Journal of Advances in Medicine and Medical Research

34(22): 437-449, 2022; Article no.JAMMR.92513
ISSN: 2456-8899
(Past name: British Journal of Medicine and Medical Research, Past ISSN: 2231-0614, NLM ID: 101570965)

Incidence and Predictors of No Reflow Phenomenon in Patient Undergoing Primary Percutaneous Coronary Intervention

Eman Abd El Hady El Setiha [a*], Ehab Abdellatif El Guindy [a], Raghda Ghonimy El Sheikh [a], Ayman Mohamed Elsaid [a] and Medhat Mohamed Ashmawy [a]

[a] Cardiovascular Medicine Department, Faculty of Medicine, Tanta University, Tanta, Egypt.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMMR/2022/v34i224831

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/92513

Original Research Article

Received 06 August 2022
Accepted 13 October 2022
Published 18 October 2022

ABSTRACT

Objective: To evaluate the incidence, clinical and angiographic predictors of no reflow phenomenon in patient undergoing primary percutaneous coronary intervention (PCI).
Methods: This prospective observational cross-sectional study was carried out on 748 patients who underwent primary coronary angioplasty after acute ST- Segment Elevation Myocardial Infarction (STEMI). Patients were subdivided in to two groups: Group I: (case group) patients with no-reflow phenomenon (NRP) in the absence of dissection, thrombus, spasm or high-grade residual stenosis and group II: (Control group) one consecutive STEMI patient after each case, with TIMI flow III after primary PCI. All patients were subjected to clinical and laboratory examination, electrocardiogram (ECG), echocardiography (ECHO) and PCI.
Results: 22.9% of patients had no-reflow; 10 % had persistent no reflow and 12.9% had transient no reflow. Multivariate analyses identified that age (OR=1.417, 95% CI 1.319–1.521), diabetes mellitus (DM) (OR=10.110, 95% CI 3.950–25.880), hypertension (HTN) (OR=0.326, 95% CI 0.142–0.752), total ischemia time ≥6 hours (OR=60.511, 95% CI 24.973–146.618), SBP<90 mmHg (OR=0.238, 95% CI 0.091–0.621) , lesion length ≥20 mm(OR=16.182, 95% CI 5.008–52.287) , high thrombus burden (thrombus grade ≥4) (OR=2.914, 95% CI 1.018–8.338), balloon pre dilatation

**Corresponding author: E-mail: eman.elsetiha@med.tanta.edu.eg;*

(OR=0.272, 95% CI 0.093–0.791), stent length ≥20 mm(OR=7.709, 95%CI 33.346–17.758), balloon post dilatation (OR=5.885, 95% CI 2.571–13.474), CRP (OR=1.016, 95% CI 1.002–1.030) were the independent predictors of the no-flow phenomenon.
Conclusions: Clinical and laboratory predictors on admission were associated with higher percentage of no-reflow phenomenon. while angiographic predictors could independently predicts no-reflow after Primary PCI.

Keywords: Predictors; no reflow phenomenon; percutaneous coronary intervention.

1. INTRODUCTION

Timely reperfusion of the infarct-related coronary artery using percutaneous coronary intervention (PCI) is the optimum ST segment elevation myocardial infarction (STEMI) treatment. Yet, despite opening the affected epicardial coronary artery, myocardial perfusion often might not be restored causing no-reflow [1,2].

No-reflow phenomenon (NRP) is a myocardial hypoperfusion state due to microvascular obstruction in spite of patent epicardial coronary vessels [3].

Patients with impaired flow or no reflow after revascularization will usually suffer from obvious bad outcome like higher incidence of death due to cardiac causes, heart failure symptoms as well as pericardial effusion [4].

Several clinical factors have been found to impact the functional and clinical prognosis of MI cases [5,6]. Although these factors may have an impact on the development of microvascular dysfunction, their link to the NRP remains unclear [7,8].

No reflow diagnosis can be suspected initially by patient symptoms and electrocardiography ischemic changes or persistent ST segment elevation in spite of patent coronary culprit vessel [9,10]. Diagnosis of no reflow can be confirmed by different angiographic scores. The thrombolysis in myocardial infarction flow scoring system (TIMI flow score) provides easy tool to evaluate degree of coronary perfusion [11]. Also, TIMI frame score can be used for coronary reperfusion and diagnosis of no reflow [12,13].

This work aimed to evaluate the incidence, clinical and angiographic predictors of no reflow phenomenon in patient undergoing primary PCI.

2. MATERIALS AND METHODS

a) Study design: This prospective observational cross-sectional trial was carried out at cardiovascular medicine department Tanta university hospitals, Egypt. This trial was conducted in a period of two years starting from October 2019.

b) Study populations: 748 cases who were subjected to primary coronary angioplasty after acute ST- Segment Elevation Myocardial Infarction (STEMI) according to STEMI guidelines indications to primary PCI [14] cases were classified into 2 groups: **Group I: (case group)** patients with NRP in the absence of dissection, thrombus, spasm or high-grade residual stenosis and **Group II: (Control group)** one consecutive STEMI patient following every case, with TIMI flow III following primary PCI. Group I were divided in to 2 sub-groups according to treatment response and TIMI flow post primary PCI: **Sub Group A: (persistent No-reflow group)** patients failed to respond to treatment of No-reflow with TIMI flow 0-I post primary PCI in the absence of dissection, thrombus, spasm or high-grade residual stenosis and **sub group B: (Transient No-reflow group)** patients responded to treatment of no reflow with TIMI flow ≥ II post primary PCI in the absence of dissection, thrombus, spasm or high-grade residual stenosis.

c) Methods: All cases were subjected to: history taking, clinical examination, twelve leads surface electrocardiogram (ECG), venous sampling for routine laboratory investigations at hospital admission before primary PCI and Echocardiography by M-mode and modified Simpson method using a GE vivid seven Cardiac ultrasound phased array system with tissue Doppler imaging using M4S transducer 4 M.Hz. were done during admission before PCI to assess LV systolic function, volume and assess Segmental wall motion abnormalities and global wall motion [15].

