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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

The prognostic value of admission mean platelet volume to platelet count ratio in patients with ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention

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Abstract

Background: Mean platelet volume to platelet count (MPV/Plt) ratio has been demonstrated to be a good indicator of long-term mortality in patients with non-ST-segment elevation myocardial infarction (NSTEMI). However, the prognostic value of MPV/Plt in ST-elevation myocardial infarction (STEMI) is not reported.

Aim: To determine whether the MPV/Plt ratio on admission has any predictive value for major adverse cardiac events including short- and long-term mortality in STEMI.

Methods: In this prospective study, 470 STEMI patients who underwent primary percutaneous coronary intervention (PCI) were enrolled. The patients were divided into three tertiles based on the MPV/Plt ratio on admission. The first tertile (n = 149) was defined as MPV/Plt ratio ≤ 0.029, second tertile (n = 154) 0.029–0.038, and third tertile (n = 159) ≥ 0.038. Primary clinical outcomes consisted of the sum of cardiovascular (CV) mortality, non-fatal re-infarction, and stroke. Secondary clinical outcomes were CV mortality, non-fatal re-infarction, target-vessel revascularisation, stroke, and advanced heart failure.

Results: There was no difference between study groups regarding the primary ($p > 0.05$) and the secondary outcomes ($p > 0.05$) except for one-year non-fatal re-infarction rate, which was found to be significantly higher in the highest MPV/Plt ratio group ($p = 0.045$). Age, Killip class > 1, and left ventricular ejection fraction were found to be independent predictors of long-term CV mortality in multivariate analysis ($p = 0.009$, $p = 0.035$, and $p < 0.001$, respectively).

Conclusions: While the MPV/Plt ratio was demonstrated to be associated with one-year non-fatal re-infarction, it was not related to in-hospital, one-month, and one-year CV mortality in patients with STEMI, who underwent primary PCI.

Key words: mean platelet volume to platelet count ratio, ST-segment elevation myocardial infarction, primary percutaneous coronary angioplasty, prognosis

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INTRODUCTION

ST-segment elevation myocardial infarction (STEMI) remains a leading cause of morbidity and mortality. Therefore, risk stratification is a very important issue to prevent and manage acute coronary syndrome (ACS) [1]. Thrombosis, platelet activation, and inflammation play important roles not only in the pathophysiology of acute ischaemic syndromes [2], but also in the process of atherogenesis, especially in the progression

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of the disease [3]. Mean platelet volume (MPV) is a potential marker of platelet activation and is associated with increased cardiovascular (CV) mortality in ACS patients with increased MPV [4]. Platelet count (Plt) is found to be associated with inflammation and platelet reactivity [5, 6]. It was observed in studies conducted with ACS patients that an association existed between Plt and adverse CV events [7–12]. MPV/Plt ratio is a new marker and it has been reported that increased MPV/Plt ratio was a better predictor of long-term CV mortality in non-STEMI (NSTEMI) patients than MPV and Plt alone in a recent study [13]. The relationship between MPV/Plt ratio and adverse CV events in patients with acute STEMI has not been researched so far. In this study, we investigated the relationship between MPV/Plt ratio and in-hospital and long-term CV events in STEMI patients undergoing primary percutaneous coronary intervention (PCI).

METHODS

Study population

In this prospective study, 530 consecutive patients, who were admitted to a large-volume tertiary training and research hospital with a diagnosis of STEMI and underwent primary PCI, were enrolled. The inclusion criteria of the study were as follows: electrocardiography (ECG) revealing STEMI, defined as > 30 min of continuous typical chest pain and ST-segment elevation ≥ 2 mm in two contiguous ECG leads within 12 h of symptom onset or up to 18 h if there was evidence of continuing ischaemia or haemodynamic instability. We excluded patients if they had no indication for PCI (n = 15), were not suitable for PCI (n = 15), or had missing or unavailable haemogram data at admission (n = 30). Therefore, the final study population consisted of 470 patients; patients were stratified into equal tertiles according to admission MPV/Plt ratio. The first tertile (n = 149) was defined as MPV/Plt ratio ≤ 0.029, second tertile (n = 154) 0.029–0.038, and third tertile (n = 159) ≥ 0.038. All primary PCI procedures were performed in a single high-volume tertiary care centre (> 3000 PCI/year) by expert operators performing more than 75 PCIs per year. Written informed consent was obtained from all the participants, and the study was approved by the Local Ethics Committee and institutional review board. The study complied with the Declaration of Helsinki.

Analysis of patient data

The demographic data, CV risk factors and comorbidities, and clinical and physical examination data on admission were recorded during a systematic review of patient files and hospital records. Reperfusion time and door-to-balloon time were also recorded.

