbers and percentages (n, %) and compared using the chi-square test.

IG%, immature granulocyte percentage; IG#, immature granulocyte count; NLR, neutrophil-to-lymphocyte ratio; WBC, white blood cell; CRP, C-reactive protein; NEUT%, neutrophil percentage; LYMPH%, lymphocyte percentage.

tion, depending on the distribution. For group comparisons, the Mann-Whitney U test was used for non-normally distributed variables, while independent samples *t*-test was used for normally distributed ones. Categorical variables are presented as numbers and percentages (n, %), and compared using the chi-square test. A p-value < 0.05 was considered statistically significant. Receiver operating characteristic (ROC) analysis was performed to determine the optimal cut-off values for certain parameters to distinguish between the CA and UA groups. Descriptive statistics for the ROC analysis included cut-off values, area under the curve (AUC), sensitivity, and specificity. Additionally, the areas under the ROC curves were compared using the MedCalc software (Version: 22.014, MedCalc Software Ltd., Ostend, Belgium).

Additionally, multivariable logistic regression analysis was performed to determine independent predictors of CA. Results were reported as Odds ratios (OR) with 95% Confidence intervals (CI) to quantify the strength of the associations. Statistical significance was set at $p < 0.05$.

A post-hoc power analysis was conducted using G*Power 3.1.9.2 software (version 3.1.9.2; Heinrich Heine University Düsseldorf, Düsseldorf, North Rhine-Westphalia, Germany) to evaluate the statistical power of the study. A power level of ≥0.80 was considered sufficient for detecting significant differences between the groups.

All statistical analyses were performed using SPSS software (Version: 23.0, SPSS Inc., Chicago, IL, USA), and a p-value < 0.05 was considered statistically significant.

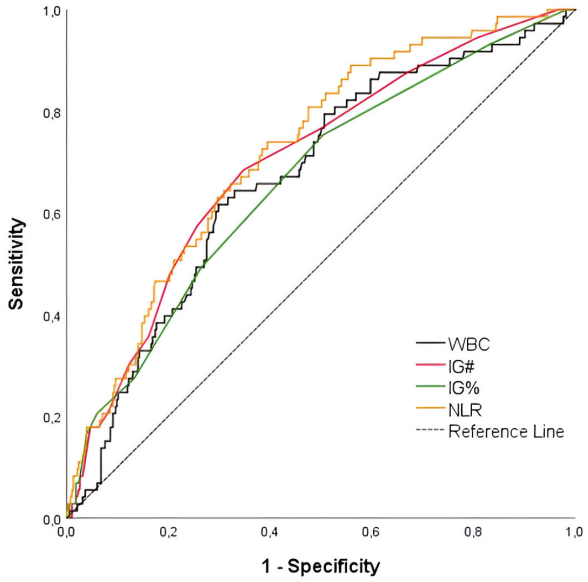

Fig. 2. Receiver operating characteristic (ROC) curve of parameters in predicting complicated appendicitis. This ROC curve was generated using SPSS software (Version 23.0, SPSS Inc., Chicago, IL, USA).

Results

In this study, 84.1% (n = 386) of the patients were diagnosed with UA, and 15.9% (n = 73) with CA. Of these, 41% (n = 188) were female and 59% (n = 271) were male. The median age of all the patients was 34 years [range, 25–45 years]. The median age of the patients diagnosed with CA was significantly higher (36 [28–52] years) than that

Table 2. Post-hoc power analysis for sample size justification.

Test type	Analysis	Effect size (f)	α Error probability	Power (1-β error prob)	Noncentrality parameter (λ)	Critical t	Group 1 (uncomplicated appendicitis)	Group 2 (complicated appendicitis)	Total sample size	Actual power
Wilcoxon-Mann-Whitney test	A priori: Compute required sample size	0.50	0.05	0.95	3.6232506	1.9663152	386	73	459	0.950934

Table 3. ROC analysis results of parameters in predicting complicated appendicitis.

