

Can Complete Blood Count Parameters be Used to Estimate Pre-interventional Coronary Flow and Thrombus Burden in Acute Coronary Syndrome?

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ABSTRACT

Background/Aims: Complete blood count (CBC) is a simple laboratory test which can be performed within minutes following emergency department admission. This retrospective study aimed to determine whether CBC parameters could predict pre-interventional thrombolysis in myocardial infarction (TIMI) flow and thrombus burden in patients with the acute coronary syndrome (ACS).

Methods: A total of 237 patients presenting with ACS were included retrospectively. Pre-interventional TIMI flow grade and angiographic thrombus burden were classified from angiographic images. In addition, blood samples for CBC were obtained upon admission to the emergency department. They were compared in patients with poor and good pre-interventional TIMI flow and patients with low and high pre-interventional thrombus burden.

Results: Patients with TIMI grade 2&3 flow had significantly lower haemoglobin, hematocrit, leukocyte, neutrophil, neutrophil / MCV ratio and neutrophil/lymphocyte ratio, while they had substantially higher eosinophil, basophil and eosinophil/lymphocyte ratio and basophil/lymphocyte ratio than those with TIMI grade 0&1 flow, regardless of the clinical scenario (USAP, NSTEMI, or STEMI). Patients with grade 5 angiographic thrombus burden had significantly higher haemoglobin, hematocrit, MCV, leukocyte, neutrophil, neutrophil / MCV ratio, and neutrophil/lymphocyte ratio. In contrast, they had substantially lower eosinophil and eosinophil/lymphocyte ratios than those with grade 14 thrombus burden.

Conclusion: CBC parameters, including leukocyte and eosinophil counts and neutrophil/lymphocyte and eosinophil/lymphocyte ratios, may be helpful in the estimation of pre-interventional coronary flow and thrombus burden.

Keywords: Coronary flow, thrombus, acute coronary syndrome, neutrophil, eosinophil

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INTRODUCTION

Coronary artery disease (CAD) is a leading concern since cardiovascular deaths are reported to account for about 30% of deaths globally.¹ Acute coronary syndrome (ACS), a term describing various conditions, including unstable angina pectoris (USAP) and ST-elevation myocardial infarction (STEMI), often results from plaque rupture and associated intracoronary thrombus generation.² Although ACS can occasionally result in mortality, surviving patients suffer from several comorbidities, including heart failure, arrhythmia and angina (from residual ischemia). Besides prompt treatment, optimal management of ACS necessitates accurate risk assessment and outcome stratification.

The primary pathophysiological mechanism underlying ACS is a limitation of blood flow in one or more coronary arteries associated with plaque rupture and thrombus formation. Nevertheless, coronary vasospasm with or without underlying atherosclerosis may also rarely lead to the development of ACS. Intracoronary thrombus burden in patients with ACS has been shown to strongly predict outcomes following coronary intervention.³ In patients with high thrombus burden, elimination of myocardial ischemia may not be achieved despite optimal revascularization. However, prompt estimation of thrombus burden can enable early initiation of antithrombotic agents such as

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Glycoprotein IIb/IIIa antagonists, thereby facilitating myocardial salvage in patients with ACS.

Studies have shown that chronic inflammation has a vital role in ACS.⁴ Cells involved in the inflammation process trigger the cytokine cascade in atherosclerosis. Inflammation has also been suggested to destabilize atherosclerotic plaques and accelerate the atherosclerotic process.⁵ An increase in the number of inflammatory cells in circulation is thought to be associated with poor prognosis in ACS.⁶⁻¹¹ In addition, parameters such as neutrophil-lymphocyte ratio (NLR), monocyte-lymphocyte ratio (MLR), systemic immune-inflammation index and systemic inflammatory response index have been reported to be associated with poor ACS prognosis.¹²

A complete blood count (CBC) is a simple laboratory test which can be performed within minutes following emergency department admission. Several CBC parameters have previously been shown to predict outcomes in patients with ACS.⁶⁻¹¹ However, it needs to be clarified whether these parameters are reliable in predicting initial Thrombolysis in Myocardial Infarction (TIMI) flow grade and thrombus burden. Therefore, we sought to determine whether various CBC parameters could predict pre-interventional TIMI flow and thrombus burden in ACS.