Primary PCI for infarct related artery (IRA) within 24 hours of presentation, Grade of blood flow after procedure was determined by TIMI blood flow grade classification system [16]. IRA was

identified according to the culprit lesion on the basis of the infarct location on the admission ECG and the angiographic findings (target vessel, lesion characteristics). Multivessel disease was defined as presence of ≥ 1 lesion with >50% stenosis in ≥ 1 major epicardial coronary artery or its major branches remote from the IRA [17].

Thrombus grading score was utilized to assess clot burden, [18] PCI was immediately performed with a 6-Fr guiding catheter. Thrombus aspiration, balloon pre-dilatation and post-dilatation were performed when indicated. The type of stents (drug-eluting stent or bare metal stent) was left to the surgeon's discretion. Reperfusion success is measured by TIMI blood flow grade: Reperfusion was deemed successful (TIMI 3) or abnormal (TIMI 0-1-2).

Patients with No-reflow received intracoronary medications in the form of nitrates, glycoprotein IIb/IIIa inhibitor, calcium channels blocker, adrenaline.

Statistical analysis:

Using IBM SPSS v 20.0, the data were analysed (Armonk, NY: IBM Corp). Quantitative and percentage descriptions were provided for qualitative data. The mean and standard deviation were used to characterize the quantitative data. Chi-square or Fisher's Exact or Monte Carlo correction was used to compare categorical variables between groups, F-test (ANOVA) for normally distributed quantitative variables, to compare between more than two groups, and Post Hoc test (Tukey) for pairwise comparisons and Kruskal Wallis test for abnormally distributed quantitative variables, to compare between more than two studied groups, and Post Hoc (Dunn's multiple comparisons test) for pairwise comparisons. Using univariate and multivariate analysis, independent predictors of the no-reflow phenomena were identified. P value ≤ 0.05 was considered statistically significant.

3. RESULTS

In our study, 22.9 % of cases developed no-reflow. Patients with persistent no reflow was 10 % and patients with transient no reflow was 12.9% Table 1.

Persistent no reflow and transient no reflow had no significant difference between them regarding age, gender distribution, DM, HTN, smoking, SBP, killip class, STEMI localization, ischemic time, lesion length, number of diseased vessels, lesion localization, IRA, balloon pre dilatation and balloon post dilatation, while persistent no reflow and transient no reflow groups had significantly older cases (>60 years old), higher percentages of males and females, higher percentages of diabetic, hypertensive patients, lower percentages of smokers compared to control group, lower SBP (<90 mmHg), longer Total Ischaemia Time (>6 hrs), longer Lesion length (≥ 20), more MVD and higher percentage of balloon predilatation and postdilatation compared to control group (P ≤ 0.05). Dyslipidemia, family history of previous coronary artery diseases and HR had no significant variation between the studied groups. killip class was significantly different in Persistent no reflow and transient no reflow groups in which class ≥ III was the predominant classification compared to control group. Location of infarction was significantly different in Persistent no reflow and transient no reflow groups in which the most common infarction was the anterior one followed by the inferior compared to control group. Lesion localization was significantly different in Persistent no reflow and transient no reflow groups as they had more proximal lesions compared to control group. IRA was significantly different in persistent no reflow and transient no reflow groups in which the most common IRA was LAD followed by RCA compared to control group (LAD followed by LCX). Persistent no reflow group had significantly lower pre-procedural TIMI flow score (≤1) than transient no reflow group. Persistent no reflow group had significantly lower pre-procedural TIMI flow score (≤1) than control group. Transient no reflow group had significantly higher pre-procedural TIMI flow score (>1) than control group. Persistent no reflow group had significantly higher Thrombus grade (≥4) compared to Transient no reflow and control groups. No significant difference was found between transient no flow and control groups. Persistent no reflow group had significantly longer (>20) Stent compared to Transient no reflow and control groups. Transient no reflow group had significantly longer (>20) Stent compared to control group. Post-procedural TIMI flow score was significantly different between Persistent no reflow (most patients had TIMI grades 0 and I) and transient no reflow groups (TIMI grades II, III were the most common). Post-procedural TIMI flow score was significantly different between Persistent no reflow (most patients had TIMI

grades 0 and I) and control groups in which all patients had TIMI III. Post-procedural TIMI flow score was significantly different between transient no reflow groups (TIMI grades II, III were the most common) and control groups in which all patients had TIMI III Table 2.

Persistent no reflow and Transient no reflow groups had significantly higher WBCs number, elevated S. Creatinine and CRP (mg/L) levels compared to control group. Persistent no reflow and Transient no reflow groups had significantly lower EF (<40) compared to control group. No significant difference was found between Persistent no reflow and Transient no reflow groups regarding WBCs, S. Creatinine, CRP (mg/L) and EF. Persistent no reflow group had significantly more Malignant arrhythmia compared to Transient no reflow group. No significant variation was found between Persistent no reflow and control groups and between Transient no reflow and control groups. Persistent no reflow and Transient no reflow groups had significantly more cardiogenic shock and in hospital mortality compared to control group. Hb had no significant difference between the studied groups Table 3.

Multivariate analyses identified that age (OR=1.417, 95%CI 1.319–1.521, P=0.001) , DM (OR=10.110, 95%CI 3.950–25.880, P=0.001), HTN (OR=0.326, 95%CI 0.142–0.752, P=0.001), total ischemia time ≥6 hours (OR=60.511, 95%CI 24.973–146.618, P=0.001), SBP<90 mmHg (OR=0.238, 95%CI 0.091–0.621, P=0.003), lesion length ≥20 mm (OR=16.182, 95%CI 5.008–52.287, P=0.001), high thrombus burden (thrombus grade ≥4) (OR=2.914, 95%CI 1.018–8.338, P=0.046), balloon pre dilatation (OR=0.272, 95%CI 0.093–0.791, P=0.017), stent length ≥20 mm (OR=7.709, 95%CI 33.346–17.758, P=0.001), balloon post dilatation (OR=5.885, 95%CI 2.571–13.474, P=0.001), CRP (OR=1.016, 95%CI 1.002–1.030, P=0.027) were the independent predictors of the no-flow phenomenon Table 4.

