ejpmr, 2017,4(09), 847-854

SJIF Impact Factor 4.161

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

PREDICTORS AND OUTCOMES OF NO-REFLOW PHENOMENON FOLLOWING PRIMARY PERCUTANEOUS INTERVENTION FOR ST ELEVATION MYOCARDIAL INFARCTION

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Article Received on 21/07/2017 **Article Revised on 11/08/2017** **Article Accepted on 31/08/2017**

ABSTRACT

Objective: After acute myocardial infarction (AMI), the immediate therapeutic goal is to establish patency of the infarct-related artery. The successful restoration of epicardial coronary artery patency, however, does not necessarily translate into improved tissue perfusion. The 'no-reflow' phenomenon, characterized by inadequate flow at tissue level despite a reopened epicardial coronary artery after percutaneous coronary intervention. Although uncommon side effects of percutaneous coronary intervention, no-reflow phenomenon is considered a critical complication if not reversed, causes a high rate of mortality and morbidity.[1] **Methods:** The study population consisted of 120 consecutive patients presented with STEMI and treated with PPCI during the period from the 1st of November 2016 to July 2017 in Al-Azhar Main University Hospital, and the national heart institute (NHI), Giza, Egypt.All patients were subjected to informed consent, detailed history taking, clinical evaluation, ECG analysis and laboratory investigations (including admission CBC, RPG, lipid profile). Door to balloon time computed and given in hours. Coronary angiography (showing the initial TIMI flow) and PCI procedure (whether POBA, BMS, or DES were used, and the occurrence of no reflow phenomenon) were also documented. Patients were put under observation to detect the occurrence of any in-hospital MACE or other hemodynamic complications. **Results:** The incidence of no reflow was 13.2%, and in hospital MACE was 5%, with cardiac death as the predominant form of in hospital MACE. The group with no reflow or in hospital MACE showed significantly older age, longer door to balloon time, higher levels of admission RPG, N/L ratio, and MPV.Compared to the literature, Egyptian patients had more diabetes mellitus, more dyslipidaemia, longer door to balloon time, than patients studied in Europe, and Japan. Stenting in primary coronary intervention in our country was the usual practice according to ESC guidelines. **Conclusion:** Older patient age, longer door to balloon time, admission hyperglycemia, higher admission N/L ratio, MPV, longer reperfusion time, elevated level of high sensitive CRP on admission, and markedly elevated levels of CKMB, large thrombus burden LTB , are useful predictive factors for the occurrence of no reflow post PPCI, and/or in hospital MACE.

KEYWORDS: Acute myocardial infarction, No-reflow phenomenon, Percutaneous coronary intervention, Thrombus.

INTRODUCTION

Primary percutaneous coronary intervention (PCI) is the reperfusion strategy of choice in restoring blood flow to the occluded coronary artery in patients with ST elevation myocardial infarction (STEMI).[2] Impaired coronary flow (Thrombolysis in Myocardial infarction grade < 3) despite restoration of epicardial coronary artery patency in the absence of any spasm or dissection is known as no-reflow.[3]

It is thought to be caused by a combination of ischemic endothelial injury that obstructs the capillary lumen, neutrophil accumulation, reactive oxygen species and distal embolization of atherothrombotic debris. No-reflow occurs in 11–41% of STEMI patients treated by primary PCI and is associated with poor left ventricular function, adverse clinical events and death.[4]

A number of clinical, serologic and angiographic parameters have been shown to be associated with no-reflow. The results of clinical trials testing a number of treatment strategies for no-reflow have been conflicting and there is no definitive treatment of no-reflow once it has occurred.[5,6]

In the absence of an effective treatment strategy, it is crucial to prevent no-reflow by knowing the predictors or risk factors of no-reflow. Previous studies have identified

various predictors of no-reflow, which are different between studies, likely due to the differences in the populations being studied.[7]

