Relationship between hematological parameters and myocardial perfusion in patients with acute anterior myocardial infarction managed by primary percutaneous coronary intervention

Ahmed EL Missiri MD, Ehab Mohamed Elfekky MD, Sameh Mosaad MD, Mahmoud Hamad Salama MBBCh

Department of Cardiovascular, Faculty of medicine, Ain shams university
mahmoudhamad01115227426@gmail.com

Abstract: Background: Elevated white blood cell count and neutrophils to lymphocyte ratio consider a good Predictor in risk stratification in chronic stable coronary arteries disease and prognostic marker In long and short term cardiovascular mortality. **Objective:** To evaluate relationship between total leukocyte count TLC, neutrophills to lymphocyte NLR and myocardial perfusion in patient with acute anterior ST segment elevation myocardial infarction managed by primary PCI. **Patients and Methods:** This study is a prospective observational study. It was conducted at Ain Shams University and October 6 university hospitals from 15/11/2017 to 15/5/2018. The study was conducted on 60 patients diagnosed as acute anterior ST segment elevation myocardial infarction who underwent primary percutaneous coronary intervention within 6 hour from onset of symptoms with mean age 58.45 ± 10.61 Eighty percent of subjects were males. **Results:**. We found that the TLC and NLR was significantly associated with MBG and TIMI grades, patients with MBG 0-1 had significantly higher TLC & NLR than patients with MBG 2-3. patient with MBG (2 & 3) had significantly lower peak CKMB than patients with MBG 0 & 1, there is excess rate of morbidity and mortality in patient with impaired myocardial perfusion. **Conclusion:** The present study shows that higher TLC and NLR at admission were significantly correlated with poor perfusion outcomes, morbidity, low ejection fraction and mortality.

[Ahmed EL Missiri, Ehab Mohamed Elfekky, Sameh Mosaad, Mahmoud Hamad Salama. **Relationship between hematological parameters and myocardial perfusion in patients with acute anterior myocardial infarction managed by primary percutaneous coronary intervention.** *Nat Sci* 2019;17(5):95-103]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 11. doi:10.7537/marsnsj170519.11.

Keywords: Acute myocardial infarction, neutrophil-to-lymphocyte ratio, myocardial blush grade.

1. Introduction

Acute myocardial infarction (AMI) is one of the leading causes of death worldwide. According to recent epidemiological figures, the prevalence of the disease approaches three million people worldwide with more than one million deaths in the United States, annually. Moreover, the incidence of AMI in developing lower-income countries has increased despite the recent advances in the management of its risk factors (1). AMI is a major public health burden with high mortality out of the hospital. Data indicate that at least one-third of patients die before coming to the hospital and another 40-50% are dead upon arrival. Another 5-10% of patients will die within the first 12 months after their myocardial infarction (2).

The global incidence rate of AMI was 8.6 million (Global Burden of Disease Study 2013 Collaborators 2015). According to a presenting electrocardiogram, it has been reported that more than 3 million people are currently diagnosed with an ST-segment elevation MI (STEMI) (3).

According to Euro Heart Survey, the in-hospital mortality rate of patients with STEMI ranges from 6% to 14% (4).

Atherosclerosis is a progressive, complex and multi factorial disease characterized by the accumulation of lipids and fibrous elements in the large arteries and inflammation plays an important role in all stages of the atherosclerosis development (5).

Inflammatory processes along with endothelial dysfunction initiates a progressive process within the arterial wall, resulting in the reduction or obstruction of blood supply to end organs of the body (6).

The neutrophil-to-lymphocyte ratio (NLR) has been shown to be a marker of inflammation and closely related to increased cardiovascular mortality and morbidity (7).

Elevated white cell count in patients with STEMI is related to the body stress response and changes due to coronary endothelial dysfunction. This: Up-regulates the production of inflammatory cells and cytokines. Promotes. (s) and capillary congestion. Induces and aggravates acute coronary disease (8).

It was reported that high NLR values could be a useful parameter in evaluating cardiovascular risk (9).

Positive correlation between NLR values at admission and the severity of coronary artery disease was found (10).

NLR value could be the determinant of coronary atherosclerosis progression. High NLR values at admission were identified to be more with rupture-prone coronary atherosclerotic plaque components (11).

High NLR Associated with poor prognosis in patients with acute STEMI [12].

High NLR Found to be a determinant of mortality and cardiovascular incidents in patients who underwent angiography or cardiac revascularization [13].

Aim of the Work

To evaluate relationship between TLC, NLR and myocardial perfusion in patient with acute ST segment elevation myocardial infarction managed by primary PCI.

Patients and Methods

Type of study:

Prospective observational study.

Study setting:

The study was conducted in Ain Shams University Hospital and 6TH October University Hospital.

Study period:

From 15-11-2017 until 15-5-2018.