METHODS

This study was conducted by retrospective evaluation of patients with ACS admitted to the coronary care unit of our institution between March 2020 and March 2021. Patient data were recorded, including clinical and angiographic characteristics and blood test results from electronic archives. Ethics committee approval was obtained by the Clinical Research Ethics Committee of Haseki Training, and Research Hospital (Karar No: 71-2021, Tarih: 08.09.2021) and the study was conducted with respect to the Helsinki Declaration. We did not include patients diagnosed with cardiogenic shock and subjects with contraindications for coronary angiography.

Acute coronary syndromes were defined as clinical conditions, including unstable angina pectoris (USAP), ST-segment elevation myocardial infarction (STEMI) and non-STEMI (NSTEMI), which can lead to acute myocardial ischemia. The TIMI flow grade was classified as follows: grade 0 (lack of flow), grade 1 (contrast material observed beyond obstruction but lack of distal perfusion), grade 2

(complete perfusion but delayed flow) or grade 3 (normal flow).¹³ Angiographic thrombus burden classification: grade 0 (none), grade 1 (possibly present), grade 2 (maximum thrombus dimension less than half of the vessel diameter; VD), grade 3 (greater than half but less than twice VD), grade 4 (greater than twice VD), and grade 5 (complete occlusion).¹⁴

Blood samples for CBC were obtained upon admission. Blood samples were analyzed by flow cytometry in an automated system (XT-2000i, Sysmex®, Kobe, Japan). Comparisons were based on poor versus good pre-interventional TIMI flow (0&1 vs 2&3) and on low (grade 1 to 4) versus high (grade 5) pre-interventional thrombus burden.

Statistical analysis

The SPSS version 21 software for the Windows operating system was utilized for analyses with a significance threshold of $p < 0.05$. (IBM, Armonk, NY, USA). The presence/absence of Gaussian distribution was checked with Q-Q and histogram plots. Those fulfilling parametric assumptions were analyzed with the independent samples t-test, whereas the Mann-Whitney U test was used for non-parametric comparisons. Nominal variables were analyzed with chi-square tests. A descriptive depiction of variables was performed with mean $\pm$ SD or median (2575 percentiles) for quantitative variables, while absolute (n) and relative frequencies (%) were given for nominal variables. Receiver Operating Characteristic (ROC) curve analysis with the Youden J index was used to determine discrimination characteristics and cut-off thresholds.

RESULTS

In total, 237 patients (mean age 56.21 ± 11.45 years, 42 females and 195 males) with ACS were included in this retrospective analysis. Clinical and angiographic characteristics and blood test results are summarized (Table 1).

Patients with TIMI grade 2&3 flow had lower haemoglobin ($p = 0.015$), hematocrit ($p = 0.029$), leukocyte ($p < 0.001$), neutrophil ($p < 0.001$), neutrophil / MCV ratio ($p = 0.001$) and neutrophil/lymphocyte ratio (NLR) ($p = 0.017$). In contrast, they had higher hypertension frequency ($p = 0.017$), eosinophil ($p = 0.001$), basophil ($p = 0.003$), eosinophil/lymphocyte ratio (ELR) ($p < 0.001$), and basophil/lymphocyte ratio ($p = 0.013$) compared to the