Parameter	AUROC	95 % CI	Cut-off	Sensitivity	Specificity	p
WBC	0.670	(0.604–0.736)	15.01	0.616	0.701	<0.001
IG#	0.699	(0.635–0.764)	0.06	0.685	0.652	<0.001
IG%	0.663	(0.595–0.731)	0.35	0.753	0.496	<0.001
NLR	0.720	(0.660–0.780)	6.10	0.740	0.605	<0.001

AUROC, area under the receiver operating characteristic curve; CI, Confidence interval.
p-values were determined using AUROC with the null hypothesis that the AUROC is equal to 0.5. A p-value of <0.05 was considered statistically significant, indicating that the model's performance was significantly better than random chance.

of those diagnosed with UA (33 [25–44] years, $p = 0.016$). The length of hospital stay for patients diagnosed with CA was significantly longer (3 [2–4] days) than for those with UA (2 [2–3] days, $p < 0.001$). Similarly, CRP, direct bilirubin, total bilirubin, WBC, IG#, IG%, NEUT%, and NLR were significantly higher, whereas LYMPH% was significantly lower in CA cases than in UA cases ($p < 0.001$) (Table 1).

A post-hoc power analysis was conducted using the Wilcoxon-Mann-Whitney test, referencing the effect size reported in the study by Ünal [7] With an effect size of 0.50, an α error probability of 0.05, and a power of 0.95, the analysis determined that a total sample size of 459 patients (386 UA, 73 CA) was adequate for detecting statistically significant differences between the groups. Additionally, an analysis was applied to adjust for class imbalance ($p < 0.05$), ensuring more balanced comparisons (Table 2).

ROC curves were drawn to observe the effectiveness of the laboratory parameters (WBC count, NLR, IG#, and IG%) in diagnosing CA (Fig. 2). All parameters were significant in differentiating CA from UA ($p < 0.001$). ROC analysis for diagnosing CA showed that a cut-off value of 15.01 for WBC count had an area under the ROC curve (AUROC) of 0.670, a sensitivity of 61.6%, and a specificity of 70.1%. For IG#, a cut-off value of 0.06 had an AUROC of 0.699, sensitivity of 68.5%, and specificity of 65.2%. For IG%, a cut-off value of 0.35 had an AUROC of 0.663, sensitivity of 75.3%, and specificity of 49.6%. For the NLR, a cut-off value of 6.10 had an AUROC of 0.720, sensitivity of 74.0%, and specificity of 60.5% ($p < 0.001$). According to the AUROC values, NLR (0.720) was a stronger predictor for diagnosing CA than IG# (0.699), IG% (0.663), or WBC (0.670) (Table 3).

In the univariate analysis, several parameters were associated with CA. These variables were included in the multivariate logistic regression model to determine the independent predictors. However, after adjusting for potential confounders, none of the included variables reached statistical significance ($p > 0.05$). The OR for WBC was 1.133 (95% CI: 0.979–1.313, $p = 0.095$), while the ORs for immature granulocyte count (IG#) and percentage (IG%) were 0.000 (95% CI: 0.000–1.595, $p = 0.056$) and 6.740 (95% CI: 0.873–52.064, $p = 0.067$), respectively. Although these parameters showed a trend towards significance, they did not meet the threshold for independent association with CA. The intercept of the model was 41.270 ($p = 0.576$), indicating no significant baseline effect (Table 4).

The cut-off values determined in Table 2 for WBC, neutrophil-to-lymphocyte ratio (NLR), immature granulocyte count (IG#), and immature granulocyte percentage (IG%) were incorporated into a multivariate logistic regression model to assess their independent predictive value for CA. Among these parameters, only NLR >6.10 was identified as a statistically significant independent predictor, with an OR of 2.334 (95% CI: 1.234–4.414, $p = 0.009$), indicating that patients with an NLR above this threshold had a 2.33-fold increased risk of developing CA. WBC >15.01 showed a trend towards significance (OR: 1.770, 95% CI: 0.909–3.447, $p = 0.093$), but the difference was not statistically significant. Similarly, IG# >0.06 (OR: 1.564, 95% CI: 0.704–3.472, $p = 0.272$) and IG% >0.35 (OR: 1.400, 95% CI: 0.650–3.015, $p = 0.390$) were not found to be statistically significant predictors in the multivariate model (Table 5).