Laboratory measurements

Blood samples were drawn from the antecubital vein after overnight fasting into standardised tubes containing dipotassium ethylenediaminetetraacetic acid (EDTA) to be stored at room temperature. An automatic blood counter (Beckman Coulter, Miami, FL) was used for whole blood counts. The levels of MPV and other haematological parameters were measured after 120 min from venipuncture. The expected values for MPV in our laboratory ranged from 6.8 to 10.8 fL. Other biochemical analyses were determined by standard methods.

Blood samples for glycated haemoglobin (HbA1c) were obtained in the first 24 h after admission, and HbA1c level was assayed using an automated, high-performance liquid chromatography analyser (Trinity Biotech Premier, USA).

A 12-lead ECG was recorded in each patient just after hospital admission, and the type of myocardial infarction (MI) was also determined based on the ECG criteria. At 24 h to 72 h after revascularisation a transthoracic echocardiographic study was performed using a Vivid S5 probe 3S-RS (GE Healthcare) with a 1.7/3.4 MHz phased-array transducer, and the left ventricular ejection fraction (LVEF) was calculated using the biplane Simpson method [14]. The glomerular filtration rate (GFR) was estimated by the simplified Modification of Diet in Renal Disease (MDRD) equation [15].

Coronary angiography, primary angioplasty and stenting procedure

All patients received a chewable 300 mg aspirin tablet and clopidogrel (600 mg loading dosage) before coronary angiography. Angiographic data of the patients were evaluated from catheter laboratory records. Emergency coronary angiography and angioplasty were performed by percutaneous femoral approach. A non-ionic, low-osmolality contrast medium was used in all patients. The artery that was presumed to be unobstructed was injected first. Blood flow in the infarct-related artery (IRA) was graded according to the Thrombolysis in Myocardial Infarction (TIMI) classification [16]. Heparin (100 IU/kg) was administered when the coronary anatomy was first defined. After visualising the left and right coronary arteries, 2.5 μg of nitrate was selectively injected into the IRA to rule out a possible coronary spasm. An angiographic evaluation was made by visual assessment. Primary angioplasty, including balloon angioplasty and/or stent implantation, was performed only for IRA according to the lesion type. For each procedure, interventional success at the acute phase was defined as reducing obstruction and stenosis to 30% of the IRA with TIMI 3 flow just after primary angioplasty. After angioplasty, all patients were admitted to the coronary care unit, where 100 mg of aspirin and 75 mg of clopidogrel were given. The use of glycoprotein IIb/IIIa inhibitors was left to the discretion of the operator.

Definitions

Reperfusion time was measured as the time from symptom onset until coronary reperfusion was obtained with balloon inflation. The door-to-balloon time was defined as the time

between hospital admission and balloon inflation. The patients were evaluated according to the Killip clinical examination classification [17]. Advanced heart failure was defined as New York Heart Association classification ≥ 3. Anaemia was diagnosed if the baseline haemoglobin concentration was < 13 mg/dL in males and < 12 mg/dL in females. Renal failure was defined as GFR < 60 mL/min/1.73 m^2, estimated by the MDRD equation [15]. Diabetes mellitus (DM) was defined as a history of DM or use of insulin or any other drug to control blood glucose. Cardiovascular mortality was defined as unexplained sudden death, death due to acute STEMI, heart failure, or arrhythmia. We defined the repeat target vessel revascularisation (TVR) as PCI or coronary bypass surgery performed because of restenosis or reocclusion of the IRA. Reinfarction was described according to the third universal definition of MI [18]. We estimated the occurrence of definite or probable stent thrombosis defined according to Academic Research Consortium criteria [19].

Follow-up

Follow-up data of the study patients were obtained from hospital records or by interviewing (in person or by telephone) the patients, their families, or their personal physicians. Study endpoints were blindly assessed. Primary clinical outcomes consisted of the sum of CV mortality, non-fatal reinfarction, and stroke. Secondary clinical outcomes were CV mortality, non-fatal reinfarction, TVR, stroke, and advanced heart failure

Statistical analysis

Descriptive analyses are presented mean ± standard deviation (SD), and categorical variables are expressed as percentages and counts. Groups were compared with one-way ANOVA and χ^2 tests. Multiple group comparisons were performed with Monte Carlo simulation if the χ^2 test did not provide the condition applied. When an overall significance was observed, pairwise post-hoc tests were performed using Tukey's test. The Spearman correlation coefficient was calculated for the comparison of two data sets. A backward stepwise multivariate Cox regression analysis that included variables with $p < 0.1$ was performed to identify independent predictors of one-month and one-year CV mortality. A backward stepwise multivariate logistic regression analysis that included variables with $p < 0.1$ was performed to identify independent predictors of reinfarction. Survival analysis was conducted using Kaplan-Meier survival curves, and differences were compared using the log-rank test. A p value < 0.05 was considered statistically significant. Analysis was performed using SPSS version 17.0.0 (SPSS Inc., Chicago, IL).