Table 1. Incidence of no-reflow

N = 1635	No (%)
Group I (case / no reflow)	374 (22.9 %)
Persistent no reflow	163 (10 %)
Transient no reflow	211 (12.9 %)

Data are presented as frequency (%). MI: Myocardial infarction

Table 2. Comparison between the three studied groups according to age, sex, risk factors and angiographic and procedural characteristics

		Persistent no reflow (n= 163)	Transient no reflow (n= 211)	Control (n= 374)	p
		No (%)	No (%)	No (%)	
Age (years)	<60	12 (7.4 %)	16 (7.6 %)	284 (75.9 %)	<0.001*
	>60	151 (92.6 %)	195 (92.4 %)	90 (24.1 %)	p_1=0.936
					p_2<0.001*
					p_3<0.001*
Age (years)		65.79 ± 4.43	65.80 ± 4.59	54.02 ± 8.65	<0.001*
					p_1=1.000
					p_2<0.001*
					p_3<0.001*
Sex	Male	142 (87.1 %)	179 (84.8 %)	233 (62.3 %)	<0.001*
	Female	21 (12.9 %)	32 (15.2 %)	141 (37.7 %)	p_1=0.541
					p_2<0.001*
					p_3<0.001*
DM		125 (76.7 %)	156 (73.9 %)	215 (57.5 %)	<0.001*
					p_1=0.541
					p_2<0.001*
					p_3<0.001*
HTN		128 (78.5 %)	157 (74.4 %)	223 (59.6 %)	<0.001*

		Persistent no reflow (n= 163)	Transient no reflow (n= 211)	Control (n= 374)	p
		No (%)	No (%)	No (%)	
					p_1=0.354 p_2<0.001* p_3<0.001*
Smoker		84 (51.5 %)	97 (46 %)	235 (62.8 %)	<0.001* p_1=0.286 p_2=0.014* p_3<0.001*
Dyslipidemia		82 (50.3 %)	103 (48.8 %)	184 (49.2 %)	0.957
Family History		54 (33.1 %)	69 (32.7 %)	89 (23.8 %)	0.051
SBP	>90	56 (34.4 %)	79 (37.4 %)	273 (73 %)	<0.001*
	<90	107 (65.6 %)	132 (62.6 %)	101 (27 %)	p_1=0.538 p_2<0.001* p_3<0.001*
HR	<75	39 (23.9 %)	51 (24.2 %)	61 (16.3 %)	0.098
	>75	124 (76.1 %)	60 (75.8 %)	313 (83.7 %)	
Killip Class	< III	56 (34.4 %)	81 (38.4 %)	301 (80.5 %)	<0.001*
	≥ III	107 (65.6 %)	130 (61.6 %)	73 (19.5 %)	p_1=0.422 p_2<0.001* p_3<0.001*
Location of infarction	Ant	112 (68.7 %)	138 (65.4 %)	158 (42.2 %)	<0.001*
	Inferior	42 (25.8 %)	58 (27.5 %)	61 (16.3 %)	p_1=0.885
	Lat	6 (3.7 %)	11 (5.2 %)	126 (33.7 %)	p_2<0.001*
	Other	3 (1.8 %)	4 (1.9 %)	29 (7.8 %)	p_3<0.001*
Total Ischaemia Time	<6 hrs	26 (16 %)	42 (19.9 %)	251 (67.1 %)	<0.001*
	>6 hrs	137 (84 %)	169 (80.1 %)	123 (32.9 %)	p_1=0.326 p_2<0.001* p_3<0.001*
Lesion length	< 20	37 (22.7 %)	57 (27 %)	192 (51.3 %)	<0.001*
	≥ 20	126 (77.3 %)	154 (73 %)	182 (48.7 %)	p_1=0.340 p_2<0.001* p_3<0.001*
MVD		76 (46.6 %)	91 (43.1 %)	101 (27 %)	<0.001* p_1=0.500 p_2<0.001* p_3<0.001*
Lesion Localization Proximal	Proximal	114 (69.9 %)	142 (67.3 %)	159 (42.5 %)	<0.001*
	Midsegment	43 (26.4 %)	57 (27 %)	127 (34 %)	p_1=0.645
	Distal	6 (3.7 %)	12 (5.7 %)	88 (23.5 %)	p_2<0.001* p_3<0.001*
IRA	LAD	124 (76.1 %)	155 (73.5 %)	224 (59.9 %)	<0.001*
	LCX	11 (6.7 %)	117 (8.1 %)	84 (22.5 %)	p_1=0.826
	RCA	28 (17.2 %)	39 (18.5 %)	66 (17.6 %)	p_2<0.001* p_3<0.001*
TIMI pre	>1	15 (9.2 %)	41 (19.4 %)	58 (15.5 %)	0.024*
	≤1	148 (90 .8 %)	170 (80.6 %)	316 (84.5 %)	p_1=0.006* p_2=0.049* p_3<0.001*
Thrombus grade	<4	39 (23.9 %)	71 (33.6 %)	215 (57.5 %)	<0.001*
	≥4	124 (76.1 %)	140 (66.4 %)	159 (42.5 %)	p_1=0.034* p_2<0.001* p_3=0224

		Persistent no reflow (n= 163)	Transient no reflow (n= 211)	Control (n= 374)	p
		No (%)	No (%)	No (%)	
Predilatation		128 (78.5 %)	145 (68.7 %)	215 (57.5 %)	<0.001* p_1=0.340 p_2<0.001* p_3<0.001*
Stent length	<20	35 (21.5 %)	70 (33.2 %)	244 (65.2 %)	<0.001*
	>20	128 (78.5 %)	141 (66.8 %)	130 (34.8 %)	p_1=0.013* p_2<0.001* p_3<0.001*
Postdilatation		69 (42.3 %)	69 (32.7 %)	78 (20.9 %)	<0.001* p_1=0.056 p_2<0.001* p_3=0.002*
TIMI Post	TIMI 0	135 (82.8 %)	0 (0 %)	0 (0 %)	<0.001*
	TIMI 1	28 (17.2 %)	0 (0 %)	0 (0 %)	p_1<0.001*
	TIMI 2	0 (0 %)	184 (87.2 %)	0 (0 %)	p_2<0.001*
	TIMI 3	0 (0 %)	27 (12.8 %)	374 (100 %)	p_3<0.001*