Study population:

Inclusion criteria:

Patient with acute anterior ST segment elevation myocardial infraction (STEMI) first attack treated with primary Percutaneous coronary intervention (PCI) within 6 hours from the onset of symptoms. ECG criteria to diagnose STEMI were used according to European society of cardiology: ST-segment elevation (measured at the J-point) is considered suggestive of ongoing coronary artery acute occlusion in the following cases: at least two contiguous leads with ST-segment elevation ≥ 2.5 mm in men < 40 years, ≥2 mm in men ≥ 40 years, or ≥ 1.5 mm in women in leads V_2–V_3 and/or ≥ 1 mm in the other leads [in the absence of left ventricular (LV) hypertrophy or left bundle branch block LBBB)] [14].

Exclusion criteria:

Patients with history of previous STEMI or non STsegment elevation acute coronary syndrome. Infectious or inflammatory disease such as chronic cholyecystitis, nephtitis, pharyngitis and bronchitis. Patients who presented more than 6 hours from the onset of symptoms. Hematological disorders such as leukemia, polythycemia and lymphoma. Patients on regular hemodialysis. History of heart failure. History of significant valvular affection. History of atrial fibrillation. Recent of cerebrovascular stroke. Previous history of CABG or PCI.

Sampling size:

Sixty patients with acute anterior STEMI

Ethical consideration:

An informed consent was obtained from all the patients, approval of the Ain Shams university ethical committee was obtained according to the ethical guidelines of the 1975 declaration of Helsiniki as revised in 2008.

Thorough history taking with special stress on risk factors fpr coronary artery disease including:

a-Smoking:

Tobacco smoking consists of drawing into the mouth, and usually the lungs, smoke from burning tobacco [15], patients was classified into: Smokers. Ex smokers: patients who stop smoking for more than 6 mothers. Non smokers.

b- Hypertension:

Hypertension is defined as a systolic blood pressure (SBP) of 140 mm Hg or more, or a diastolic blood pressure (DBP) of 90 mm Hg or more, or taking antihypertensive medication [16].

c- Diabetes Mellitus:

Diabetes mellitus was defined as previous diagnosis, specific treatment (oral drug or insulin), fasting glycemia >126 mg/dL, or glycosylated hemoglobin (HbA1c) >6.5%.

d- Family history:

Family history of premature coronary heart disease defined as fatal or nan fatal cardiovascular disese in < 55 years in first-degree male relatives and < 65 years in female relatives) [17].

*e- **dyslipidemia:***

Dyslipidemia was defined as total cholesterol > 200 mg/dl, LDL > 130 mg/dl, HDL < 35 mg/dl, or triglycerides >1.7 150 mg/dl, or a combination thereof [18].

Thorough clinical examination:

General examination with special emphasis on:

Blood pressure measurement. Heart rate.

Local examination:

Auscultation of heart sounds and murmurs for possible complication of myocardial infarction.

Laboratory investigations including:

In all patients, whole blood from peripheral vein on admission, uncentrifuged and anticogulated using Ethylenediaminetetraacetic acid (**EDTA** to obtain differential comlete blood count, total leukocyte count (TLC), and neutrophills to lymphocyte ratio (NLR) using automated analyzer Medonic M32.

Normal value of TLC 4,000 to 11,000 white blood cells per microliter of blood.

NLR obtaining by dividing absolute number of neutrophills by absolute number of lymphocyte.

Normal value of NLR normal NLR values in an adult population are between 0.78 and 3.53 [19].

Creatine kinase MB (ck-MB) quantitative assessment by obtatining serum specimen anticogulated with EDTA and centrifuged on admission, after 8 hours and after 16 hours using automated analyzer Bechman coulter.

Normal reference value of ck-MB (5_25) IU /L [20].

Coronary angiography and primary PCI:

All patients were given 300mg aspirin and 600 mg of clopidogrel as loading dose on admission.

All primary PCI procedures were performed using the standard femoral approach with a 6-French left guiding catheter, At the start of the procedure, intravenous heparin 10000 IU was given.

The blood flow in the infarct-related artery (IRA) was graded according to the Thrombolysis in Myocardial Infarc-tion (TIMI) in several orthogonal views to obtain TIMI flow grades which defined as grading system scoring system from 0-3 referring to levels of coronary blood flow assessed during PCI: TIMI 0 flow (no perfusion) refers to the absence of any antegrade flow beyond a coronary occlusion. TIMI 1 flow (penetration without perfusion) is faint antegrade coronary flow beyond the occlusion, with incomplete filling of the distal coronary bed. TIMI 2 flow (partial reperfusion) is delayed or sluggish antegrade flow with complete filling of the distal territory. TIMI 3 is normal flow which fills the distal coronary bed completely [21].