RESULTS

Baseline demographic and clinical characteristics of the study groups are presented in Table 1. The mean MPV/Plt ratio of the study population was 0.0577 (range: 0.0218–0.1955). The rate of male gender was significantly higher in the highest

Table 1. Baseline characteristics of the study patients

Variable	First MPV/Plt tertile (n = 149)	Second MPV/Plt tertile (n = 154)	Third MPV/Plt tertile (n = 159)	P
Age	53 ± 11	55 ± 13	58 ± 13	0.07
Male gender	111 (74.5%)	123 (79.9%)	137 (86.7%)	**0.026**
Smoking	108 (72.5%)	114 (75%)	115 (72.8%)	0.863
Diabetes mellitus	26 (28.3%)	32 (20.8%)	34 (21.4%)	0.614
Hypertension	48 (31.8%)	48 (31.2%)	64 (40.3%)	0.167
Hyperlipidaemia	30 (19.9%)	21 (13.6%)	27 (17.0%)	0.346
Bypass history	4 (2.6%)	1 (0.7%)	5 (3.1%)	0.280
PCI history	21 (13.9%)	21 (13.6%)	21 (13.2%)	0.984
MI history	23 (15.2%)	26 (16.9%)	26 (16.4%)	0.923
Stroke history	7 (4.6%)	3 (1.9%)	7 (4.4%)	0.380
Anterior MI	69 (46%)	72 (46.8%)	65 (40.9%)	0.523
Killip class > 1	14 (9.6%)	11 (7.3%)	12 (7.7%)	0.854
Systolic BP [mm Hg]	134 ± 33	133 ± 32	136 ± 33	0.950
Diastolic BP [mm Hg]	83 ± 17	80 ± 19	83 ± 21	0.425
Heart rate [bpm]	85 ± 18	79 ± 18	75 ± 19	0.193
Reperfusion time [min]	243 ± 115	256 ± 141	257 ± 149	0.614
Door-to-balloon time [min]	42 ± 14	42 ± 15	42 ± 16	0.969

Values are given as mean ± standard deviation or number and percentage (in brackets); MPV — mean platelet volume; Plt — platelet count; MI — myocardial infarction; PCI — percutaneous coronary intervention; BP — blood pressure

Table 2. Laboratory findings of the study patients

Variable	First MPV/Plt tertile (n = 149)	Second MPV/Plt tertile (n = 154)	Third MPV/Plt tertile (n = 159)	P
Baseline creatinine [mg/dL]	0.96 ± 0.57	0.93 ± 0.35	0.97 ± 0.39	0.910
GFR [mL/min/1.73 m²]	110 ± 30	114 ± 37	96 ± 35	0.073
Peak CK-MB [IU/L]	146.6 ± 111.6	134.4 ± 146.5	131.7 ± 140.5	0.380
Peak troponin T [ng/mL]	12.8 ± 8.6	12.3 ± 12.2	12.1 ± 11.9	0.953
Total cholesterol [mg/dL]	205.4 ± 43.9	208.7 ± 42.9	186.6 ± 55.9	**0.025**
LDL-C [mg/dL]	137.3 ± 34	138.1 ± 34.8	123.6 ± 40.7	**0.019**
HDL-C [mg/dL]	37.2 ± 9.3	42.8 ± 11.1	42.1 ± 9.6	0.330
Triglycerides [mg/dL]	135.6 ± 80.5	129.7 ± 86.9	127.1 ± 162.5	0.176
Glucose at admission [mg/dL]	152.6 ± 41.6	174.8 ± 50.7	176.4 ± 16.6	0.260
WBC [10³/L]	16.2 ± 3.9	12.5 ± 8.5	11.0 ± 3.8	**< 0.001**
Neutrophil count [10³/L]	9.9 ± 4.2	9.8 ± 3.7	8.5 ± 4.2	0.050
Haematocrit [g/dL]	39.9 ± 5.3	38.6 ± 5.5	43.6 ± 6.7	0.111
Platelet [10³/L]	395.5 ± 66.1	257.7 ± 71.8	105.8 ± 74.6	**< 0.001**
LVEF [%]	46.9 ± 8.5	48.7 ± 8.5	45.0 ± 8.9	0.739