*Data are presented as mean ± SD and frequency (%), * significant as P value ≤ 0.05, p1: p value for comparing between persistent no reflow and transient no reflow, p2: p value for comparing between persistent no reflow and control, p3: p value for comparing between transient no reflow and control. DM: Diabetes mellitus, HTN: Hypertension, SBP: Systolic blood pressure, HR: Heart rate, MVD: Coronary microvascular disease, IRA: Infarct-related artery, LAD: Left anterior descending artery, LCX: Left circumflex artery, RCA: Right coronary artery, TIMI: Thrombolysis in myocardial infarction*

Table 3. Laboratory findings and common in hospital complications in no reflow and control groups

		Persistent no reflow (n= 163)	Transient no reflow (n= 211)	Control (n= 374)	p
Hb		12.53 ± 0.53	12.53 ± 0.54	12.45 ± 0.73	0.184
WBCs		13.34 ± 1.13	13.20 ± 1.16	11.70 ± 1.28	<0.001* p_1=0.537 p_2<0.001* p_3<0.001*
S. Creatinine level		1.44 ± 0.25	1.42 ± 0.26	1.16 ± 0.23	<0.001* p_1=0.731 p_2<0.001* p_3<0.001*
CRP (mg/L)		63.98 ± 32.17	59.94 ± 33.46	26.50 ± 21.59	<0.001* p_1=0.236 p_2<0.001* p_3<0.001*
EF	**>40**	39 (23.9 %)	68 (32.2 %)	260 (69.5 %)	<0.001*
	<40	124 (76.1 %)	143 (67.8%)	114 (30.5 %)	p_1=0.078 p_2<0.001* p_3<0.001*
Malignant arrhythmia		20 (12.3 %)	10 (4.7 %)	28 (7.5 %)	0.025* p_1=0.008* p_2=0.074 p_3=0.195

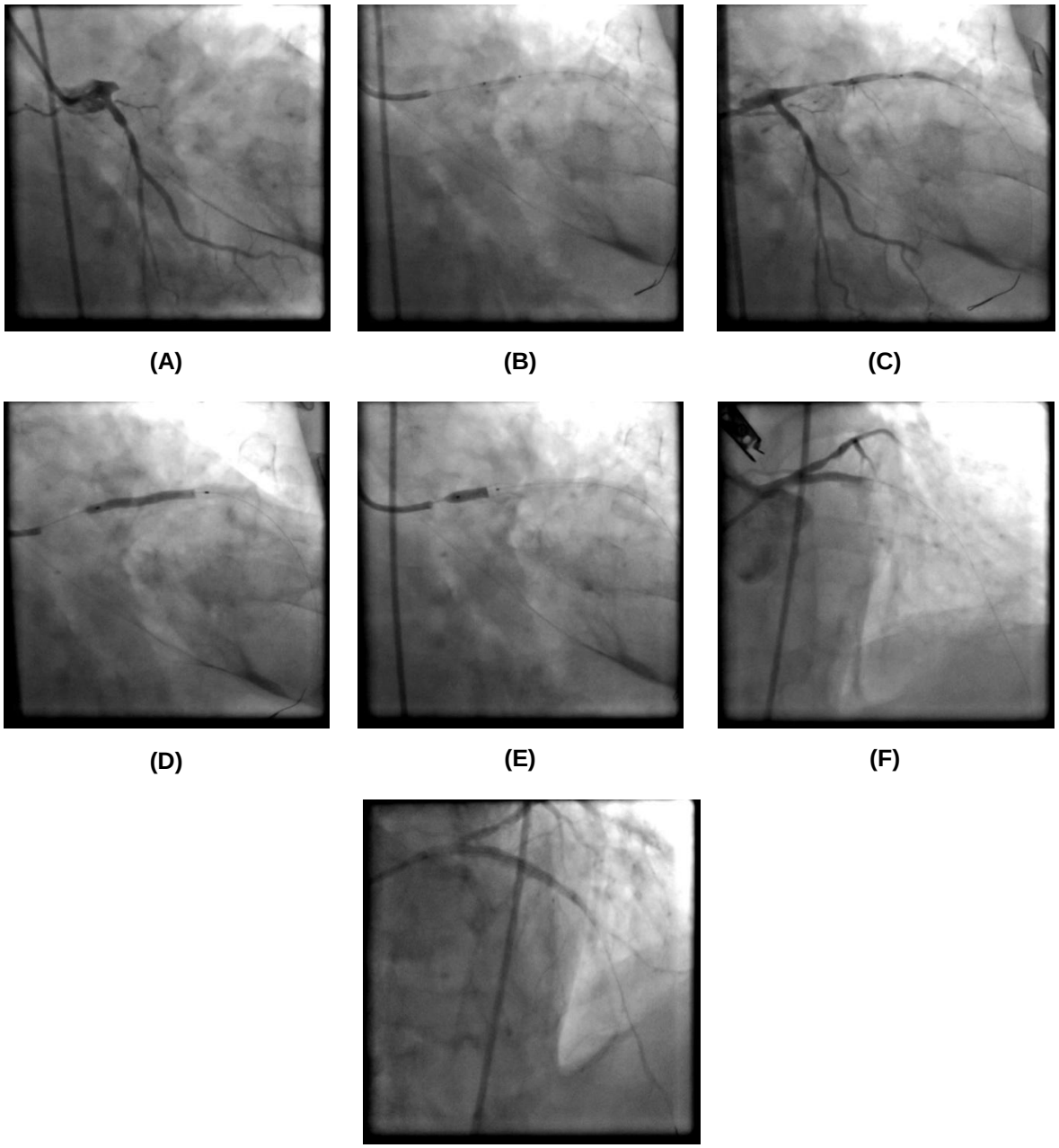
	Persistent no reflow (n= 163)	Transient no reflow (n= 211)	Control (n= 374)	p
Cardiogenic shock	107 (65.6 %)	52 (24.6 %)	48 (12.8 %)	<0.001* p_1<0.001* p_2<0.001* p_3<0.001*
In hospital mortality	111 (68.1 %)	68 (32.2 %)	36 (9.6 %)	<0.001* p_1<0.001* p_2<0.001* p_3<0.001*