Table 1. Summary of patients' characteristics, clinical findings and laboratory measurements	
Age	56.21 ± 11.45
Sex	
Female	42 (17.7%)
Male	195 (82.3%)
Hypertension	104 (43.9%)
Diabetes mellitus	75 (31.6%)
Hyperlipidemia	116 (48.9%)
COPD	18 (7.6%)
Cerebrovascular accident	9 (3.8%)
Malignancy	5 (2.1%)
Peripheral artery disease	4 (1.7%)
Coronary artery disease	69 (29.1%)
CABG	12 (5.1%)
Type	
Unstable angina	19 (8.0%)
NSTEMI	78 (32.9%)
STEMI	140 (59.1%)
Treated vessel	
LAD	84 (35.4%)
CX	50 (21.1%)
RCA	79 (33.3%)
LAD + CX	7 (3.0%)
IMA	3 (1.3%)
AO-CX	3 (1.3%)
AO-D1	1 (0.4%)
CX + RCA	2 (0.8%)
AO-RCA	2 (0.8%)
LAD + RCA	2 (0.8%)
None	4 (1.7%)
Treatment	
Medical	3 (1.3%)
PTCA	8 (3.4%)
Direct stenting	75 (31.6%)
PTCA + Stent	144 (60.8%)
Bentall + Myotomy	1 (0.4%)
CABG	6 (2.5%)
Hemoglobin	14.31 ± 1.85
Hematocrit	41.77 ± 5.02
Platelet (x1000)	249.62 ± 68.92
MCV	85.82 ± 6.01
MPV	10.55 ± 0.96
MCHC	34.23 ± 1.23
White blood cell	10720 (8630 - 13300)
Lymphocyte	2670 (1780 - 3700)
Neutrophil	6530 (5020 - 9070)
Monocyte	730 (540 - 900)
Eosinophil	150 (80 - 250)
Basophil	30 (20 - 50)
Neutrophil / MCV ratio	76.56 (57.99 - 107)
Lymphocyte / MCV ratio	31.03 (20.69 - 44.02)
Platelet / lymphocyte ratio	90.28 (65.28 - 134.41)
Neutrophil / lymphocyte ratio	2.34 (1.57 - 4.02)
Monocyte / lymphocyte ratio	0.26 (0.19 - 0.40)
Eosinophil / lymphocyte ratio	0.05 (0.03 - 0.08)
Basophil / lymphocyte ratio	0.01 (0.01 - 0.02)

TIMI Grade Flow	
Grade 0	108 (45.6%)
Grade 1	31 (13.1%)
Grade 2	97 (40.9%)
Grade 3	1 (0.4%)
Angiographic Thrombus Burden	
Grade 0	6 (2.5%)
Grade 1	11 (4.6%)
Grade 2	2 (0.8%)
Grade 3	9 (3.8%)
Grade 4	101 (42.6%)
Grade 5	108 (45.6%)
SYNTAX-II (PCI)	25.1 (20.8 - 28.3)
SYNTAX-III (CABG)	19.05 (14.6 - 26.1)
Complication	22 (9.3%)
Retreatment	18 (7.6%)
Medical	2 (0.8%)
PTCA	4 (1.7%)
Direct stenting	4 (1.7%)
PTCA + Stent	6 (2.5%)
CABG	2 (0.8%)
Exitus	7 (3.0%)
Data are given as mean $\pm$ standard deviation or median (1st quartile - 3rd quartile) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables	
Abbreviations: AO: Aorta, CABG: Coronary artery bypass graft, COPD: Chronic obstructive pulmonary disease, CX: Circumflex artery, D1: Diagonal branches -1, LAD: Left anterior descending, MCHC: Mean corpuscular hemoglobin concentration, MCV: Mean corpuscular volume, MPV: Mean platelet volume, NSTEMI: Non-ST-elevation myocardial infarction, PCI: Percutaneous coronary intervention, PTCA: Percutaneous transluminal coronary angioplasty, RCA: Right coronary artery, STEMI: ST-elevation myocardial infarction, TIMI: Thrombolysis in myocardial infarction	