Values are given as mean ± standard deviation; MPV — mean platelet volume; Plt — platelet count; GFR — glomerular filtration rate; CK-MB — creatinine kinase MB, LDL-C — low-density lipoprotein cholesterol; HDL-C — high-density lipoprotein cholesterol; WBC — white blood cell; LVEF — left ventricular ejection fraction

MPV/Plt group compared to other groups ($p = 0.026$). The other baseline demographic and clinical characteristics were similar in all study groups. Baseline laboratory characteristics of the study groups are presented in Table 2. Total-cholesterol level, low-density lipoprotein cholesterol, white blood cell (WBC) count, and platelet count were found to be significantly lower in the highest MPV/Plt group compared to other groups ($p = 0.025$, $p = 0.019$, $p < 0.001$, $p < 0.001$, respectively). The remaining baseline laboratory characteristics were not different between all study groups.

Angiographic and procedural characteristics of the study groups are depicted in Table 3. Culprit lesions were similar in three groups ($p = 0.165$). Moreover, the rate of unsuccessful procedures was not different between the three groups ($p = 0.450$). Other angiographic and procedural characteristics were also similar in all study groups. At the time of discharge from the hospital, the duration of dual antiplatelet therapy after PCI, and use of other cardiac medications, were similar between the study groups (Table 3).

When the correlation between MPV level and Plt was analysed, a significant inverse relation was found ($r = –0.177$, $p = 0.001$).

The in-hospital outcomes of all study groups after primary PCI are reported in Table 4. There was no difference between all groups in terms of in-hospital primary and secondary outcomes, rate of cardiopulmonary resuscitation, inotropic drug usage, no-reflow phenomenon, and cardiogenic shock (all p values > 0.05) except for the rate of acute atrial fibrillation, which was found to be significantly higher in the highest MPV/Plt tertile ($p = 0.035$).

One-month and one-year outcomes are presented in Table 5. There was no difference between the study groups regarding the primary outcome ($p > 0.05$) and the secondary outcomes ($p > 0.05$) except one-year non-fatal re-infarction rate, which was found to be significantly higher in the highest MPV/Plt ratio group ($p = 0.045$).

The independent predictors of CV mortality, such as age, male gender, body mass index, DM, hypertension, history of MI, Killip class, GFR, peak troponin T, LVEF, HbA1c, MPV, Plt, MPV/Plt, and MPV×Plt, were included in a Cox regression model and analysed in a stepwise fashion. Age, Killip class > 1, and LVEF were found to be independent predictors of both one-month and one-year CV mortality in multivariate analyses. Peak troponin T level was only found as a significant independent predictor of one-month CV mortality (Tables 6, 7). The Kaplan-Meier survival plot for one-year CV mortality in all tertiles is presented in Figure 1. However, the admission level of MPV/Plt ratio was not associated with one-month and one-year CV mortality in STEMI patients undergoing primary PCI (Tables 6, 7).

The independent predictors of one-year non-fatal MI, such as age, male gender, body mass index, DM, hypertension, history of MI, Killip class, GFR, peak troponin T, LVEF, HbA1c, MPV, Plt, MPV/Plt, and MPV×Plt were included in a logistic regression model and analysed in a stepwise fashion. History of MI, HbA1c, and peak troponin level were found

Table 3. Angiographic and procedural characteristics of the study patients

Variable	First MPV/Plt tertile (n = 149)	Second MPV/Plt tertile (n = 149)	Third MPV/Plt tertile (n = 159)	P
Culprit lesion:				0.165
LAD	70 (47%)	74 (48.6%)	64 (40.4%)	
LCX	17 (11.4%)	15 (9.9%)	22 (14%)	
RCA	59 (39.6%)	63 (41.6%)	71 (45.2%)	
Others	3 ± 2	0 ± 0	0 ± 0	
Number vessel:				0.118
One-vessel disease	75 (50.9%)	70 (45.7%)	57 (36.8%)	
Two-vessel disease	39 (26.4%)	47 (30.7%)	60 (38.3%)	
Three-vessel disease	35 (23.6%)	35 (23.7%)	40 (25.9%)	
Unsuccessful procedure	9 (6%)	13 (8.2%)	8 (5%)	0.450
Stent length [mm]	20.3 ± 8.4	23.7 ± 10	25.8 ± 10.9	0.237
Stent diameter [mm]	3.54 ± 2.87	3.52 ± 0.4	3.17 ± 1.93	0.411
Invasive procedure type:				0.254
PCBA	20 (13.5%)	9 (5.9%)	18 (11.6%)	
Stent	35 (23.7%)	35 (23.1%)	36 (22.8%)	
PCBA + stent	93 (62.4%)	108 (70.2%)	103 (65.6%)	
DES use	2 (1.3%)	5 (3.2%)	4 (2.5%)	0.538
Aspirin	119 (81.5%)	120 (83.1%)	121 (78.6%)	0.570
Clopidogrel	137 (94.1%)	142 (99.1%)	148 (96.4%)	0.070
Beta-blocker	127 (87.5%)	129 (89.8%)	134 (87.7%)	0.776
ACEI/ARB	117 (80.7%)	119 (82.1%)	120 (78.1%)	0.594
Statin	127 (87.6%)	131 (91.6%)	137 (89.7%)	0.531
Insulin	6 (4.1%)	9 (6.5%)	4 (2.5%)	0.251