Patients and Methods

This study is a prospective study, comprised 120 patients with STEMI presenting to Al-Azhar Main University Hospital and National heart institute (NHI) from 1st of November 2016 to July 2017. Patients with STEMI eligible for PPCI according to European Society of Cardiology (ESC) guidelines were included.[8] while the following were excluded patients Performed percutaneous interventions for stable angina pectoris or unstable angina pectoris or non-ST elevation myocardial infarction (NSTEMI), Patients with malignancies, coagulation disorders, Advanced liver or renal disease, Patients with valvular, congenital heart diseases and those with cardiomyopathies.Every patient's record included: Informed consent taken from patients. In case of incompetent patients, the informed consent will be taken from the guardians. Thorough history taking with special emphasis on: Risk factors (Age, gender, diabetes, hypertension, smoking, dyslipidemia, family history). History of acute coronary syndromes (ACS) and revascularization. Door to balloon time (in hours). Presence of pre-infarction angina (defined as presence anginal pains within the 48 hrs. preceding the incidence of STEMI).Complete clinical examination, with demonstration of admission blood pressure, pulse, and killip class. Laboratory investigation (on admission): Complete blood count (CBC) (including mean platelet volume [MPV] and neutrophils/lymphocytes [N/L] ratio). Random plasma glucose (RPG) level (in mg/dl). Standard 12 lead electrocardiogram (ECG).Conventional coronary angiography indicating initial TIMI flow in the IRA.The patients were studied according to the presence of various clinical and laboratory variables (age, gender, absence of pre-infarction angina, door to balloon time, location of the infarction, admission plasma glucose level and CBC including N/L ratio and MPV, and initial TIMI flow in the IRA), the final TIMI flow after the PPCI, and the incidence of in hospital MACE.

RESULTS

The study was a two-center, prospective, observational study consisted of 120 consecutive patients admitted at Al-Azhar main university hospital and the national heart institute (NHI) for primary PCI from the 1st of November 2016 to 31st of July 2017. The patients are divided into two groups according to the final TIMI flow after the primary PCI, and the incidence of in hospital MACE as follows:

Group A: Had a normal flow after the PPCI and did not have in hospital MACE.
Group B: Had either no reflow after the PPCI or experienced in hospital MACE.

The two groups are then compared with respect to various clinical and laboratory variables (age, gender, absence of pre-infarction angina, door to balloon time, location of the infarction, admission RPG and CBC including N/L ratio and MPV, and initial TIMI flow in the IRA). The Baseline clinical characteristics were:The mean age was 56.3 ± 10.34 years for group A, and 62.29± 7.9 years for group B.SexinGroup A 75 (75.8%) patients were males and 24(24.2%) were females, while in group B 13 (62%) patients were males and 8(38%) were females. Risk factors:In group A, 28 (28.3%) patients are NITDM and 9 (2.8%) patients are ITDM. In group B, 10 (47.6%) patients are NITDM and 2 (9.5%) patients are ITDM. Hypertension is present in 48(48.5%) patients of group A, and in 7(33.3%) patients of group B. Dyslipidemia is present in 54(54.5%) patients of group A, and in 15(71.4%) patients of group B. In group A, 52(52.5%) patients are current smokers, 4(4%) patients are ex-smokers while 43(43.4%) patients are non-smokers. In group B, 9(42.9%) patients are current smokers, 1(4.8%) patients are ex-smokers while 11(52.4%) patients are non-smokers. History of ACS: in 19 (19.2%) patients of group A, and 3(14.3%) patients of group B. Family history of IHD: in 17(17.2%) patients of group A, and in 2(9.5%) patients of group B. Periinfarction angina: was absent in 56(56%) patients of group A, and 15(71.4%) patients of group B.

The mean admission systolic blood pressure (SBP) in group A was 129.3±28 mmHg, and in group B was 116.6±19.3 mmHg. The mean admission diastolic blood pressure (DBP) was 81±15.6 mmHg for group A, and 74.3±12 mmHg for group B.The average mean pulse rate was 85±16 bpm for group A, and 84±16 bpm for group B.The number of patients with Killip I class was 83(83.8%) in group A, and 16(76.2%) in group B. The number of patients with Killip II class was 10(10.1%) in group A, and 3(14.3%) in group B. The number of patients with Killip III class was 1(1%) in group A, and 1(4.8%) in group B. The number of patients with Killip VI class was 5(5.1%) in group A, and 1(4.8%) in group B.As regard ECG diagnosis; 72 (72.7%) patients presented with anterior STEMI in group A, and 14(66.7%) patients in group B. 21 (21.2%) patients presented with inferior STEMI in group A, and 6(28.6%) patients in group B. 6 (6.1%) patients presented with lateral STEMI in group A, and 2(9.5%) patients in group B. 8 (8.1%) patients presented with right STEMI in group A, and 1(4.8%) patient in group B. 7 (7.1%) patients presented with posterior STEMI in group A, and 2(9.5%) patients in group B.