We assessed myocardial perfusion using myocardial blush grade which was performed visually with a cine-film at a 25 frame/s rate in the left lateral position,

MBG was defines as:

Grade 0: No myocardial blush or contrast density. Grade 1: Minimal myocardial blush or contrast density. Grade 2: Moderate myocardial blush or contrast density, but less than that of a non infarct-related artery. Grade 3: Normal myocardial blush or contrast density, comparable to that of a non infarct-related artery [22].

Echocardiography:

Trans-thoracic echocardiography was performed within 24 h after the primary PCI using Philips affinity 50 w by S4-2 probe with frequency ranging from 1 to 4 MHz.

Patients were examined in left lateral decubitis position, The left ventricular ejection fraction (LVEF) was calculated according to the according to the American Society of Echocardiography by using modified Simpson's method in this way the left endocardium was traced in four apical and two chambers views at end diastole and end sustole to obtain left ventricular end diastolic and end systolic volumes as well as LVEF according to the American Society of Echocardiography.

Normal reference value for mean LVEF in is (62 ± 5 %) [23].

Clinical end points:

Patients was assessed for in hospital morbidity which defined as comined end point of re infraction, stroke, pulmonary edema, cadiogenic shock and malignant arrhythmia. In hospital mortality has been recorded.

Data management:

All the data obtained were collected, revised, refined, then edited and tabulated on IBM compatible P.C.

The data were then analyzed statistically using SPSS statistical package, version (23). Description of quantitative variables was in the form of mean and standard deviation (SD) or median and range.

Description of qualitative variables was performed as frequency and percentage.

Comparison between quantitative variables was carried out by student *T* test of two independent samples, which was expressed in the form of *T*-value and p-values.

Chi square test:

It compares between 2 or more categorical groups (tables 2x2 or more). Non parametric (Mann Whitney) test was used to compare subgroups that did not have normal distribution. Correlations were assessed using Pearson's correlation coefficient (r). The significance of the results were assessed in the form of P-value differentiated into; Non- significant when P-value >0.05. Significant when P-value ≤ 0.05. Highly significant when P-value ≤ 0.01.

3. Results

The results are shown in the following tables (Tables 1-6).

Table (1): Comparison between MBG groups regarding Demographic data.

		MBG 0-1	MBG 2-3	Test value	P-value	Sig.
		No. = 22	**No. = 38**			
Age	Mean±SD	63.32 ± 9.66	55.63 ± 10.21	2.864•	0.006	HS
	Range	37 – 80	34 – 74			
Sex	Females	7 (31.8%)	5 (13.2%)	3.032*	0.082	NS
	Males	15 (68.2%)	33 (86.8%)			
Smoking	Negative	10 (45.5%)	15 (39.5%)	0.205*	0.651	NS
	Positive	12 (54.5%)	23 (60.5%)			
Family history	Negative	14 (63.6%)	21 (55.3%)	0.402*	0.526	NS

		MBG 0-1	MBG 2-3	Test value	P-value	Sig.
		No. = 22	No. = 38			
	Positive	8 (36.4%)	17 (44.7%)			
Hypertension	Negative	8 (36.4%)	18 (47.4%)	0.687*	0.407	NS
	Positive	14 (63.6%)	20 (52.6%)			
D.M.	Negative	5 (22.7%)	21 (55.3%)	6.007*	0.014	S
	Positive	17 (77.3%)	17 (44.7%)			
Dyslipidemia	Negative	8 (36.4%)	21 (55.3%)	1.993*	0.158	NS
	Positive	14 (63.6%)	17 (44.7%)			

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*: Chi-square test; •: Independent t-test; ‡: Mann Whitney test

Table (2): Comparison between MBG groups regarding Systolic BP, diastolic BP and HR

		MBG 0-1	MBG 2-3	Test value	P-value	Sig.
		No. = 22	No. = 38			
Systolic BP	Mean±SD	141.82 ± 19.67	138.65 ± 18.88	0.614•	0.542	NS
	Range	100 – 170	110 – 180			
Diastolic BP	Mean±SD	82.73 ± 8.27	81.08 ± 8.43	0.731•	0.468	NS
	Range	60 – 100	70 – 100			
HR	Mean±SD	80.14 ± 13.80	76.84 ± 8.89	1.118•	0.268	NS
	Range	64 – 120	59 – 91			

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*: Chi-square test; •: Independent t-test; ‡: Mann Whitney test

Table (3): Comparison between MBG groups regarding CKMB at baseline, after 8 hrs and after 16 hrs.

		MBG 0-1	MBG 2-3	Test value	P-value	Sig.
		No. = 22	No. = 38			
CKMB at baseline	Median (IQR)	40.5 (31 - 53)	38.5 (35 - 42)	-0.622‡	0.534	NS
	Range	13 – 378	8 – 97			
CKMB after 8 hrs	Median (IQR)	415.5 (214.5 - 576)	266.5 (140 - 370)	-2.086‡	0.037	S
	Range	108 – 2300	50 – 780			
CKMB after 16 hrs	Median (IQR)	85 (47.5 - 146)	60.5 (42 - 75)	-2.168‡	0.030	S
	Range	21 – 1320	25 – 234			

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*: Chi-square test; •: Independent t-test; ‡: Mann Whitney test

Table (4): Comparison between MBG groups regarding TLC, NLR and TIMI flow.