Table 2. Summary of laboratory measurements with regard to TIMI Grade Flow			
	TIMI Grade Flow		
	Grade 0 & 1 (n=139)	Grade 2 & 3 (n=98)	p
Age	55.52 $\pm$ 11.41	57.18 $\pm$ 11.51	0.271
Sex			
Female	22 (15.8%)	20 (20.4%)	0.461
Male	117 (84.2%)	78 (79.6%)	
Hypertension	52 (37.4%)	52 (53.1%)	0.017
Diabetes mellitus	41 (29.5%)	34 (34.7%)	0.397
Hemoglobin	14.57 $\pm$ 1.61	13.95 $\pm$ 2.10	0.015
Hematocrit	42.39 $\pm$ 4.49	40.90 $\pm$ 5.60	0.029
Platelet (x1000)	246.24 $\pm$ 63.15	254.41 $\pm$ 76.43	0.370
MCV	86.46 $\pm$ 5.62	84.91 $\pm$ 6.44	0.051
MPV	10.56 $\pm$ 0.96	10.54 $\pm$ 0.96	0.869
MCHC	34.36 $\pm$ 1.15	34.05 $\pm$ 1.32	0.059
White blood cell	11560 (9350 - 14170)	9535 (8150 - 12120)	<0.001
Lymphocyte	2470 (1660 - 3980)	2780 (1900 - 3640)	0.454
Neutrophil	7310 (5180 - 10320)	5720 (4560 - 7200)	<0.001
Monocyte	740 (560 - 920)	670 (530 - 870)	0.070
Basophil	30 (20 - 40)	30 (20 - 50)	0.003
Platelet / lymphocyte ratio	92.15 (65.44 - 139.07)	85.83 (65.12 - 125.28)	0.606
Neutrophil / lymphocyte ratio	2.62 (1.49 - 5.39)	2.06 (1.72 - 2.90)	0.017
Monocyte / lymphocyte ratio	0.28 (0.18 - 0.45)	0.24 (0.19 - 0.34)	0.110
Eosinophil / lymphocyte ratio	0.04 (0.02 - 0.07)	0.06 (0.04 - 0.09)	<0.001
Basophil / lymphocyte ratio	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.02)	0.013
Data are given as mean $\pm$ standard deviation or median (1st quartile - 3rd quartile) for continuous variables according to normality of distribution			
Abbreviations: MCHC: Mean corpuscular hemoglobin concentration, MCV: Mean corpuscular volume, MPV: Mean platelet volume			

Table 3. TIMI grade 2 & 3 prediction performance of the laboratory measurements (all patients)								
	Cut-off	Sensitivity	Specificity	Accuracy	PPV	NPV	AUC (95.0% CI)	p
Hemoglobin	≤ 13.5	36.7%	79.1%	61.6%	55.4%	64.0%	0.572 (0.497 - 0.648)	0.058
Hematocrit	≤ 38.1	28.6%	84.9%	61.6%	57.1%	62.8%	0.565 (0.490 - 0.640)	0.089
White blood cell	≤ 10415	66.3%	66.9%	66.7%	58.6%	73.8%	0.664 (0.594 - 0.733)	<0.001
Neutrophil	≤ 7330	77.6%	49.6%	61.2%	52.1%	75.8%	0.648 (0.579 - 0.717)	<0.001
Basophil	> 25	69.4%	49.6%	57.8%	49.3%	69.7%	0.610 (0.538 - 0.683)	0.004
NLR	≤ 3.56	85.7%	41.0%	59.5%	50.6%	80.3%	0.591 (0.519 - 0.663)	0.017
ELR	> 0.056	63.3%	64.0%	63.7%	55.4%	71.2%	0.658 (0.589 - 0.727)	<0.001
BLR	> 0.0104	68.4%	51.1%	58.2%	49.6%	69.6%	0.595 (0.522 - 0.667)	0.013
Abbreviations: AUC: Area under ROC curve, BLR: Basophil -to-lymphocyte ratio, CI: Confidence intervals, ELR: Eosinophil -to-lymphocyte ratio, NLR: Neutrophil-to-lymphocyte ratio, NPV: Negative predictive value, PPV: Positive predictive value								