A structured literature search was conducted using PubMed, Scopus, and Web of Science databases to identify relevant studies published between January 2015 and February 2025. The search strategy included the combined use of the keywords "immature granulocyte", "appendicitis", and "complicated appendicitis". The search

Table 4. Multivariate logistic regression analysis of factors associated with complicated appendicitis.

	p	OR	95% CI	
			Lower	Upper
Age	0.163	1.017	0.993	1.040
CRP	0.060	1.004	1.000	1.007
Bilirubin, direct	0.841	1.408	0.050	39.462
Bilirubin, total	0.264	1.810	0.639	5.130
WBC	0.095	1.133	0.979	1.313
IG#	0.056	0.000	0.000	1.595
IG%	0.067	6.740	0.873	52.064
NEUT%	0.217	0.916	0.797	1.053
LYMPH%	0.088	0.854	0.717	1.024
NLR	0.131	1.070	0.980	1.169
Intercept	0.576	41.270		

Multivariate logistic regression analysis was performed to identify independent predictors of complicated appendicitis. A p-value < 0.05 was considered statistically significant.

Table 5. Multivariate logistic regression analysis based on cut-off values for predicting complicated appendicitis.

	p	OR	95% CI	
			Lower	Upper
WBC cut-off				
≤15.01	0.093	1.770	0.909	3.447
>15.01				
IG# cut-off				
≤0.06	0.272	1.564	0.704	3.472
>0.06				
IG cut-off				
≤0.35	0.390	1.400	0.650	3.015
>0.35				
NLR cut-off				
≤6.10	0.009	2.334	1.234	4.414
>6.10				
Intercept	0.576	41.270		

Multivariate logistic regression analysis was performed using predefined cut-off values to assess the association between laboratory parameters and complicated appendicitis. p-value < 0.05 was considered statistically significant.

included original research articles that reported the immature granulocyte count (IG#) or immature granulocyte percentage (IG%) as diagnostic markers for CA. Studies were considered eligible if they provided clearly defined cut-off values along with sensitivity, specificity, and area under the curve (AUC) data based on ROC curve analysis or logistic regression. Only studies involving patients older than 16 years of age with histopathologically confirmed appendicitis were included. In contrast, studies were excluded if they were non-original (such as reviews or conference abstracts), lacked a clear distinction between CA and UA, or failed to report numerical diagnostic performance metrics. Furthermore, studies focusing on pediatric surgery or those involving patients aged <16 years were excluded. After screening the titles, abstracts, and full texts according to these criteria, five studies were identified and included for comparative evaluation, as shown in Table 6 (Ref. [7,11–14]).

Discussion

In the present study, we determined that the IG value and percentage cut-off value for predicting CA were 0.06 and 0.35, respectively. The AUROC values, sensitivities, and specificities of these results were 0.69, 68%, and 65.2%, and 0.663, 75.3%, and 49.6%, respectively ($p < 0.001$). In comparison with existing studies, our IG# cut-off value (0.060) and corresponding AUC (0.690) were consistent with those reported by Turkes *et al*. [11] (AUC: 0.700) and Kubat and Şengül [13] (AUC: 0.737), suggesting moderate diagnostic performance. Notably, Güler *et al*. [12] reported a higher AUC (0.743), yet lower IG% sensitivity (44.1%) compared to ours (75.3%).

In contrast, Ünal [7] reported remarkably high sensitivity and specificity values for both IG# and IG%, likely due to methodological differences, including higher IG cut-off thresholds (0.104 and 0.60, respectively) and possibly a more severe patient population. Park *et al*. [14] reported a lower diagnostic accuracy (AUC: 0.56), which might be explained by their use of a limited IG% range without IG# data. Overall, despite minor differences, our findings are in line with the literature in supporting the potential utility of immature granulocytes—particularly IG#—as supplementary diagnostic markers for CA [7,11–14].