		MBG 0-1	MBG 2-3	Test value	P-value	Sig.
		No. = 22	No. = 38			
TLC	Mean±SD	12695.45 ± 4362.01	10185.53 ± 2606.88	2.796•	0.007	HS
	Range	5700 – 22500	5900 – 17000			
NLR	Mean±SD	6.70 ± 2.37	3.98 ± 1.42	5.522•	0.000	HS
	Range	2.2 – 12	1.2 – 8.3			
TIMI FLOW	0	1 (4.5%)	0 (0.0%)	20.727*	0.000	HS
	1	3 (13.6%)	0 (0.0%)			
	2	6 (27.3%)	0 (0.0%)			
	3	12 (54.5%)	38 (100.0%)			

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*: Chi-square test; •: Independent t-test; ‡: Mann Whitney test

Table (5): Comparison between MBG groups regarding ejection fraction post intervention, morbidity and mortality.

		MBG 0-1	MBG 2-3	Test value	P-value	Sig.
		No. = 22	No. = 38			
Ejection fraction Post intervention	Mean±SD	40.05 ± 7.80	54.47 ± 4.67	-8.820•	0.001	HS
	Range	20 – 50	45 – 62			
Morbidity	No	14 (63.6%)	34 (89.5%)	5.813*	0.016	S
	Yes	8 (36.4%)	4 (10.5%)			
Mortality	No	18 (81.8%)	38 (100.0%)	7.403*	0.007	HS
	Yes	4 (18.2%)	0 (0.0%)			

P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*: Chi-square test; •: Independent t-test; ‡: Mann Whitney test

Table (6): Correlation between (TLC, NLR) and CKMB at base line at 8 hours at 16 hours, and Echo post intervention.

	TLC		NLR	
	R	P-value	R	P-value
CKMB after 8 hrs	**0.511****	**0.001**	**0.495****	**0.001**
CKMB after 16 hrs	**0.404****	**0.002**	**0.432****	**0.001**
EF post intervention	**-0.342****	**0.009**	**-0.556****	**0.001**

4. Discussion

In patients presenting with STEMI, primary percutaneous coronary intervention (PCI) is considered the optimal reperfusion strategy. Based on current available data, recent guidelines recommend the primary PCI as a preferred reperfusion therapy for STEMI when provided within 90 minutes at experienced centers; they also spurred the rapid development of interventional therapies to treat acute MI lesions [24, 25].

Despite this wide use of primary PCI to re-establish anterograde flow after AMI, complete recovery of myocardial perfusion may not be achieved with this procedure alone. Persistent myocardial hypoperfusion in the presence of a patent epicardial coronary artery results in a condition known as 'no reflow'. This is generally caused by microvascular obstruction and tends to counteract the beneficial effects of reperfusion, leading to recurrent myocardial ischemia, myocyte necrosis, arrhythmias and contractile impairment [26].

The present study was a prospective observational study that included 60 patients diagnosed with acute anterior STEMI and underwent primary PCI within 6 hours from onset of symptoms.

The current available evidence shows that the incidence of AMI increases significantly with age to extend from 0.06% of men <45 years of age to 2.46% of those ≥75 years old [1]. On the other hand, the incidence of AMI was reported to be significantly higher in males [27]. In the present study, the mean age of the included patients was 58.45 ± 10.61 years and the vast majority of the patients were males (80%).

With the introduction of primary PCI, the mortality from AMI has decreased from ~20% in the late 1980s to ~5–7% in routine practice in the USA and Europe [28]. In our cohort, the mortality rates following primary PCI were only 6.7%, while the morbidity rate was 20%.

In line with our findings, **Jahic** [29] performed a prospective study on 549 STEMI patients who underwent primary PCI to evaluate the feasibility and outcomes of primary PCI for STEMI in regional tertiary care cardiac center in Bosnia and Herzegovina. Primary PCI involved balloon dilatation (2.7%) and stent implantation (97.3%). The incidence of all-cause mortality was 3.1%).

Similarly, **Dubey and colleagues** [30] studied the outcomes of primary PCI for acute STEMI at a tertiary care center in North India on 371 patients during the period from February 2103 to May 2015. The total in-hospital mortality was 2.9%.

The objective of primary PCI is to restore normal blood flow in the infarct-related artery. Previous studies have shown that preservation of the microcirculation is critical for a positive clinical outcome. Several diagnostic techniques have been employed to evaluate tissue-level microvascular perfusion in the last decade. Thrombolysis in Myocardial Infarction (TIMI) grades correlate with the final infarct size in patients with AMI treated with thrombolysis. However, the TIMI flow cannot be used as reliable markers of myocardial tissue perfusion after reperfusion therapy [31]. Despite normal coronary patency, tissue perfusion may be impaired or absent. Myocardial blush grade (MBG) has been well validated as an angiographic technique to assess myocardial perfusion in patients with STEMI. It is strongly related to prognosis in patients undergoing primary PCI for STEMI [32].