Table 4. Summary of laboratory measurements with regard to Angiographic Thrombus Burden classification			
	Angiographic Thrombus Burden		
	Grade 0 - 4 (n=129)	Grade 5 (n=108)	p
Age	57.04 ± 11.13	55.21 ± 11.81	0.222
Sex			
Female	27 (20.9%)	15 (13.9%)	0.214
Male	102 (79.1%)	93 (86.1%)	
Hypertension	67 (51.9%)	37 (34.3%)	0.006
Diabetes mellitus	46 (35.7%)	29 (26.9%)	0.147
Hemoglobin	14.00 ± 1.97	14.68 ± 1.62	0.005
Hematocrit	40.97 ± 5.30	42.74 ± 4.50	0.007
Platelet (x1000)	250.70 ± 75.18	248.33 ± 60.91	0.793
MCV	85.07 ± 6.09	86.70 ± 5.82	0.038
MPV	10.57 ± 0.98	10.52 ± 0.94	0.694
MCHC	34.14 ± 1.32	34.34 ± 1.12	0.224
White blood cell	9710 (8150 - 12120)	11970 (9645 - 15000)	<0.001
Lymphocyte	2680 (1860 - 3550)	2480 (1655 - 4085)	0.785
Neutrophil	5760 (4580 - 7420)	7405 (5475 - 11105)	<0.001
Monocyte	690 (540 - 870)	750 (550 - 925)	0.129
Eosinophil	170 (100 - 260)	135 (30 - 230)	0.003
Basophil	30 (20 - 50)	20 (20 - 40)	0.051
Platelet / lymphocyte ratio	85.64 (65.28 - 125.28)	93.26 (64.72 - 139.55)	0.553
Neutrophil / lymphocyte ratio	2.17 (1.68 - 3.05)	2.74 (1.47 - 5.67)	0.024
Monocyte / lymphocyte ratio	0.26 (0.19 - 0.36)	0.27 (0.17 - 0.45)	0.418
Eosinophil / lymphocyte ratio	0.06 (0.04 - 0.09)	0.04 (0.02 - 0.07)	<0.001
Basophil / lymphocyte ratio	0.01 (0.01 - 0.02)	0.01 (0.01 - 0.02)	0.089
Data are given as mean ± standard deviation or median (1st quartile - 3rd quartile) for continuous variables according to normality of distribution			
Abbreviations: MCHC: Mean corpuscular hemoglobin concentration, MCV: Mean corpuscular volume, MPV: Mean platelet volume			

Table 5. Angiographic Thrombus Burden grade 5 prediction performance of the laboratory measurements (all patients)								
	Cut-off	Sensitivity	Specificity	Accuracy	PPV	NPV	AUC (95.0% CI)	p
Hemoglobin	> 13.7	77.8%	38.0%	56.1%	51.2%	67.1%	0.591 (0.519 - 0.663)	0.016
Hematocrit	> 39.8	78.7%	36.4%	55.7%	50.9%	67.1%	0.587 (0.515 - 0.659)	0.022
MCV	> 89.1	33.3%	81.4%	59.5%	60.0%	59.3%	0.569 (0.495 - 0.642)	0.069
White blood cell	> 10415	70.4%	61.2%	65.4%	60.3%	71.2%	0.684 (0.616 - 0.752)	<0.001
Neutrophil	> 9540	35.2%	91.5%	65.8%	77.6%	62.8%	0.662 (0.593 - 0.732)	<0.001
NLR	> 3.56	43.5%	81.4%	64.1%	66.2%	63.3%	0.585 (0.509 - 0.662)	0.024
ELR	≤ 0.029	40.7%	86.8%	65.8%	72.1%	63.6%	0.669 (0.599 - 0.739)	<0.001
Abbreviations: AUC: Area under ROC curve, CI: Confidence intervals, ELR: Eosinophil -to-lymphocyte ratio, MCV: Mean corpuscular volume, NLR: Neutrophil-to-lymphocyte ratio, NPV: Negative predictive value, PPV: Positive predictive value								