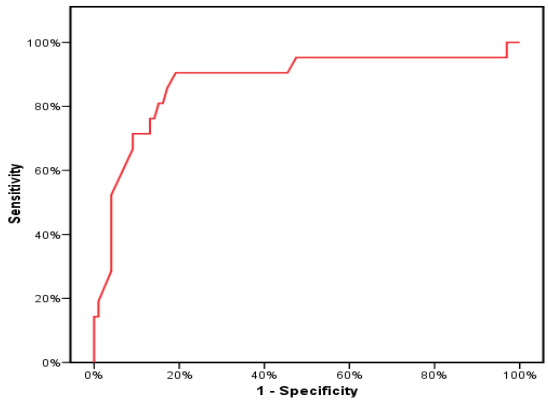
	Group A (n = 99)		Group B (n = 21)		χ^2	p
	No	%	No	%		
Diabetes						
Non-diabetic	62	62.6	9	42.9	2.803	□□□□□
Diabetic	37	37.4	12	57.1	2.083	0.094
Insulin	9	9.1	2	9.5	0.004	^{FE}p =1.000
OHD	28	28.3	10	47.6	2.994	0.084
Hypertension	48	48.5	7	33.3	1.602	0.206
Smoking						
Non-smoker	43	43.4	11	52.4	0.560	0.454
Smoker	52	52.5	9	42.9	0.648	0.421
Ex-smoker	4	4.0	1	4.8	0.023	^{FE}p =1.000
Dyslipidemia	54	54.5	15	71.4	2.021	0.155
Family History	17	17.2	2	9.5	0.760	^{FE}p=0.521
Previous ACS	19	19.2	3	14.3	0.279	^{FE}p=0.762
Absence of periinfarction angina	56	56.6	15	71.4	1.584	0.208
SBP						
Min. – Max.	50.0 – 200.0		70.0 – 160.0		1.971	0.051
Mean ± SD	129.29 ± 27.93		116.67 ± 19.32			
Median	130.0		120.0			
DBP						
Min. – Max.	30.0 – 120.0		40.0 – 90.0		1.870	0.064
Mean ± SD	81.06 ± 15.62		74.29 ± 12.07			
Median	80.0		70.0			
Pulse						
Min. – Max.	41.0 – 120.0		60.0 – 130.0		0.069	0.945
Mean ± SD	84.56 ± 16.33		84.29 ± 15.69			
Median	80.0		88.0			
Killip class						
I	83	83.8	16	76.2	0.702	0.526
II	10	10.1	3	14.3	0.314	0.698
III	1	1.0	1	4.8	1.488	0.321
IV	5	5.1	1	4.8	0.003	1.000

	Group A (n = 99)		Group B (n = 21)		χ^2	p
	No	%	No	%		
ECG						
Anterior MI	72	72.7	14	66.7	0.313	0.576
Lateral MI	6	6.1	2	9.5	0.334	^{FE}p=0.628
Inferior MI	21	21.2	6	28.6	0.538	^{FE}p=0.565
Right MI	8	8.1	1	4.8	0.275	^{FE}p=1.000
Posterior MI	7	7.1	2	9.5	0.150	^{FE}p=0.656

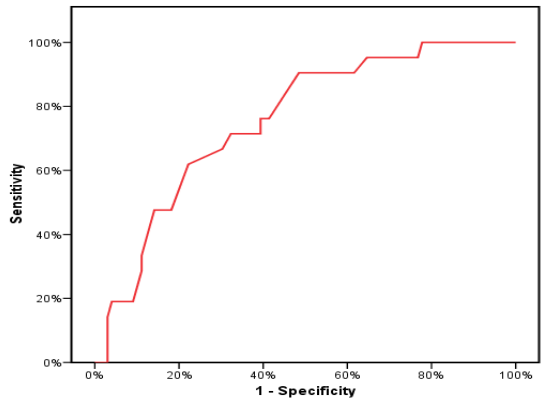
The mean time from onset of symptoms to balloon inflation in 1ry PCI was 6±3.8 hours in group A, versus 15.9±7.8 hours in group B.