In the present study, 83.3% of the patients had TIMI grade 3. On the other hand, 63.3% of the patients had MBG grade 2-3 and 36.7% had MBG grade 0-1. In terms of the association between the MBG grades and the demographic characteristics of the included patients, our analysis showed that patients with MBG 2-3 were significantly younger and were less likely to be diabetic.

Similarly, **Kaya and colleagues** [(33)] performed a prospective study to determine whether MBG grades were associated with MACE during follow-up in a high-risk AMI population undergoing primary PCI with stent implantation. Post MBG-3 was observed in only 34% of patients. There were no statistically significant associations between MBG grade and age or diabetes.

The exact causes of such discrepancies between our findings and the abovementioned studies are unclear. However, it can be attributed to many methodological differences. Moreover, patients' characteristics were apparently different in which some studies included NSTEMI patients. The notable difference in sample size may be another factor.

Similarly, **Celik and colleagues** [(34)] investigated the impact of admission estimated glomerular filtration rates (eGFR) on the development of poor myocardial perfusion after primary PCI in patients presenting with acute STEMI. The study population consisted of 80 patients with STEMI and patients with MBG 0-1 had significantly higher peak CK-MB levels than patients with MBG 2-3.

In addition, the present study showed that patients with MBG 2-3 had significantly significant lower rates of morbidity than patients MB than patients with MBG 0-1. In line with our findings, **Kaya and colleagues** [(33)] reported that less post-intervention AMI or any other major adverse cardiac events (MACE) occurred in patients with MBG 3 compared with MBG 1 or 2. MBG 3 was a strong predictor of absence of MACE during 5-year follow-up.

Similarly**, Cura and colleagues** [(35)] performed analyzed the data of 981 patients from 2 large randomized trials. The incidence of final MBG 3 was 81%. MBG grade < or =2 was independently associated with increasing age, increasing heart rate, and incidence of MACE.

In agreement with our findings, **Sattur and colleagues** [(36)] performed a meta-analysis study to correlated early and late mortality with markers of reperfusion in STEMI. A total of 44 studies with 19,955 patients were included. The results showed that there was a significant correlation between MBG and 30-days and 1-year mortality. In nearly 6000 patients, there was substantial excess mortality in those with MBG 0-1 compared with MBG 2-3.

Similarly, **Brener and colleagues** [(37)] compared the infarct size (IS) measured by magnetic resonance imaging in patients with successful (MBG 2-3) versus unsuccessful (MBG 0-1) microcirculatory reperfusion in the INFUSE-AMI (Intracoronary Abciximab and Aspiration Thrombectomy in Patients With Large Anterior Myocardial Infarction) trial. The results showed that the MBG 2-3 was achieved in 367 patients (81.4%). MBG 2-3 was associated with ~a 30% reduction in mortality. At 30 days, the rate of death was significantly lower (1.7% vs. 8.3%; p = 0.0008) in the MBG 2-3 group.

As mentioned before, elevation of the TLC during AMI is associated with adverse outcomes and, therefore, it can be used as a predictor of myocardial perfusion following primary PCI (**Barron et al.**, **2000**). In the present study, we found that the TLC was significantly associated with MBG and TIMI grades, patients with MBG 0-1 had significantly higher TLC than patients with MBG 2-3. Moreover, the TLC correlated significantly with peak CK-MB and ejection fraction post-intervention.

In concordance with our findings, **Mariani and colleagues** (**2006**) performed a prospective study on 238 consecutive AMI patients treated with successful primary PCI TO correlate total and differential leucocyte (WBC) count with MBG, peak CK levels, and left ventricular (LV) functional recovery at 6 months. The results showed that the TLC was significantly higher in patients with MBG 0-1 than patients with MBG 2-3. In addition, increased neutrophil levels was an independent factor related to peak CK, whereas neutrophils and monocytes peaks were related to ST-segment resolution as well as to MBG 2–3. Monocytes number was independently associated with 6-month LV functional recovery.

Similar, **Sabatine and colleagues** (**2002**) evaluated the relationship between baseline TLC count, other baseline variables and biomarkers, angiographic findings, and clinical outcomes in 2,208 patients in the Treat angina with Aggrastat and determine Cost of Therapy with an Invasive or Conservative Strategy-Thrombolysis In Myocardial Infarction 18 (TACTICS-TIMI 18) trial. The results showed that Higher baseline WBC counts were associated with lower TIMI flow grades ($p = 0.0045$) and MBG grades ($p = 0.03$) as well as a greater extent of coronary artery disease ($p < 0.0001$).