Values are given as mean ± standard deviation or number and percentage (in brackets); MPV — mean platelet volume; Plt — platelet count; LAD — left anterior descending artery; LCX — left circumflex artery; RCA — right coronary artery; PCBA — primary coronary balloon angioplasty; DES — drug eluting stent; ACEI/ARB — angiotensin-converting enzyme inhibitors/angiotensin receptor blocker

to be independent predictors of one-year non-fatal MI in multivariate analysis (Table 8).

DISCUSSION

In this study, the rate of one-year non-fatal re-infarction was demonstrated to be higher in the highest MPV/Plt ratio. The primary and the secondary outcomes other than one-year non-fatal re-infarction did not yield significant differences across groups although the rates were higher in the high MPV/Plt group. Age, killip class > 1, and LVEF were determined to be independent predictors of one-month and one-year CV mortality in multivariate logistic regression analysis, while no such association was observed with MPV/Plt ratio. Moreover, history of MI, HbA1c, and peak troponin level were reported to be independent predictors of one-year non-fatal MI in patients with STEMI undergoing primary PCI.

Acute coronary syndrome is characterised by a ruptured, vulnerable plaque and subsequent intraluminal thrombus formation, blocking the blood flow and causing MI. Platelets play an important role in the pathogenesis of ACS. There are contradictory publications in the medical literature about the relationship between the Plt on admission and mortality and CV events in patients with ACS. Mueller et al. [9] reported a non-linear relationship between Plt and long-term mortality in patients with NSTEMI, and long-term mortality was detected to be higher in the study among patients with low and also with high platelet counts. Conversely, two other studies carried out in STEMI patients receiveing thrombolytic therapy did not show a clear relationship between Plt and CV outcomes [11, 12].

Inflammation, coronary thrombus load, and platelet activation and aggregation play an important role both in the pathogenesis of acute MI and in the development of adverse CV events. While increased MPV value reflects platelet activation, reduced MPV is claimed to have a possible association with high-grade inflammation [4, 20]. Increased Plt is associated with increased inflammation and serum levels of soluble CD40 ligands, while reduced Plt is associated with increased platelet activation, increased platelet load, and higher gly-

Table 4. The in-hospital outcomes of all study patients

Variable	First MPV/Plt tertile (n = 149)	Second MPV/Plt tertile (n = 154)	Third MPV/Plt tertile (n = 159)	P
Primary outcomes	7 (4.7%)	5 (3.2%)	11 (6.9%)	0.322
Secondary outcomes:				
Cardiovascular mortality	5 (4.1%)	3 (2.8%)	6 (4.7%)	0.858
Non-fatal reinfarction	10 (6.7%)	10 (6.5%)	8 (5%)	0.796
TVR	11 (6.7%)	10 (6.5%)	8 (5%)	0.743
Stroke	2 (1.3%)	0 (0%)	0 (0%)	0.121
Advanced heart failure	15 (10.1%)	12 (7.8%)	18 (11.3%)	0.567
Cardiopulmonary resuscitation	9 (6.1%)	6 (3.9%)	13 (8.2%)	0.278
Ventricular tachycardia	7 (4.7%)	6 (3.9%)	7 (4.4%)	0.941
Ventricular fibrillation	7 (4.7%)	6 (3.9%)	7 (4.4%)	0.466
Use of inotropes	10 (6.7%)	10 (6.5%)	17 (10.7%)	0.305
Cardiogenic shock	8 (5.4%)	6 (3.9%)	12 (7.5%)	0.369
IABP usage	7 (4.6%)	4 (2.7%)	6 (3.8%)	0.622
Atrial fibrillation	2 (1.3%)	2 (1.3%)	7 (4.4%)	**0.035**
Acute thrombosis	11 (7.4%)	9 (5.8%)	7 (4.4%)	0.286
Subacute thrombosis	0 (0%)	1 (0.6%)	0 (0%)	0.368
Blood transfusion	0 (0%)	0 (0%)	2 (1.6%)	0.147
No-reflow	32 (21.6%)	36 (23.8%)	21 (20%)	0.717
Use of tirofiban	56 (37.6%)	53 (34.4%)	46 (28.9%)	0.264