The observed differences in sensitivity and specificity across the studies may stem from several methodological and statistical factors. First, variations in the sample size and case distribution can influence the estimation of these diagnostic metrics because an imbalanced representation of CA and UA cases may lead to spectrum bias. Second, differences in the selection of cut-off values, particularly whether they were determined using the Youden Index, maximized specificity, or another optimization criterion, can directly impact the trade-off between sensitivity and specificity. Third, laboratory measurement techniques and equipment calibration may introduce inter-study variability, affecting the reproducibility of immature granulocyte parameters. Finally, statistical differences in handling missing data, adjustments for confounding variables, and the use of different validation methods (internal vs. external validation) can further contribute to discrepancies in the reported diagnostic performance. While ROC curve analysis demonstrated that IG# and IG% alone did not provide superior diagnostic accuracy for distinguishing complicated from UA, it is noteworthy that among the evaluated biomarkers, the diagnostic performance was highest for NLR (AUROC: 0.720), followed by IG# (AUROC: 0.699),

Table 6. Literature comparison for statistical results of IG# and IG% percentages.

Study name	Cut-off IG# value	Sensitivity IG# (%)	Specificity IG# (%)	AUC for IG#	*p* value	Cut-off value IG%	Sensitivity IG% (%)	Specificity IG% (%)	AUC for IG%	*p* value
Ustuner *et al*. (Our study)	0.060	68.0	65.2	0.690	<0.001	0.35	75.3	49.6	0.663	<0.001
Güler *et al*. [12]	0.035	66.1	73.6	0.743	<0.01	0.35	44.1	72.1	0.588	0.059
Turkes *et al*. [11]	0.030	61.8	70.8	0.700	0.001	0.20	58.8	55.4	0.630	0.030
Kubat and Şengül [13]	0.055	74.4	60.6	0.737	<0.001	-	-	-	-	-
Park *et al*. [14]	-	-	-	-	-	0.30	68.0	44.0	0.569	0.598
Ünal [7]	0.104	93.0	93.8	0.960	0.001	0.60	94.4	97.9	0.970	0.001

Cut-off values represent the optimal threshold for predicting complicated appendicitis. Sensitivity and specificity values are expressed as percentages (%). A p-value < 0.05 was considered statistically significant.

WBC (AUROC: 0.670), and IG% (AUROC: 0.663). Although IG# and IG% may not be sufficient as standalone diagnostic tools, their use as complementary markers alongside other established inflammatory parameters may enhance risk stratification, particularly in equivocal or borderline cases. Integrating IG# and IG% into a broader inflammatory panel together with NLR and WBC could therefore improve the overall predictive accuracy for CA and support more reliable clinical decision-making.

In the multivariable logistic regression analysis, none of the evaluated laboratory parameters—including WBC count, IG#, IG%, and NLR—remained statistically significant as independent predictors of CA. Similarly, when the predefined cut-off values determined by ROC analysis were incorporated into the multivariate model, only an NLR value greater than 6.10 emerged as a significant independent predictor, while the cut-off values for WBC, IG#, and IG% did not demonstrate statistical significance. These findings suggest that the associations observed between these markers and CA in the univariate analyses may be confounded by overlapping inflammatory responses and other factors. The absence of consistent statistical significance in both adjusted models underscores the complexity of inflammatory dynamics in appendicitis and indicates that, when considered alone, these markers may not provide sufficient discriminatory power for clinical decision making.

According to literature, IG% and IG# are associated with many infectious, inflammatory, and malignant conditions [15]. The cut-off values for each disease varied among the studies. Aydin *et al*. [16] found an IG% cut-off value of 65% in their study of acute pancreatitis. Çaparlar *et al*. [17] found that the optimal IG% values for accurately predicting necrosis caused by colonic volvulus were 0.065 and 0.65, respectively. Durak *et al*. [18] determined that the cut-off value of IG# for its association with necrosis in acute mesenteric ischemia was 0.225. Senlikci *et al*. [19] found that the immature granulocyte count was statistically significant for predicting bowel necrosis in incarcerated hernias, with a cut-off value of 0.065, 63% sensitivity, and 80% specificity. Currently, there is no generally recognized value for immunoglobulin (IG) levels under different clinical conditions. Although IG can easily be measured and detected, its association with specific clinical conditions must be assessed through comprehensive studies before it can be widely adopted in clinical practice.