Laboratory results In group A, the median of admission random plasma glucose was 150 mg/dl (range=358 mg/dl), while in group B the median was 280 mg/dl (range=336 mg/dl). The Mean neurophils/lymphocytes ratio in group A was 5.44±3.53, while in group B it was 8.19±3.05. ROC curve analysis of results revealed that N/L ratio >4.6 predicts no reflow or in hospital MACE with sensitivity 90.4%, and specificity 51.5%. The mean of mean platelet volume(MPV) in group A was 8.58±1.84 fl, while in group B it was 11.9±2.09 fl. ROC curve analysis of results revealed that MPV >9.9 fl predicts no reflow or in hospital MACE with sensitivity 90.4%, and specificity 80.8%.

	Group A (n = 99)	Group B (n = 21)	Test of sig.	p
Plasma glucose				
Min. – Max.	84.0 – 442.0	104.0 – 440.0	Z = 3.377*	0.001*
Mean ± SD	186.38 ± 84.65	275.29 ±104.11		
Median	150.0	280.0		
N/L ratio				
Min. – Max.	1.20 – 24.0	2.80 – 13.0	Z = 3.665	<0.001*
Mean ± SD	5.44 ± 3.53	8.19 ± 3.05		
Median	4.50	8.0		
MPV				
Min. – Max.	5.0 – 13.0	5.90 – 15.0	t = 7.320*	<0.001*
Mean ± SD	8.58 ± 1.84	11.90 ± 2.09		
Median	8.20	12.20		



ROC curve for the diagnostic performance for MPV with groups.



ROC curve for the diagnostic performance for N/L ratio with groups.

Angiographic findings and procedural aspects

In group A, IRA was LAD in 70(70.7%) patients, D1 in 5(5.1%) patients, CX in 2(2%) patients, OM in 1(1%) patient, RCA in 20(20.2%) patients, and PDA in 1(1%) patient. 63 patients (63.9%) had multivessel disease. In group B, IRA was LAD in 14(66.7%) patients, CX in 2(9.5%) patients, and RCA in 5 (23.8%) patients; while none had D1, OM, or PDA as IRA. 13 patients (64.7%) had multivessel disease.

	Group A (n = 99)		Group B (n = 21)		χ^2	p
	No	%	No	%		
Infarct related artery						
LAD	70	70.7	14	66.7	0.135	^{FE}p =0.714
D1	5	5.1	0	0.0	1.107	^{FE}p =0.585
CX	2	2.0	2	9.5	3.027	^{FE}p =0.141
OM	1	1.0	0	0.0	0.214	^{FE}p = 1.000
RCA	20	20.2	5	23.8	0.137	^{FE}p =0.769
PDA	1	1.0	0	0.0	0.214	^{FE}p = 1.000

FE: Fisher Exact test, χ^2: Chi square test

Initial TIMI flow (before 1ry PCI)

In group A, 87(87.6%) patients had initial TIMI 0 flow, 25(25.3%) patients had initial TIMI 1flow, and 5(5.1%) patients had initial TIMI 2 flow.In group B, 19(90.4%) patients had initial TIMI 0 flow, 1(4.8%) patient had initial TIMI 1flow, and 1(4.8%) patient had initial TIMI 2 flow.

Type of stent used

In group A, bare metal stents (BMS) had been used in 51(51.5%) patients, while drug eluting stents (DES) had been used in 48(48.5%) patients.In group B, BMS had been used In 12(57.1%) patients, while DES had been used in 7(33.3%) patients. Two patients had only balloon angioplasty.