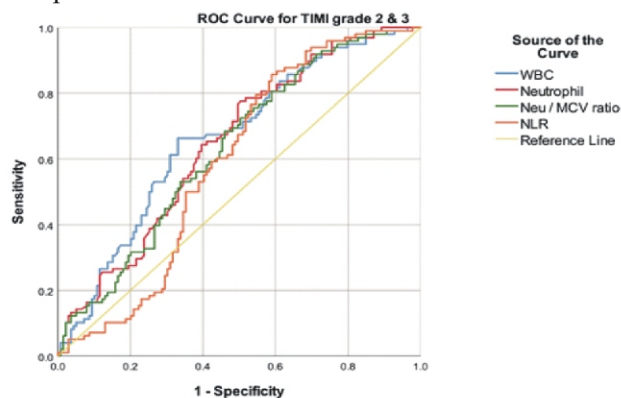


Fig. 1a. ROC curves of variables to predict TIMI grade 2&3

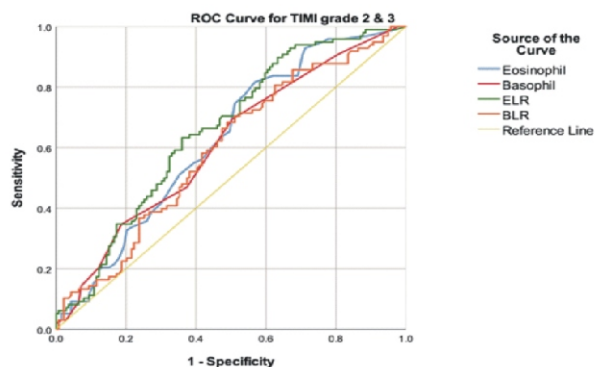


Fig. 1b. ROC curves of variables to predict TIMI grade 2&3

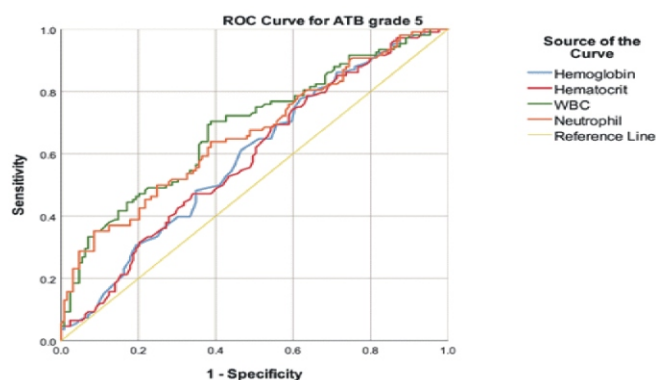


Fig. 2a. ROC curves of variables to predict angiographic thrombus burden grade 5

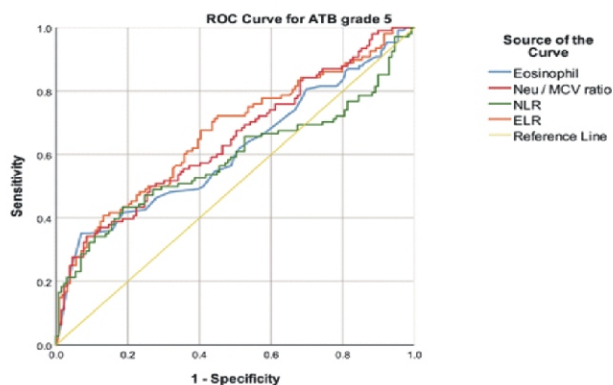


Fig. 2b. ROC curves of variables to predict angiographic thrombus burden grade 5

TIMI grade 0&1 flow group, regardless of the clinical scenario (USAP, NSTEMI, or STEMI) (Table 2). The predictive performance of leukocyte ($p < 0.001$), neutrophil ($p < 0.001$), eosinophil ($p = 0.001$), basophil ($p = 0.004$), neutrophil / MCV ratio ($p = 0.001$), NLR ($p = 0.017$), ELR ($p < 0.001$) and basophil/lymphocyte ratio ($p = 0.013$) were found to be significant for the identification of TIMI grade 2&3. NLR had the highest sensitivity and negative predictive value, while leukocyte had the highest specificity, accuracy and positive predictive values (Table 3, Fig. 1a, Fig. 1b).