In addition, **Ferrari and colleagues** (**2016**) correlated the TLC rise with the size of STEMI in a sub-analysis of the TETHYS trial. The TLC at hospital admission was significantly correlated with the CK, peak CK, and MB portion of CK.

In contrary, **Prasad and colleagues** (**2007**) examined whether leukocytosis is a negative prognostic factor in patients who underwent primary

PCI for acute AMI. Clinical outcomes and reperfusion success, using TIMI flow and MBG, were examined according to tertiles of baseline leukocyte count in 1,268 patients who underwent primary PCI for AMI in the CADILLAC trial. Patients with higher leukocyte count were younger and more likely to be current smokers. MBG 2-3 was achieved at similar rates after PCI in patients with low, intermediate, and high baseline leukocyte counts (52.0% vs 51.5% vs 50.1%, p = 0.8).

Again, the exact causes of such discrepancies between our findings and the abovementioned study are unclear. However, it can be attributed to many methodological differences, different patients' characteristics, or sample size.

Notably, our analysis showed that there was statistically signifcant association between TLC and mortality or morbidities; patients with higher TLC had a higher mortality rate than patients wilt lower TLC.

In agreement with our findings, **Barron and colleagues** [38] examined the relationship between the TLC and angiographic findings in 975 patients in the Thrombolysis In Myocardial Infarction (TIMI) 10A and 10B trials. The results showed that a higher TLC count was associated with poorer TIMI myocardial perfusion grades. Mortality rates were higher in patients with a higher WBC count.

Additionally, **Núñez and colleagues** [39] assessed the association between TLC and long-term mortality in 1118 AMI patients either with STEMI or non-STEMI. The authors reported that the TLC on admission was an independent predictor of mortality in both non-STEMI and STEMI patients.

Similarly, **Salehi and colleagues** [40] assessed the relation between TLC count on admission and mortality in STEMI patients treated with primary PCI. A total 205 patients with STEMI less than 24 hours before admission who admitted for primary angioplasty enrolled in the study. TLC count remained a significant predictor of morbidities and mortality after multivariable adjustment in one month and 12 months follow-up. Patients with higher TLC had significantly higher incidence of re-thrombosis and other other MACE.

In the present study, we also assessed the association between NLR and myocardial perfusion after primary PCI. We found that the NLR was significantly associated with MBG and TIMI grades, patients with MBG 0-1 had significantly higher NLR than patients with MBG 2-3. Moreover, the NLR correlated significantly with peak CK-MB and echocardiographic findings post-intervention.

In concordance with our findings, **Soylu and colleagues** [41] investigated the relationship between the NLR and coronary flow velocity after primary PCI in patients presenting with STEMI. Two hundred and ten patients who had undergone primary PCI were included. NLR was determined to be higher in patients with insuffiecient perfusion than in patients with sufficient perfusion. Also, NLR was found as an independent predictor of severe no-reflow development.

Huang and colleagues [42] explored the relationship between NLR and poor myocardial perfusion in patients with acute STEMI after primary PCI. A total of 143 patients who underwent primary PCI after STEMI were divided into good and poor perfusion groups The NLR and TLC were significantly higher in the poor perfusion group than the good perfusion group ($p < 0.05$). Multiple linear regression analysis showed that NLR was an independent risk factor of poor outcomes in STEMI patients after primary PCI.

While, **Toprak and colleagues** [43] investigated the relationship between NLR and no-reflow, along with the in-hospital and long-term outcomes in patients with STEMI. A total of 304 consecutive patients suffering from STEMI who underwent primary PCI were included. The results showed that the NLR was signifcantly higher in patients with MBG <2.).

In addition, our analysis showed that there was statistically signifcant association between NLR and mortality; patients with higher NLR had higher mortality rate than patients wilt lower NLR.

Conclusion

In conclusion, The present study shows that higher TLC and NLR at admission were significantly correlated with poor perfusion outcomes and mortality. Ther is strong positive correlation between TLC AND NLR with cardiovascular morbidity, negative correlation with LV ejection fraction post imtervension.

References

1. Chadwick Jayaraj J, Davatyan K, Subramanian SS, et al. (2019): Epidemiology of Myocardial Infarction. In Myocardial Infarction. Intech Open. https://doi.org/10.5772/intechopen.74768
2. Mechanic OJ & Grossman SA (2018): Acute Myocardial Infarction. Stat Pearls. Stat Pearls Publishing. Retrieved from http:// www. ncbi. nlm. nih. gov/ pubmed/29083808
3. White HD & Chew DP (2008): Acute myocardial infarction. Lancet, 372: 570-584.
4. Cabello JB, Burls A, Emparanza JI, Bayliss SE, Quinn T (2016): Oxygen therapy for acute myocardial infarction. Cochrane Database of Systematic Reviews. (12).
5. Tanındı A, Erkan AF, Ekici B, Alhan A, Töre HF (2014): Neutrophil to lymphocyte ratio is associated with more extensive, severe and