Values are given as number and percentage (in bracket). Primary outcomes: cardiovascular mortality, non-fatal reinfarction, stroke. MPV — mean platelet volume; Plt — platelet count; TVR — target-vessel revascularisation; IABB — intra-aortic balloon pump

Table 5. The one-month and one-year outcomes of all study patients

Variable	First MPV/Plt tertile (n = 149)	Second MPV/Plt tertile (n = 154)	Third MPV/Plt tertile (n = 159)	P
Primary outcomes	9 (6%)	9 (5.8%)	15 (9.4%)	0.382
Secondary outcomes:				
One-month cardiovascular mortality	9 (6%)	9 (5.8%)	15 (9.4%)	0.382
One-month non-fatal reinfarction	5 (3.4%)	9 (5.8%)	10 (6.3%)	0.463
One-month TVR	10 (6.7%)	13 (8.4%)	11 (6.9%)	0.818
One-month stroke	1 (0.7%)	1 (0.6%)	0 (0%)	0,590
One-month advanced heart failure	30 (20.4%)	36 (23.1%)	34 (21.4%)	0.538
Primary outcomes	15 (10.1%)	8 (5.9%)	19 (11.9%)	0.102
Secondary outcomes:				
One-year cardiovascular mortality	13 (8.7%)	8 (5.9%)	19 (11.9%)	0.105
One-year non-fatal reinfarction	8 (5.4%)	10 (6.5%)	20 (12.6%)	**0.045**
One-year TVR	18 (12.1%)	16 (10.4%)	22 (13.8%)	0.646
One-year stroke	3 (2%)	2 (1.3%)	4 (2.5%)	0.737
One-year advanced heart failure	30 (20.3%)	22 (14.4%)	34 (21.4%)	0.238

Values are given as number and percentage (in bracket). Primary outcomes: cardiovascular mortality, non-fatal reinfarction, stroke; MPV — mean platelet volume; Plt — platelet count; TVR — target-vessel revascularisation

coprotein VI surface expression and plasma concentration, which reflects increased activation and enhanced recruitment of platelets to a vascular damage site and increased inflammation [5–7, 21–25]. MPV/Plt ratio is a newly discovered marker

Table 6. Effects of multiple variables on the one-month cardiovascular mortality in univariate and multivariate Cox regression analyses

Variable	Univariate OR	95% CI	P	Multivariate OR	95% CI	P
Age	1.133	1.090–1.177	< 0.001	1.094	1.018–1.175	0.02
Male gender	3.889	1.651–9.157	0.002	1.520	0.380–6.080	0.55
Body mass index	0.915	0.789–1.062	0.243			
Diabetes mellitus	3.356	1.414–7.964	0.006	2.724	0.751–9.881	0.12
Hypertension	2.561	1.079–6.078	0.033	0.973	0.289–3.272	0.96
MI history	1.675	0.614–4.571	0.314			
Killip class > 1	10.309	4.368–24.902	< 0.001	0.222	0.051–0.970	0.03
GFR [mL/min/1.73 m^2]	0.965	0.951–0.979	< 0.001	0.995	0.974–1.017	0.66
Peak troponin T [ng/mL]	1.044	1.012–1.078	0.006	0.945	0.895–0.999	0.044
LVEF	0.852	0.814–0.892	< 0.001	0.89	0.816–0.971	0.003
HbA1c	1.095	0.849–1.414	0.484			
MPV/Plt	1.217	0.687–3.873	0.001	1.015	0.986–1.032	0.154
MPV	1.647	1.187–2.270	0.003	1.204	0.807–1.796	0.363
Plt	1.000	0.994–1.005	0.878			

OR — odds ratio; CI — confidence interval; MI — myocardial infarction; GFR — glomerular filtration rate; LVEF — left ventricular ejection fraction; HbA1c — glycated haemoglobin; MPV — mean platelet volume; Plt — platelet count

Table 7. Effects of multiple variables on the one-year cardiovascular mortality in univariate and multivariate Cox regression analyses