*Data are presented as mean ± SD and frequency (%), * significant as P value < 0.05, p1: p value for comparing between persistent no reflow and transient no reflow, p2: p value for comparing between persistent no reflow and control, p3: p value for comparing between transient no reflow and control. Hb: haemoglobin, WBCs: White blood cells, CRP: C-reactive protein, EF: Ejection fraction*

Table 4. Univariate and multivariate regression analysis of independent predictors of no-reflow in study population (n = 374 vs 374)

	Univariate		#Multivariate	
	p	**OR (95% C.I)**	**p**	**OR (95% C.I)**
Age	<0.001*	1.286 (1.241 – 1.332)	<0.001*	1.417 (1.319–1.521)
DM	<0.001*	2.235 (1.637 – 3.051)	<0.001*	10.110 (3.950–25.880)
HTN	<0.001*	2.168 (1.582 – 2.972)	<0.001*	0.326 (0.142–0.752)
Killip Class (≥III)	<0.001*	7.133 (5.122 – 9.933)	0.266	1.782 (0.644–4.929)
Total Ischaemia Time (>6)	<0.001*	9.183 (6.536 – 12.901)	<0.001*	60.511 (24.973–146.618)
SBP (<90)	<0.001*	0.209 (0.153 – 0.285)	0.003*	0.238 (0.091–0.621)
IRA (LAD)	<0.001*	1.995 (1.460 – 2.725)	0.061	0.465 (0.208–1.037)
Lesion Localization Proximal	<0.001*	2.934 (2.175 – 3.957)	0.472	1.333 (0.610–2.914)
Thrombus grade (≥4)	<0.001*	3.245 (2.398 – 4.392)	0.046*	2.914 (1.018–8.338)
Pre dilatation	<0.001*	1.999 (1.471 – 2.717)	0.017*	0.272 (0.093–0.791)
Stent length	<0.001*	4.808 (3.526 – 6.557)	<0.001*	7.709 (3.346–17.758)
Lesion Length (≥20)	<0.001*	3.142 (2.306 – 4.282)	<0.001*	16.182 (5.008–52.287)
Post dilatation	<0.001*	2.219 (1.602 – 3.075)	<0.001*	5.885 (2.571–13.474)
CRP (mg/L)	<0.001*	1.043 (1.036 – 1.050)	0.027*	1.016 (1.002–1.030)

DM: Diabetes mellitus, HTN: Hypertension, SBP: Systolic blood pressure, #: All variables with p<0.05 was included in the multivariate, IRA: Infarct-related artery, CRP: C-reactive protein



(A) **(B)** **(C)**

(D) **(E)** **(F)**

(G)

Fig. 1. Female patient aged 74 years, known to be a diabetic and hypertensive patient. she wasn't smoker and had no history of dyslipidemia nor family history of previous coronary artery diseases and not known to be a cardiac patient before. The LAD was the IRA. (A) Injection of left coronaries in Right Anterior Oblique (RAO)caudal view showing proximal total thrombotic occlusion of the LAD (IRA) and proximal 50 % occlusion of LCX, (B) Balloon pre dilatation of proximal LAD using 2 *12 mm semicompliant balloon, (C) Injection of left coronaries in RAO caudal view after balloon pre dilatation showing TIMI I flow of the LAD, (D) Stenting of proximal LAD in RAO caudal view using 3 *33 mm DES stent, (E) Stenting of osteo proximal LAD in RAO caudal view using 3.5*12 mm stent, (F) Injection of left coronaries in Postero Anterior (PA) cranial view after LAD stenting showing TIMI 0 flow in the LAD, (G) Injection of left coronaries in PA cranial view showing TIMI I flow in the LAD after injection of tirofiban and calcium channel blockers .The patient returned to the CCU where she started Glycoprotein IIb/IIIa IV infusion. The patient was still hemodynamically unstable and died within 4 hours after PCI