Patients with grade 5 angiographic thrombus burden had higher hypertension frequency ($p = 0.006$), haemoglobin ($p = 0.005$), hematocrit ($p = 0.007$), MCV ($p = 0.038$), leukocyte ($p < 0.001$), neutrophil ($p < 0.001$), neutrophil / MCV ratio ($p < 0.001$), NLR ($p = 0.024$) and lower eosinophil ($p = 0.003$) and ELR ($p < 0.001$) than those with grade 1-4 thrombus burden (Table 4). Performance for the prediction of high thrombus burden (grade 5) was found to be significant in the following parameters: haemoglobin ($p = 0.016$), hematocrit ($p = 0.022$), leukocyte ($p < 0.001$), neutrophil ($p < 0.001$), eosinophil ($p = 0.003$), neutrophil / MCV ratio ($p < 0.001$), NLR ($p = 0.024$) and ELR ($p < 0.001$). Hematocrit had the highest sensitivity, eosinophil count had the highest specificity, accuracy and positive predictive values, and leukocyte had the highest negative predictive value (Table 5, Fig. 2a, Fig. 2b).

DISCUSSION

This retrospective study shows that ACS patients with poor flow and high thrombus burden had higher haemoglobin, hematocrit, leukocyte, neutrophil, and NLR, and lower ELR than patients with TIMI grade 2&3 flow and those with low thrombus burden. Admission NLR had the relatively best predictive values for TIMI grade 0&1 flow. However, the positive predictive values of CBC parameters to detect pre-interventional TIMI grade 2&3 flow were low. An admission NLR of >3.56 was determined to have low sensitivity but high specificity for predicting high pre-interventional thrombus burden. A leukocyte value of $>10415/\text{mm}^3$ had acceptable sensitivity and specificity for predicting high pre-interventional thrombus burden. However, although haemoglobin and hematocrit had high sensitivity for predicting the pre-interventional high thrombus burden, their specificity was relatively low.

Pre-interventional TIMI flow is associated with early stent thrombosis and is a predictor of mortality in ACS.^{15,16} STEMI patients presenting with poor TIMI flow grade (TIMI flow grade 1&2) have been identified to have worse clinical outcomes compared to those with the better pre-interventional coronary flow.^{17,18} Pre-interventional TIMI flow grade was also linked to larger infarct size in STEMI patients.¹⁹ Like poor TIMI flow, thrombus grade has also been related to stent thrombosis. Of note, in a prospective British Columbia registry, TIMI thrombus grade was ≥ 4 in 77.2% of the 101 patients presenting with definite stent thrombosis,²⁰ indicating the high frequency of this risk factor. This is particularly important considering that pre-interventional thrombus burden has been associated with increased mortality risk.³

Glycoprotein IIb/IIIa inhibitors and Cangrelor use as adjunct therapies in percutaneous coronary intervention may improve post-procedural TIMI flow grade and patient clinical outcomes.²¹ Given that pre-interventional TIMI flow grade and thrombus burden influences not only procedural success but also has a significant impact on clinical outcomes, the determination of patients with poor coronary flow at admission to the emergency department may improve survival through the administration of necessary antiaggregant treatment.