Variable	Univariate OR	95% CI	P	Multivariate OR	95% CI	P
Age	1.112	1.078–1.142	< 0.001	1.089	1.051–1.128	0.001
Male gender	2.557	1.171–5.584	0.019			
Body mass index	0.865	0.755–0.991	0.037			
Diabetes mellitus	3.121	1.448–6.725	0.004			
Hypertension	2.082	0.979–4.430	0.057			
MI history	1.675	0.614–4.571	0.314			
Killip class > 1	10.364	4.739–22.670	< 0.001	0.327	0.113–0.948	0.040
GFR [mL/min/1.73 m^2]	0.966	0.953–0.979	< 0.001			
Peak troponin [ng/mL]	1.047	1.020–1.075	0.001			
LVEF	0.836	0.822–0.891	< 0.001	0.838	0.787–0.892	< 0.001
HbA1c	1.132	0.913–1.402	0.258			
MPV/Plt	1.033	1.012–1.052	0.001	1.013	0.987–1.040	0.324
MPV	1.597	1.183–2.155	0.002	1.074	0.697–1.656	0.745
Plt	1.000	0.995–1.004	0.903			
MPV×Plt	1.000	1.000–1.001	0.616			

Abbreviation as in Table 6

used as a prognostic indicator of ACS. Because MPV/Plt ratio may reflect the factors involved in the pathogenesis of ACS more accurately than MPV and Plt separately, this ratio may be superior in predicting CV events and mortality in patients with ACS. In a study by Azab et al. [13] in NSTEMI patients, admission MPV/Plt ratio was found to be associated with four-year all-cause mortality, but no association was observed between MPV and Plt. In that study, patients in the first and third tertile had higher four-year all-cause mortality rates than those in the second tertile. The authors claimed that the increased MPV/Plt ratio is an indicator of increased platelet activation and aggregation; reduced MPV/Plt ratio is an indicator of increased inflammation, underlying the association between change in MPV/Plt ratio and all-cause mortality. In our study, on the other hand, the short- and long-term rates of CV mortality were similar across the MPV/Plt ratio groups. Prior studies reported

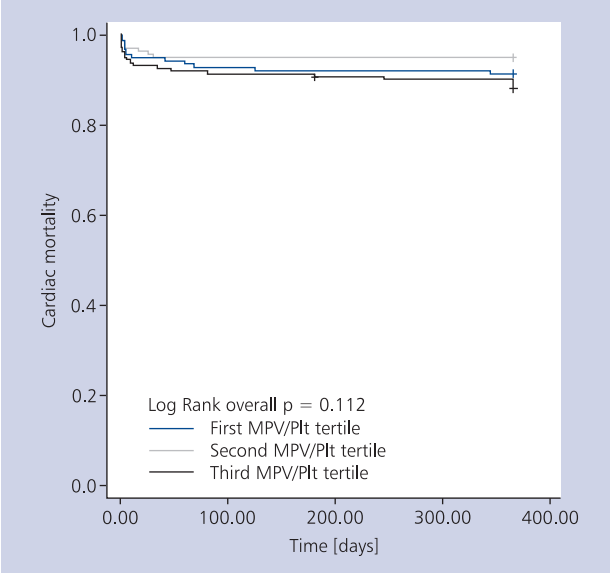

Figure 1. The Kaplan-Meier survival plot for one-year cardiovascular mortality in all tertiles; MPV — mean platelet volume; Plt — platelet count

a J-shaped association between Plt and mortality in NSTEMI patients, while no such relationship was detected in STEMI patients undergoing thrombolytic therapy [9, 11, 12]. These different results were claimed to be because of different pathophysiological mechanisms underlying STEMI and NSTEMI. This can also explain why we failed to demonstrate an association between short- and long-term CV mortality and MPV/Plt ratio among STEMI patients undergoing primary PCI, as opposed to the findings of Azab et al. [13]. Moreover, similar to the Azab et al. [13] study, WBC count was found to be higher in the lowest MPV/Plt group compared to the other groups. This finding was in accordance with prior publications reporting an association of inflammation with low MPV and high Plt [20].

In our study, the rate of one-year non-fatal re-infarction was reported to be higher in the highest MPV/Plt ratio group compared to middle and lowest groups. Since an increased MPV/Plt ratio reflects increased platelet activity and increased thrombus load, this finding can explain the raised post-STEMI re-infarction rate among these patients. Furthermore, our study patients received the optimal standard medical treatment including anticoagulant and antiaggregant medications, and MPV/Plt ratios were recorded on admission before cardiac catheterisation, which might affect the outcomes to a minor extent.

Limitations of the study

This study was a single-centre study. It was non-randomised and therefore subject to selection bias. We did not evaluate the high-sensitivity C-reactive protein, other pro-inflammatory cytokines, or other markers indicative of platelet count. Also, since MPV/Plt ratio was measured only once on admission, we could not evaluate the changes in MPV/Plt ratio in response to aggressive treatment, due to lack of serial measurements. The lack of a control group of patients with e.g. stable coronary artery disease was the last limitation of the present study.