The sample size of our study, which consisted of 459 cases, was larger than those of previous studies on the same topic. Additionally, the rate of complex appendicitis (15.9%) aligns with findings reported in the literature [3,11–13,20]. This consistency in complex appendicitis rates underscores the reliability of our data and supports the generalizability of our results to broader populations. Alignment with the literature suggests that the diagnostic process in our emergency department is effective and that patient education regarding the recognition and timely treatment of symptoms may be adequate.

Despite the growing presence of new and advanced nomogram research utilizing machine learning and artificial intelligence to predicting CA [21,22], there is still ongoing research on laboratory and radiological markers [23,24]. In this study, we observed that the WBC (cut-off value: 15.01, $p \leq 0.001$) and NLR (cut-off value: 6.1, $p \leq 0.001$) values were significantly greater in cases of CA, which is consistent with previous research [25].

Our study has several limitations. Given its retrospective design, there is a possibility of missing data and inability to control for certain confounding factors. Additionally, as this study was conducted at a single institution, its generalizability should be approached with caution. Furthermore, while our study aimed to investigate the role of immature granulocyte count (IG#) and percentage (IG%) in predicting CA, we could not establish a direct relationship between IG parameters and clinical severity indicators such as perforation and abscess formation due to limitations in data collection. Utilizing a control group of healthy individuals without appendicitis could strengthen the statistical robustness of our findings, particularly in differentiating inflammatory responses between physiological and pathological states. Additionally, the surgeries included in this study were performed using both open and laparoscopic techniques, and while efforts were made to minimize potential biases, variations in the surgical approach may still have influenced postoperative outcomes. However, the impact of this variability was mitigated by the reliable identification of CA,

as confirmed by pathology reports. Finally, although both gangrenous and perforated appendicitis fall under the category of CA, they represent distinct pathophysiological processes, with gangrenous appendicitis characterized by localized necrosis and perforated appendicitis involving gross contamination and abscess formation. Although these differences could influence surgical management and clinical outcomes, both were grouped together in this study to maintain statistical power and because both conditions typically necessitate surgical intervention rather than conservative management. Future studies should aim to validate the predictive role of IG# and IG% in CA through prospective, multicenter designs that incorporate detailed clinical, laboratory, and radiological parameters, with a particular focus on exploring their correlations with disease severity indicators such as symptom duration, fever, perforation, and abscess formation, in order to better elucidate their prognostic value and potential utility in optimizing clinical management. Additionally, comparing IG parameters with established scoring systems and employing multivariate analyses or machine learning models could refine risk stratification. Integrating IG markers into early decision-making algorithms may help optimize patient management, particularly in settings in which traditional markers provide inconclusive results.

Conclusions

This study suggests that the immature granulocyte count (IG#) and percentage (IG%) may serve as supplementary markers to distinguish CA from uncomplicated cases. While these markers showed moderate diagnostic accuracy and findings were in line with the existing literature, their independent predictive value was not confirmed in the multivariable analysis. Given the retrospective and single-center nature of this study, as well as the absence of subgroup analysis for gangrenous and perforated appendicitis, these results should be interpreted with caution. Further large-scale, multicenter, prospective studies are necessary to validate these findings and determine the precise role of IG parameters in clinical decision-making.

Availability of Data and Materials

The data supporting the findings of this study are available from the corresponding author upon reasonable request. However, personal identifiers and confidential personnel data will not be shared to ensure privacy and compliance with ethical standards.

Author Contributions

MAU was responsible for the conceptualization, study design, data collection, literature analysis, supervision, statistical analysis, and drafting of the original manuscript. OFA contributed to the study design, interpretation of data, manuscript writing, literature review, and critical revision. AVO contributed to data collection and data curation. MCA contributed to the statistical analysis and critically reviewed the manuscript. All authors contributed to the critical revision of the manuscript for important intellectual content, approved the final version for publication, and agreed to be accountable for all aspects of the work, ensuring accuracy and integrity.

Ethics Approval and Consent to Participate

This study was approved by the Clinical Research Ethics Committee of Bursa City Hospital (Approval Number: 2023-12/7). As this was a retrospective study, informed consent was not required. The study was conducted in accordance with the principles of the Declaration of Helsinki, and all patient data were anonymized to ensure confidentiality and compliance with ethical standards.

Acknowledgment

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

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