Comparison between the two studied groups according to initial TIMI flow and Type of stent used

	Group A (n = 99)		Group B (n = 21)		Test of sig.	p
	No	%	No	%		
Initial TIMI flow						
0	87	87.6	19	90.4	0.113	$^{FE}p = 1.000$
1	25	25.3	1	4.8	4.286^{*}	$^{FE}p = 0.042^{*}$
2	5	5.1	1	4.8	0.003	$^{FE}p = 1.000$
Type of stent used						
No stent	0	0.0	2	9.5	$\chi^2 = 9.588^{*}$	$^{FE}p = 0.029^{*}$
BMS	51	51.5	12	57.1	$\chi^2 = 0.220$	0.810
DES	48	48.5	7	33.3	$\chi^2 = 1.602$	0.236

Z: Z for Mann Whitney test.
χ^2: Chi square test.
MC: Monte Carlo test.
FE: Fisher Exact test.
*: Statistically significant at $p \leq 0.0.5$

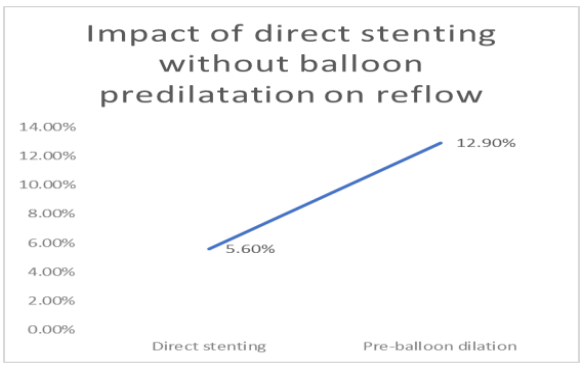
The impact of initial and residual thrombus burden on no reflow

Large thrombotic burden **(LTB)** was observed in 62 patients among them 30 patients underwent aspiration thrombectomy, the no-reflow phenomenon occurred most frequently in LTB patients without thrombectomy, followed by those who underwent thrombectomy and the small thrombus burden group (33.8 vs. 23.8 vs. 9.5%, respectively, P<0.001).

	No	%
Large thrombotic burden	62	51.6
aspiration thrombectomy	30	49.3
No-reflow incidence	21	17.5
LTB patients without thrombectomy	7	33.3
LTB patients underwent thrombectomy	5	23.8
small thrombus burden	2	9.5

Comparison between direct stenting versus balloon predilation in incidence of no reflows

Patients who underwent direct stenting (n = 89) had a better risk profile compared with the use of balloon predilation (n = 31). The incidence of angiographic no-reflow was 12.9% in the balloon predilation group and 5.6% in the direct stenting group (P = .040).



DISCUSSION

Baseline clinical characteristics

We found in our study that the mean age was close to the mean age in other studies, with significantly higher in no reflow group than in reflow group (62.29 ± 7.9 years vs 56.3 ± 10.3 years respectively, p=0.014), with prevalence of DM and dyslipidemia higher than that published in the literature, because of the pandemic of DM in our country which may in part be associated with the metabolic syndrome and stressing the urgent need for a national policy for primary and secondary prevention of diabetes and dyslipidemia. The prevalence of smoking in our country is still high inspite of aggressive public health efforts to limit tobacco use. Control of hypertension is of utmost importance, as this is one of the major risk factors, with comparison with above mentioned studies, the ratio of hypertensive patients were not largely different to our study.

Ndrepepa G et al[9] Studied the clinical factors related to the development of no-reflow phenomenon after successful coronary reperfusion in patients with AMI. Between January 1998 and December 2007, 1518 patients with STEMI presenting within 24 hours from the symptom onset were treated with PPCI in the Deutsches Herz zentrum Munich. Mean age of the no reflow group patients was significantly higher than the reflow group (65.8 vs 61.4 years, p=0.001), and history of previous MI was significantly higher in no reflow group than reflow group (18.5% vs 11.7% respectively, p=0.041), with non-significant difference in sex(71.3% vs 75% respectively), presence of DM(14.8% vs 20.3%, respectively), hypertension(66.7% vs 67.3% respectively), current smoking (30.6% vs 40.5% respectively) & dyslipidemia (57.4% vs 58.1% respectively).