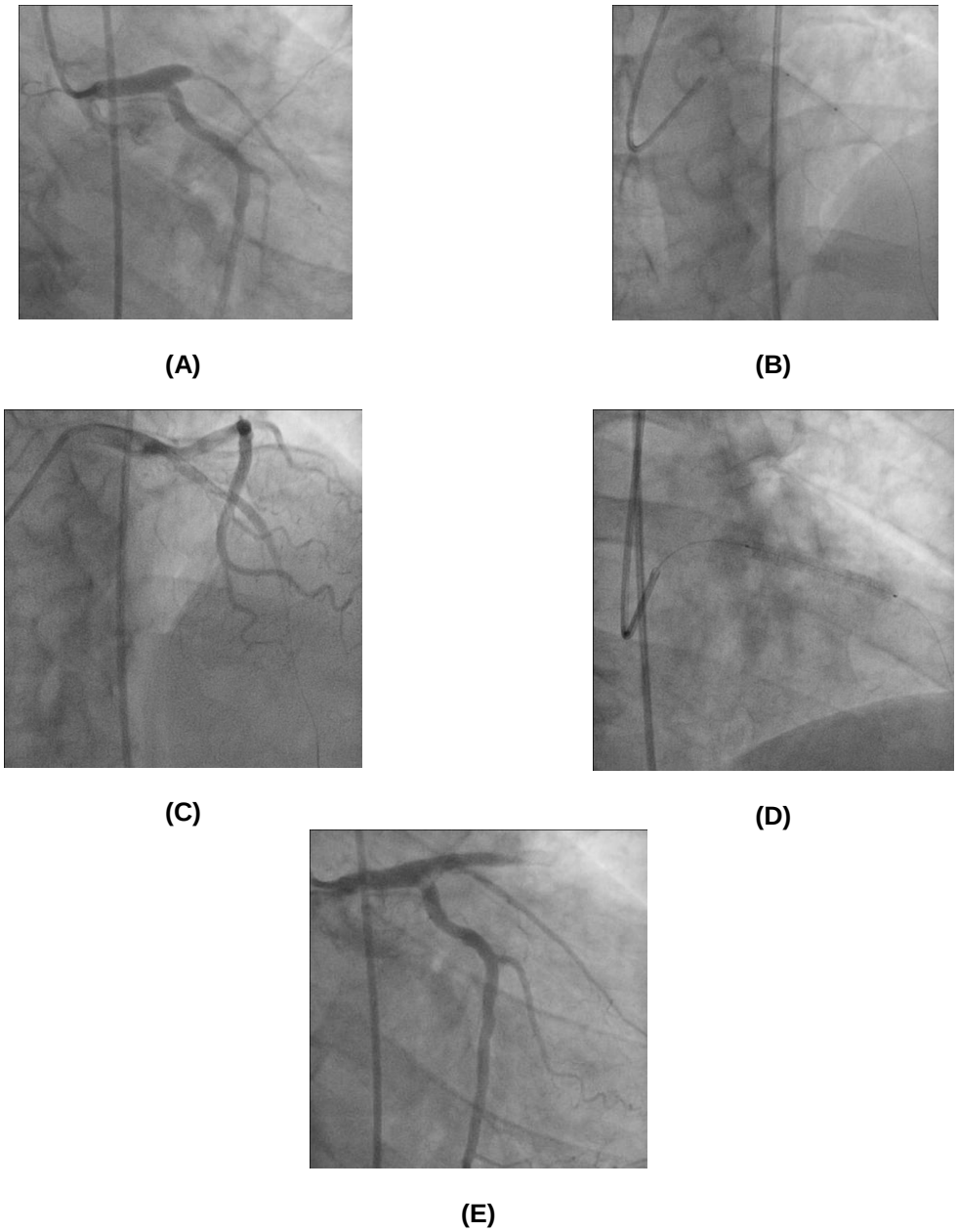


Fig. 2. Male patient aged 53 years, known to be a diabetic patient, smoker and had history of dyslipidemia, no family history of previous coronary artery diseases and not known to be a cardiac patient before. The LAD was the IRA. (A) Injection of left coronary artery in RAO caudal view showing proximal total thrombotic occlusion of the LAD TIMI 0, (B) Pre dilatation of the LAD in PA cranial view using 2.5*10 mm balloon, (C) Injection of left coronary in PA cranial view after balloon pre dilatation showing TIMI I flow, (D) Stenting of proximal LAD in RAO cranial view using stent 4*38 mm stent, (E) Injection of left coronary artery in RAO caudal view after LAD stenting showing TIMI 0 flow in the LAD and thrombus dislodgement in distal of the left main artery and osteal LCX artery .Trials of intracoronary injection of nitrates, Glycoprotein IIb/IIIa, calcium channel blockers and epinephrine failed to get reflow. The patient transferred to the CCU, he was hemodynamically unstable so, he received I.V. vasopressors, positive inotropic drugs, Glycoprotein IIb/IIIa, anticoagulant and assistive respiratory support. He improved and discharged 5 days later

4. DISCUSSION

Although primary PCI is the most beneficial and rewarding reperfusion technique in patients with acute ST-segment– elevation myocardial infarction (STEMI), it fails to restore optimal myocardial reperfusion in a considerable number of cases mostly due to NRP [19].

In our trial, 22.9 % of cases developed no-reflow. Patients with persistent no reflow was 10 % and patients with transient no reflow was 12.9%. Measured by TIMI grade, the incidence of no-reflow following routine PCI is 1% to 5%, and the incidence of no-reflow in AMI cases is 2.3% to 41% in some studies [6].

In Papapostolou et al. [1] trial, the occurrence of transient no-reflow was 3.2 % (590 patients) and the occurrence of persistent no-reflow was 0.8% (144 patients). In Kim et al. [20] the occurrence of transient no reflow was 4.9 % (213 patients) and the occurrence of persistent no reflow was 1 % (45 patients). In Aggarwal et al. [21] ,the occurrence of no reflow was 18.9 % (182 patients) by myocardial blush grade (MBG)<2. In Ghazanfer Ali Shah et al. [22] angiographical slow/no flow during the operation occurred in 53 (9.5%) cases, while normal flow was achieved in 506(90.5%). In Pantea-Roşan et al. [23] the incidence of no reflow was 14.6%.

In Yang et al. [6] the incidence of no-reflow was 29.5% (331 patients). In Jomaa et al. [24] no-reflow occurred in 44 (12.5%) cases. The incidence of no reflow was 6.2 % in a study conducted by Ipek et al. [25]. In Aeinfar et al. [26] the occurrence of NRP was 63 (15.9%). In Zhou et al. [27] the incidence of no reflow was 17.3% (54 patients). In Tasar et al. [28] the no reflow was reported in 10% of the patients (324 patients). In a trial by Li Dong-bao et al. [29] the no reflow was reported in 19.5 % of the cases with acute STEMI (41 cases). In a trial conducted by Harrison et al. [30] the no reflow was reported in 2.3% of the STEMI cases (6,553 cases). In Al Azzoni et al. [31] the incidence was 2.6%. It is also known that higher rates have been noted with other modalities that can assess microvascular flow: 34 to 39 percent using myocardial contrast echocardiography [32].

In our study, multivariate analyses identified that age (OR=1.417, 95% CI 1.319–1.521), DM (OR=10.110, 95% CI 3.950–25.880), HTN (OR=0.326, 95% CI 0.142–0.752), total ischemia time ≥6 hours (OR=60.511, 95% CI 24.973–146.618), SBP<90 mmHg (OR=0.238, 95% CI 0.091–0.621), lesion length ≥20 mm(OR=16.182, 95% CI 5.008–52.287), high thrombus burden (thrombus grade ≥4) (OR=2.914, 95% CI 1.018–8.338), balloon pre dilatation (OR=0.272, 95% CI 0.093–0.791), stent length ≥20 mm (OR=7.709, 95% CI 33.346–17.758), balloon post dilatation (OR=5.885, 95%CI 2.571–13.474), CRP (OR=1.016, 95% CI 1.002–1.030) were the independent predictors of the no-flow phenomenon.