Interestingly, data from prominent trials indicate that diabetes, longer delay until percutaneous intervention (PCI), smoking, and coronary disease severity are more prevalent in patients with grade 3 flow at the onset compared to subjects with grade 1&2 flow.²² The predictive role of several markers in identifying the no-reflow phenomenon, which is linked to adverse clinical outcomes in patients undergoing PCI, has been subject to various clinical studies. Several parameters, including platelet volume, platelet/lymphocyte ratio, cystatin C, neutrophil count, NLR, D-dimer, endothelin-1 and nesfatin-1 levels, have been reported to be related to no-reflow after interventional ACS treatment.^{23,24} However, whether laboratory tests are associated with pre-interventional coronary flow and thrombus burden is still relatively unknown.

The CBC measurement is a simple, fast, and readily available test to assess blood cells' number and qualitative / semi-quantitative characteristics. Based on data from

previous no-reflow studies, this study aimed to investigate whether CBC parameters could predict pre-interventional coronary flow or thrombus burden in patients with ACS. Our findings indicate that leukocyte, NLR, and ELR could predict pre-interventional TIMI flow and thrombus burden. Previous data published by Li et al. shows increased NLR in the presence of a high thrombus burden.²⁵ The authors suggested that the link between thrombus burden and NLR was due to systemic inflammation developing during ACS. Increased NLR may also indicate plaque destabilization and rupture during the development of the ACS, in which neutrophils release elastases.⁷ Inflammatory status and prothrombotic state are related to each other. Kaya et al. have shown in their study, including patients with mitral stenosis, that higher NLR was present in cases with echo contrasting in the left atrium.²⁶ Although the mechanism linking increased neutrophil/lymphocyte count and thrombosis is unclear, the systemic inflammatory process during ACS is probably responsible for the thrombogenic milieu. Our findings indicate increased leukocyte in patients with high pre-interventional thrombus burden and poor coronary flow, supporting this hypothesis.

Another interesting finding of this study was low eosinophil count and ELR in patients with poor pre-interventional TIMI flow and high thrombus burden. Limited data suggest a role for ELR in thrombosis. Mansiroglu et al. demonstrated lower eosinophil count in deep vein thrombosis compared to controls.²⁷ Like these findings, Sincer et al. have found in a patient subset of ACSs that those with STEMI (with higher thrombus burden) had lower eosinophil count compared to patients presenting with USAP or NSTEMI.²⁸ In another study by Jiang and colleagues, eosinophil count was lower in the peripheral blood samples of patients with STEMI than those with USAP. Moreover, a decrease in eosinophil count was associated with the extent of myocardial damage.²⁹ However, the exact pathophysiological mechanism linking decreased eosinophil count and high thrombus burden remain unclear.

We found that ACS patients with poor flow and high thrombus burden had greater haemoglobin and hematocrit levels. Similar results for hematocrit have been shown in previous studies. Wang et al. found a positive correlation between thrombolysis in myocardial infarction and

hematocrit. Based on this relationship, they stated that elevated hematocrit might have a role in the pathophysiology of poor flow in the coronary artery.³⁰ Çınar et al. determined a significant correlation between whole blood viscosity (calculated using hematocrit and plasma protein levels) and high thrombus burden, whereas haemoglobin was not associated with thrombus burden. They stated that the change in whole blood viscosity might cause the relationship between hematocrit and thrombus burden.³¹ Contrary to our findings, there are also studies in which haemoglobin and hematocrit values were not associated with flow and thrombus burden.^{32,33} To the best of our knowledge, no analysis detected haemoglobin level was significantly linked to poor flow and high thrombus burden.

Study limitations

There are some limitations to be mentioned. Firstly, the study's retrospective nature makes it prone to various forms of bias, and the lack of stratification concerning clinical diagnoses may have led to underlying variations. Second, other markers of inflammation were not studied. However, we particularly sought to investigate CBC parameters and their association with TIMI flow and/or thrombus burden. Further prospective research is needed to elucidate these possible relationships.

CONCLUSION

Pre-interventional estimation of coronary flow or intracoronary thrombus burden may help promptly administer necessary therapy. Our findings show that simple CBC parameters, including leukocyte count, NLR, eosinophil count and ELR, may have utility in estimating pre-interventional TIMI flow and thrombus burden.

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