Admission characteristics

In our study, we did not find the significant difference between group A and B (the normal flow and no reflow groups respectively) regarding killip class (more patients with killip class ≥ II were found in the no reflow group in some studies in the literature), pulse rate (pulse rate was significantly higher in no reflow group in some studies in the literature), location of MI (anterior MI was significantly higher in the no reflow group in some studies in the literature).

Ndrepepa G et al[10] reported that there was significant difference between the no reflow and reflow groups as regards killip class (class I 63% vs 70.9%, class ≥ II 34% vs 29.1%, p=0.019), with no significant difference between the study groups with respect to median SBP (125 vs 130 mmHg), median DBP (70 mmHg in both groups), median of pulse rate (78 bpm in both groups), and location of MI (anterior 41.7% vs 43%, inferior 41.7% vs 38.1%, lateral 16.6% vs 18.9%).

Ito M et al[11] there was significant difference between the no reflow and reflow groups as regards killip class (class I % 83.3% vs 72.1%, class ≥ II 16.7% vs 27.9%, p=0.03).

Timing variables

In our study, the door to balloon time in the normal flow group was near to that published in the literature, but the door to balloon time in the no reflow group was much longer than that published in the literature. Longer door to balloon time is associated with more ischemic injury to tissues, hence the occurrence of no reflow and in hospital MACE.

Ndrepepa G et al[10] reported that door to balloon time was significantly longer in the no reflow group than reflow group (the median was 10.7 vs 6.5 hours, p=0.001).

Akpek Met al[9] reported that door to balloon time was significantly longer in the no reflow group than reflow group (the mean was 4.8 ±1.3 hours vs 4.2±1.4 hours, p<0.001).

Laboratory results

In our study, the admission RPG was significantly higher in group B than in group A (the mean was 275.3±104.1 mg/dl vs 186.4±84.7 mg/dl, p=0.001).The N/L ratio was significantly higher in group B than in group A (the mean was 8.19±3.05 vs 5.44±3.53, p<0.001). ROC curve analysis of results revealed that N/L ratio >4.6 predicts no reflow or in hospital MACE with sensitivity 90.4%, and specificity 51.5%.The MPV was significantly higher in group B than in group A(the mean value was 11.9±2.09 fl vs 8.58±1.84 fl, p<0.001). ROC curve analysis of results revealed that MPV >9.9 fl predicts no reflow or in hospital MACE with sensitivity 90.4%, and specificity 80.8%. In this study, the admission RPG, MPV, and N/L ratio were of near values to that mentioned in literature.

Admission hyperglycemia

This study. Moreover, patients with hyperglycemia had a lower contrast enhancement score and lowerΔWMS than did those without it, even after adjusting for differences in the peak CK value. These results indicate that the effects of hyperglycemia on microvascular integrity and WMS could be independent from the infarct size. [12] Still, we could not definitely determine whether hyperglycemia was a cause or consequence of a large infarct size that could be related to the no-reflow phenomenon. Further prospective studies in which the blood glucose level was controlled before coronary reperfusion would be required to clarify these associations.

Neutrophils/Lymphocytes ratio(N/L)

N/L ratio were found to be significantly higher in patients with thrombus formation than in patients without thrombus formation.LI Dong-bao et al. found that N/L ratio was independently predictive of thrombus formation in the IRA, and thrombus formation in the IRA was the only predictor of no-reflow/slow flow during PCI.[13]

Recent studies with animal models have shown direct visualization of neutrophilic invasion of atherosclerotic plaque. Neutrophils may make plaques rupture more easily through the release of proteolytic enzymes, arachidonic acid derivatives, and superoxide radicals.[14] Therefore, the higher neutrophil count may not only mirror the exacerbated inflammatory condition found in patients with atherosclerotic disease, but also may be associated with the role of those cells in the instability of atherosclerotic plaque.