In the trial by Sabin Padmajan et al. [33] Univariate analyses identified that age >60 years, reperfusion time >6 h, low initial TIMI flow (≤1), low initial TMPG flow (≤1), a high thrombus burden, a long target lesion, Killip Class III/IV and overlap stenting were the independent predictors of no-reflow. CPK MB was not included as a predictor as it was a result of no-reflow and not a predictor (it took place following the no-reflow).

In Zhou et al. [27] Univariate analysis showed that age, time from onset to reperfusion, systolic blood pressure (SBP) on admission, Killip class of myocardial infarction, intra-aortic balloon pump (IABP) uses prior to primary PCI, TIMI flow grade prior to primary PCI, occlusion type, thrombus burden on baseline angiography, length of target lesion, reference luminal diameter and method of reperfusion were related to no-reflow ($p<0.05$ for all).

Multiple logistic regression analysis identified that age >65 years, reperfusion time>6 hours, SBP on admission ≤100 mmHg, IABP use before PCI, a low initial TIMI flow (≤1), a high thrombus burden, and a long target lesion were the independent predictors of the NRP [27].

5. LIMITATIONS

This is a single-center experience and small number of cases mainly due to the worldwide decrease in STEMI related admissions during COVID-19 period. Also, our definition of no-reflow depended on TIMI flow post-PCI. The MBG score was not included in our definition. This could have resulted in choosing only the worst no-reflow cases. IVUS hasn't been used to quantitatively assess plaque content and thrombus burden. non-invasive measures as MCE and contrast-enhanced cardiovascular magnetic resonance which can detect no-reflow and also define the extent of myocardium affected wasn't used. Lastly, the low use of

thrombus-aspirating device, which may improve myocardial reperfusion.

6. CONCLUSION

As regards clinical and laboratory predictors age, DM, HTN, total ischemia time ≥6 hours, SBP<90 mmHg, and CRP levels on admission were associated with higher percentage of NRP. Whereas the angiographic predictors; lesion length ≥20 mm, high thrombus burden (thrombus grade ≥4), balloon pre dilatation, stent length ≥20 mm and balloon post dilatation could independently predicts no-reflow after Primary PCI. The persistent no reflow phenomenon was associated with a poor in-hospital outcome and increased incidence of malignant arrhythmia, cardiogenic shock and in hospital mortality compared to the transient no reflow phenomenon or normal reflow.

ETHICAL APPROVAL AND CONSENT

The trial was conducted after approval from the Ethical Committee Tanta University Hospitals. An informed written consent was taken from the cases.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Papapostolou S, Andrianopoulos N, Duffy SJ, Brennan AL, Ajani AE, Clark DJ et al. Long-term clinical outcomes of transient and persistent no-reflow following percutaneous coronary intervention (PCI): A multicentre Australian registry. EuroIntervention: Journal of EuroPCR in Collaboration with the Working Group on Interventional Cardiology of the European Society of Cardiology. 2018;14: 185-93.
   DOI:10.4244/eij-d-17-00269
2. Schram HCF, Hemradj VV, Hermanides RS, Kedhi E, Ottervanger JP. Coronary artery ectasia, an independent predictor of no-reflow after primary PCI for ST-elevation myocardial infarction. Int J Cardiol. 2018;265:12-7.
   DOI:10.1016/j.ijcard.2018.04.120
3. Jaffe R, Charron T, Puley G, Dick A, Strauss BH. Microvascular obstruction and the no-reflow phenomenon after percutaneous coronary intervention. Circulation. 2008;117:3152-6.
   DOI:10.1161/CIRCULATIONAHA.107.742312
4. Chotechuang Y, Phrommintikul A, Kuanprasert S, Muenpa R, Patumanond J, Chaichuen T et al. Cardiovascular outcomes of early versus delayed coronary intervention in low to intermediate-risk patients with STEMI in Thailand: A randomised trial. Heart Asia. 2019;11: e011201.
   DOI:10.1136/heartasia-2019-011201
5. Hombach V, Grebe O, Merkle N, Waldenmaier S, Höher M, Kochs M, et al. Sequelae of acute myocardial infarction regarding cardiac structure and function and their prognostic significance as assessed by magnetic resonance imaging. Eur Heart J. 2005;26:549-57.10.
   DOI:1093/eurheartj/ehi147
6. Ponikowski P, Voors AA, Anker SD, Bueno H, Cleland JGF, Coats AJS, et al. 2016 ESC guidelines for the diagnosis and treatment of acute and chronic heart failure: The task force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC) Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J. 2016;37:2129-200.
   DOI:10.1093/eurheartj/ehw128
7. Abdi S, Rafizadeh O, Peighambari M, Basiri H, Bakhshandeh H. Evaluation of the clinical and procedural predictive factors of no-reflow phenomenon following primary percutaneous coronary intervention. Res Cardiovasc Med. 2015;4: e25414.
   DOI:10.5812/cardiovascmed.4(2)2015.25414
8. Yang L, Cong H, Lu Y, Chen X, Liu Y. Prediction of no-reflow phenomenon in patients treated with primary percutaneous coronary intervention for ST-segment elevation myocardial infarction. Medicine (Baltimore). 2020;99:e20152.
   DOI:10.1097/md.0000000000020152
9. De Lemos JA, Antman EM, Gibson CM, McCabe CH, Giugliano RP, Murphy SA, et al. Abciximab improves both epicardial flow and myocardial reperfusion in ST-elevation myocardial infarction. Observations from the TIMI 14 trial. Circulation. 2000;101: 239-43.
   DOI:10.1161/01.cir.101.3.239