Table 8. Effects of multiple variables on the one-year non-fatal myocardial infarction in univariate and multivariate logistic regression analyses

Variable	Univariate OR	95% CI	P	Multivariate OR	95% CI	P
Age	1.003	0.977–1.030	0.812			
Male gender	0.606	0.230–1.599	0.312			
Body mass index	0.925	0.594–1.440	0.731			
Diabetes mellitus	1.912	0.896–4.080	0.094			
Hypertension	0.833	0.403–1.724	0.623			
MI history	3.946	1.949–7.989	**0.001**	5.585	2.415–12.915	**< 0.001**
Killip class > 1	6.890	0.845–56.21	0.072			
GFR [ml/min/1.73 m^2]	0.996	0.985–1.008	0.532			
Peak troponin [ng/mL]	1.034	1.003–1.066	**0.001**	1.047	1.018–1.077	**0.002**
LVEF	0.971	0.937–1.036	0.103			
HbA1c	1.344	1.094–1.652	**0.005**	1.283	1.32–1596	**0.025**
MPV/Plt	1.009	0.986–1.032	0.446			
MPV	1.326	0.907–1.806	0.073			
Plt	1.000	0.995–1.005	0.953			
MPV×Plt	1.000	1.000–1.001	0.680			

Abbreviation as in Table 6

CONCLUSIONS

While high MPV/Plt ratio was found to be associated with one-year non-fatal re-infarction rate in patients with STEMI undergoing PCI, it was not related with short- and long-term CV mortality. Moreover, even after adjusting for various risk factors, age, LVEF, and Killip class were found to be independent predictors of long-term CV mortality in STEMI patients. Further investigations are required to clarify whether calculation of MPV/Plt ratio could be used as a marker for predicting major adverse CV events, including CV mortality in this setting.

Conflict of interest: *none declared*

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Wartość prognostyczna stosunku średniej objętości do liczby płytek krwi przy przyjęciu do szpitala u pacjentów z zawałem serca z uniesieniem odcinka ST poddanych pierwotnej przezskórnej angioplastyce wieńcowej

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Streszczenie

Wstęp: Wykazano, że stosunek średniej objętości do liczby płytek krwi (MPV/Plt) jest dobrym wskaźnikiem śmiertelności w obserwacji długookresowej u pacjentów z zawałem serca bez uniesienia odcinka ST. Jednak brakuje doniesień na temat wartości prognostycznej współczynnika MPV/Plt u chorych z zawałem serca z uniesieniem odcinka ST (STEMI).

Cel: Celem badania było ustalenie, czy współczynnik MPV/Plt przy przyjęciu do szpitala ma wartość prognostyczną w odniesieniu do poważnych zdarzeń sercowych, w tym śmiertelności wczesnej i odległej u pacjentów z STEMI.

Metody: Do tego prospektywnego badania włączono 470 chorych z STEMI, których poddano pierwotnej przezskórnej angioplastyce wieńcowej (PCI). Chorych podzielono na tercyle w zależności od wartości współczynnika MPV/Plt przy przyjęciu do szpitala. Pierwszy tercyl (n = 149) definiowano jako współczynnik MPV/Plt o wartości ≤ 0,029, drugi tercyl (n = 154) — 0,029–0,038, a trzeci tercyl (n = 159) — ≥ 0,038. Główny kliniczny punkt końcowy obejmował zgony sercowo-naczyniowe (CV) oraz zawał serca i udar mózgu niezakończone zgonem. Do drugorzędowych klinicznych punktów końcowych należały: zgon CV, ponowny zawał serca niezakończony zgonem, rewaskularyzacja docelowego naczynia, udar mózgu i zaawansowana niewydolność serca.

Wyniki: Nie stwierdzono różnic między grupami pod względem punktów końcowych, głównego ($p > 0,05$) i drugorzędowych ($p > 0,05$), oprócz częstości ponownych zawałów serca niezakończonych zgonem w ciągu roku, która była istotnie wyższa w grupie z najwyższym współczynnikiem MPV/Plt ($p = 0,045$). W analizie wieloczynnikowej wykazano, że wiek, klasa Killipa > 1 i frakcja wyrzutowa lewej komory były niezależnymi czynnikami prognostycznymi śmiertelności CV w obserwacji długookresowej (odpowiednio $p = 0,009$; $p = 0,035$ i $p < 0,001$).

Wnioski: Współczynnik MPV/Plt wiązał się z roczną częstością ponownych niezakończonych zgonem zawałów serca, jednak nie był związany z wewnątrzszpitalną, miesięczną ani roczną śmiertelnością u chorych z STEMI poddanych pierwotnej PCI.

Słowa kluczowe: stosunek średniej objętości do liczby płytek, zawał serca z uniesieniem odcinka ST, pierwotna przezskórna angioplastyka wieńcowa, rokowanie

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