complex coronary artery disease and impaired myocardial perfusion Türk Kardiyol Dern Ars. 42: 125–130.
6. Brevetti G, Giugliano G, Brevetti L, Hiatt WR (2010): Infl ammation in peripheral artery disease. Circulation. 122: 1862–1875.
7. Tamhane UU, Aneja S, Montgomery D, Rogers EK, Eagle KA, Gurm HS (2008): Association between admission neutrophil to lymphocyte ratio and outcomes in patients with acute coronary syndrome. Am J Cardiol. 102: 653–657.
8. Bae MH, Lee JH, Yang DH, Park HS, Cho Y, Chae SC (2014): White blood cell, hemoglobin and platelet distribution width as short-term prognostic markers in patients with acute myocardial infarction. J. Korean Med. Sci., 29: 519-526.
9. Açar G, Fidan S, Uslu ZA, Turkday S, Avci A, Alizade E, et al. (2015): Relationship of neutrophil-lymphocyte ratio with the presence, severity, and extent of coronary atherosclerosis detected by coronary computed tomography angiography. Angiology. 66: 174–179.
10. Arbel Y, Finkelstein A, Halkin A, Birati EY, Revivo M, Zuzut M, et al. (2012): Neutrophil/lymphocyte ratio is related to the severity of coronary artery disease and clinical outcome in patients undergoing angiography. Atherosclerosis. 225: 456–460.
11. Choi YH, Hong YJ, Ahn Y, Park IH, Jeong MH (2014): Relationship between neutrophil-to-lymphocyte ratio and plaque components in patients with coronary artery disease: virtual histology intravascular ultrasound analysis. J Korean Med Sci. 29: 950–956.
12. He J, Li J, Wang Y, Hao P, Hua Q (2014): Neutrophil-to-lymphocyte ratio (NLR) predicts mortality and adverse-outcomes after ST-segment elevation myocardial infarction in Chinese people. Int J Clin Exp Pathol. 7: 4045–4056.
13. Wang X, Zhang G, Jiang X, Zhu H, Lu Z, Xu L (2014): Neutrophil to lymphocyte ratio in relation to risk of all-cause mortality and cardiovascular events among patients undergoing angiography or cardiac revascularization: a meta-analysis of observational studies. Atherosclerosis. 234: 206–213.
14. Thygesen K, Alpert JS, Jaffe AS, et al. (2012): Third universal definition of myocardial infarction. Circulation. 126:2020–35.
15. West R & Shiffman S (2016): Smoking cessation (3rd ed.). Abingdon: Health Press.
16. Chobanian AV, Bakris GL, Black HR, et al. (2003): Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension. 42(6):1206-52.
17. Piepoli MF, Hoes AW, Agewall S, Albus C, Brotons C, Catapano AL, Cooney MT, Corra U, Cosyns B, Deaton C, Graham I (2016): 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts) Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). European heart journal. 37(29):2315-81.
18. Kavey RE, Daniels SR, Lauer RM, Atkins DL, Hayman LL, Taubert K. American Heart Association (2003): American Heart Association guidelines for primary prevention of atherosclerotic cardiovascular disease beginning in childhood. Circulation. 107(11):1562-6.
19. Patrice F, Céline K, Jean-Philippe D, Dominique L, Marie-Cécile VP, Marc De Kock (2017): Published online 2017 Jan 3. doi: 10.1186/s13104-016-2335-
20. Walker HK, Hall WD, Hurst JW (1990): Editors. Boston: Butterworths.
21. Gibson CM, Cannon CP, Murphy SA, et al. (2002): Relationship of the TIMI myocardial perfusion grades, flow grades, frame count, and percutaneous coronary intervention to long-term outcomes after thrombolytic administration in acute myocardial infarction. Circulation. 105: 1909–1913.
22. Haager PK, Christott P, Heussen N, Lepper W, Hanrath P, Hoffmann R (2003): Prediction of clinical outcome after mechanical revascularisation in acute myocardial infarction by markers of myocardial reperfusion. J Am Coll Cardiol. 41:532–538.
23. Roberto ML, Badano LP, Mor-Avi V, et al. (2015): Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American society of echocardiography and the European association of cardiovascular imaging Euro Heart J Cardiovascular Imag, 16 (5): 233-271.
24. Ghimire G, Gupta A, Hage FG (2014): Guidelines in review: 2013 ACCF/AHA Guideline for the Management of ST-Elevation Myocardial Infarction. Journal of Nuclear Cardiology. https://doi.org/10.1007/s12350-013-9808-x
25. Ibanez B, James S, Agewall S, et al. (2018): 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. European Heart Journal. https:// doi. org/ 10. 1093/ eurheartj/ ehx393.
26. Jaffe R, Charron T, Puley G, et al. (2008): Microvascular obstruction and the no-reflow phenomenon after percutaneous coronary intervention. Circulation. https://doi.org/10.1161/CIRCULATIONAHA.107.742312
27. Frasure-Smith N, Lespérance F, Juneau M, et al. (1999): Gender, depression, and one-year prognosis after myocardial infarction. Psychosomatic