10. Brener SJ, Maehara A, Dizon JM, Fahy M, Witzenbichler B, Parise H et al. 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 Cardiovasc Interv. 2013;6:718-24. DOI:10.1016/j.jcin.2013.03.013
11. Sabatine MS, Braunwald E. Thrombolysis In Myocardial Infarction (TIMI) Study Group: JACC Focus Seminar 2/8. J Am Coll Cardiol. 2021;77:2822-45. DOI:10.1016/j.jacc.2021.01.060
12. Stoel MG, De Cock CC, Spruijt HJ, Zijlstra F, Visser CA. Corrected TIMI frame count and frame count velocity. Neth Heart J. 2003;11:109-12
13. Lepper W, Sieswerda GT, Vanoverschelde JL, Franke A, De Cock CC, Kamp O et al. Predictive value of markers of myocardial reperfusion in acute myocardial infarction for follow-up left ventricular function. Am J Cardiol. 2001;88:1358-63. DOI:10.1016/s0002-9149(01)02113-0
14. Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, et al. Fourth universal definition of myocardial infarction (2018). Circulation. 2019;138:e618-e51. DOI:10.1161/cir.0000000000000617
15. Husic M, Nørager B, Egstrup K, Lang RM, Møller JE. Diastolic wall motion abnormality after myocardial infarction: Relation to neurohormonal activation and prognostic implications. Am Heart J. 2005; 150:767-74. DOI:10.1016/j.ahj.2004.11.024
16. Fajar JK, Heriansyah T, Rohman MS. The predictors of no reflow phenomenon after percutaneous coronary intervention in patients with ST elevation myocardial infarction: A meta-analysis. Indian Heart J. 2018;70(3):S406-s18. DOI:10.1016/j.ihj.2018.01.032
17. Celık T, Balta S, Demır M, Yıldırım AO, Kaya MG, Ozturk C, et al. Predictive value of admission red cell distribution width-platelet ratio for no-reflow phenomenon in acute ST segment elevation myocardial infarction undergoing primary percutaneous coronary intervention. Cardiol J. 2016;23:84-92. DOI:10.5603/CJ.a2015.0070
18. Zipes DP. Braunwald's heart disease: A textbook of cardiovascular medicine; 2015. 63.
19. Ndrepepa G, Tiroch K, Keta D, Fusaro M, Seyfarth M, Pache J et al. Predictive factors and impact of no reflow after primary percutaneous coronary intervention in patients with acute myocardial infarction. Circ Cardiovasc Interv. 2010;3:27-33. DOI:10.1161/circinterventions.109.896225
20. Kim MC, Cho JY, Jeong HC, Lee KH, Park KH, Sim DS, et al. Long-term clinical outcomes of transient and persistent no reflow phenomena following percutaneous coronary intervention in patients with acute myocardial infarction. Korean Circ J. 2016; 46:490-8. DOI:10.4070/kcj.2016.46.4.490
21. Bahrehmand M, Sadeghi E, Shafiee A, Nozari Y. Predictors of delayed and no-reflow as recognized with thrombolysis in myocardial infarction [TIMI] flow grade following Primary percutaneous coronary angioplasty. J Med Life. 2015;8:59-65
22. Shah GA, Malik T, Farooqi S, Ahmed S, Abid K. Frequency and impact of slow flow / no flow in primary percutaneous coronary intervention. J Pak Med Assoc. 2021; 71:2548-53. DOI:10.47391/jpma.12-1390
23. Pantea-Roșan LR, Pantea VA, Bungau S, Tit DM, Behl T, Vesa CM, et al. No-reflow after PPCI-A predictor of short-term outcomes in STEMI patients. J Clin Med. 2020;9:2956.
24. Jomaa W, Jnifene Z, Chamtouri I, Ben Hamda K, Maatouk F. 100.31 Predictors of no-reflow phenomenon in Tunisian Patients undergoing primary percutaneous coronary intervention for St-elevation myocardial infarction. JACC Cardiovasc Interv. 2019;12:S9-S.
25. Ipek G, Onuk T, Karatas MB, Gungor B, Osken A, Keskin M, et al. CHA2DS2-VASc Score is a predictor of no-reflow in patients with ST-Segment elevation myocardial infarction who underwent primary percutaneous intervention. Angiology. 2016;67:840-5. DOI:10.1177/0003319715622844
26. Aeinfar K, Firouzi A, Shahsavari H, Sanati H, Kiani R, Shakerian F et al. The predictors of no-reflow phenomenon after primary angioplasty for acute myocardial infarction. Int Cardiovasc Res J. 2016;10: 107-12
27. Zhou H, He XY, Zhuang SW, Wang J, Lai Y, Qi WG, et al. Clinical and procedural

predictors of no-reflow in patients with acute myocardial infarction after primary percutaneous coronary intervention. World J Emerg Med. 2014;5:96-102. DOI:10.5847/wjem.j.issn.1920-8642.2014.02.003

28. Tasar O, Karabay AK, Oduncu V, Kirma C. Predictors and outcomes of no-reflow phenomenon in patients with acute ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention. Coron Artery Dis. 2019; 30:270-6. DOI:10.1097/mca.0000000000000726
29. Dong-bao L, Qi H, Zhi L, Shan W, Wei-ying J. Predictors and long-term prognosis of angiographic slow/no-reflow phenomenon during emergency percutaneous coronary intervention for ST-elevated acute myocardial infarction. Clin Cardiol. 2010; 33:E7-12. DOI:10.1002/clc.20634
30. Harrison RW, Aggarwal A, Ou FS, Klein LW, Rumsfeld JS, Roe MT, et al. Incidence and outcomes of no-reflow phenomenon during percutaneous coronary intervention among patients with acute myocardial infarction. Am J Cardiol. 2013;111:178-84. DOI:10.1016/j.amjcard.2012.09.015
31. Al Azzoni AM, Lamelas P, Marsden T, Dzavik V, Cairns J, Meeks B, et al. Incidence and predictors of no reflow phenomenon: Insights from the total trial. J Am Coll Cardiol. 2017;69:1179.
32. Tarantini G, Cacciavillani L, Corbetti F, Ramondo A, Marra MP, Bacchiega E, et al. Duration of ischemia is a major determinant of transmurality and severe microvascular obstruction after primary angioplasty: A study performed with contrast-enhanced magnetic resonance. J Am Coll Cardiol. 2005;46: 1229-35. DOI:10.1016/j.jacc.2005.06.054
33. Sabin P, Koshy AG, Gupta PN, Sanjai PV, Sivaprasad K, Velappan P, et al. Predictors of no- reflow during primary angioplasty for acute myocardial infarction, from Medical College Hospital, Trivandrum. Indian Heart J. 2017;69 Suppl 1:S34-s45. DOI:10.1016/j.ihj.2016.12.012

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/92513