Medicine. https://doi.org/10.1097/00006842-199901000-00006

28. Jernberg T, Johanson P, Held C, et al. (2011): Association between adoption of evidence-based treatment and survival for patients with ST-elevation myocardial infarction. JAMA - Journal of the American Medical Association. https://doi.org/10.1001/jama.2011.522
29. Jahic E (2017): Experience and Outcomes of Primary Percutaneous Coronary Intervention for Patients with ST-Segment Elevation Myocardial Infarction of Tertiary Care Center in Bosnia and Herzegovina. Medical Archives, 71(3): 183.
30. Dubey G, Verma SK, Bahl VK (2017): Primary percutaneous coronary intervention for acute ST elevation myocardial infarction: Outcomes and determinants of outcomes: A tertiary care center study from North India. Indian Heart Journal, 69(3): 294–298.
31. Kolh P, Windecker S, Alfonso F, et al. (2014): 2014 ESC/EACTS Guidelines on myocardial revascularization. European Journal of Cardio-Thoracic Surgery. https://doi.org/10.1093/ejcts/ezu366
32. Rasoul S, Dambrink JHE, Breeman A, et al. (2010): The relation between myocardial blush grade and myocardial contrast echocardiography: which one is a better predictor of myocardial damage? Netherlands Heart Journal : Monthly Journal of the Netherlands Society of Cardiology and the Netherlands Heart Foundation, 18(1): 25–30.
33. Kaya MG, Arslan F, Abaci A, et al. (2007): Myocardial blush grade: A predictor for major adverse cardiac events after primary PTCA with stent implantation for acute myocardial infarction. Acta Cardiologica. https:// doi. org/ 10. 2143/ AC. 62. 5. 2023406
34. Celik T, Iyisoy A, Yuksel CU, et al. (2008): Impact of admission glomerular filtration rate on the development of poor myocardial perfusion after primary percutaneous intervention in patients with acute myocardial infarction. Coronary Artery Disease, 19(8): 543–549.
35. Cura FA, L'Allier PL, Kapadia SR, et al. (2001): Predictors and prognosis of suboptimal coronary blood flow after primary coronary angioplasty in patients with acute myocardial infarction. The American Journal of Cardiology, 88(2): 124–128.
36. Sattur S, Sarwar B, Sacchi TJ, et al. (2014): Correlation between markers of reperfusion and mortality in ST-elevation myocardial infarction: a systematic review. The Journal of Invasive Cardiology, 26(11): 587–595.
37. Brener SJ, Maehara A, Dizon JM, et al. (2013): Relationship between myocardial reperfusion, infarct size, and mortality: The INFUSE-AMI (Intracoronary abciximab and aspiration thrombectomy in patients with large anterior myocardial infarction) trial. JACC: Cardiovascular Interventions. https://doi.org/10.1016/j.jcin.2013.03.013
38. Barron HV, Cannon CP, Murphy SA, et al. (2000): Association between white blood cell count, epicardial blood flow, myocardial perfusion, and clinical outcomes in the setting of acute myocardial infarction: A thrombolysis in myocardial infarction 10 substudy. Circulation. https:// doi. org/ 10. 1161/ 01. CIR. 102.19.2329
39. Núñez J, Fácila L, Llàcer À, et al. (2005): Prognostic Value of White Blood Cell Count in Acute Myocardial Infarction: Long-Term Mortality. Revista Española de Cardiología (English Edition), 58(6): 631–639.
40. Salehi N, Eskandarian R, Sanati HR, et al. (2013): White blood cell count and mortality in acute myocardial infarction. World Journal of Cardiovascular Diseases, 03(07): 458–463.
41. Soylu K, Yuksel S, Gulel O, et al. (2013): The relationship of coronary flow to neutrophil/lymphocyte ratio in patients undergoing primary percutaneous coronary intervention. Journal of Thoracic Disease, 5(3):258–264.
42. Huang GY, Yang LJ, Wang XH, et al. (2016): Relationship between platelet-leukocyte aggregation and myocardial perfusion in patients with ST-segment elevation myocardial infarction after primary percutaneous coronary intervention. Heart & Lung, 45(5): 429–433.
43. Toprak C, Tabakci MM, Simsek Z, et al. (2015): Platelet/lymphocyte ratio was associated with impaired myocardial perfusion and both in-hospital and long-term adverse outcome in patients with ST-segment elevation acute myocardial infarction undergoing primary coronary intervention. Postepy w Kardiologii Interwencyjnej = Advances in Interventional Cardiology, 11(4): 288–297.

3/12/2019