Mean platelet volume (MPV)

In this study we assume that the presence of larger, more reactive platelets or platelet aggregates may be associated with intravascular plugging on both epicardial and tissue level of the IRA, thus resulting in no-reflow

and after PPCI. Higher MPV may correspond with the increased number of both platelet-leukocyte and platelet-platelet aggregates.[15]

Huczek Z et al[16], found that Administration of abciximab during PPCI resulted in significant reduction of six-month mortality in patients with high MPV values. The results of their study suggest that patients with high MPV on admission represent the group with higher risk for thrombosis.[17]

Akpek Met al[9] found that admission RPG was significantly higher in the no reflow group than in reflow group (the mean was 196.6±89.6 mg/dl vs 152.7±62 mg/dl, p<0.001). they also reported that the N/L ratio was significantly higher in no reflow group compared to that of normal flow group (4.6±1.7 vs. 3.1±1.9, p<0.001), and that N/L ratio >3.3 predicted no reflow with 74% sensitivity and 83% specificity.

Huczek Z et al[17] reported that the mean admission MPV was significantly higher in the no reflow patients compared with those with reflow post PPCI (10.8±0.95 fl vs 9.9±0.85 fl, p<0.0001), and that a value of MPV ≥ 10.3 fl predicted no reflow with a sensitivity 61.9%, and specificity 74.3%.

Angiographic findings and procedural aspects

In this study, there was no significant difference between groups A and B regarding IRA (**LAD** 70.7% vs 66.7%, **LCX** 2% vs 9.5%, **RCA** 20.2% vs 23.8%, **D1** 5%vs 0%, **OM** 1% vs 0%, **PDA** 1% vs 0%, respectively). No significant difference was present between the two groups regarding the initial (pre-intervention) TIMI flow grade (TIMI 0 in 87.6% vs 90.4%, TIMI 1 in 25.3% vs 4.8%, TIMI 2 in 5.1% vs 4.8%, respectively). Two patients (9.5%) in group B had POBA, while none in group A had POBA. No significant difference between the two groups regarding the type of stent used (BMS in 51.5% vs 57.1%, and DES in 48.5% vs 33.3%, respectively). In our study, more stent implantation, and more patients with initial TIMI 0 flow were found in the two studied groups than in the comparing studies, with the distribution of IRA near to that of other studies.

Ndrepepa G et al[9] found no significant difference between the reflow and no reflow groups regarding IRA (LAD 43.3% vs 42.6%, LCX 20.7% vs 15.7%, RCA 33.6% vs 37.1%), and the type of intervention (POBA in 18.3% vs 18.5%, stenting in 81.7% vs 81.5%). They found significantly more patients with pre-intervention TIMI flow grade 0 in the no reflow group (54.6% vs 83.3%, p<0.001).

Procedural Outcome

In our study, 13% of patients had no reflow (ie; TIMI flow <3, and/or MBG <2) after PPCI, and 87% of patients had reflow. There is a great variety in the literature regarding the incidence of no reflow after PPCI due to difference in the methods of diagnosis of no reflow, such as: post PPCI TIMI flow grade and MBG, radionuclide scintigraphy, and MCE, with difference in sensitivity between different methods.

Ndrepepa G et al[9] reported that TIMI 3 flow post PCI was achieved in 89% of patients and 9% suffered no reflow detected using radionuclide scintigraphy examination. They found that previous MI (18.5% in no reflow group vs 11.7% in reflow group, p=0.041), baseline TIMI flow grade (TIMI 0-1 in 88% of no reflow group vs 64% of reflow group, p<0.001) were significant independent predictors of no reflow after PPCI.

In-hospital course

In this study in-hospital MACE; cardiac death occurred in 5% of patients (6 cases), and they were cases of three vessel disease. Five of these cases were cases of incessant ventricular fibrillation that not responded to cardiopulmonary resuscitation according to European council of resuscitation guidelines, with inability to know whether they developed re-infarction or stent thrombosis. One case was presented with long standing cardiogenic shock, and died of persistent cardiogenic shock, that not responded to complete revascularization of all affected coronaries. No well-defined cases of reinfarction, stent thrombosis, and target vessel revascularization (TVR).

Akpek Met al[9] reported that in-hospital MACE; cardiac death 7%, reinfarction 5%, and in stent thrombosis 5%, with in hospital MACE significantly higher in the no reflow group (8.6% vs. 4.3%, P < 0.001), and N/L ratio was found to be independent predictor of in hospital MACE.

Study Limitations

1. The sample size is relatively small compared to large studies published in the literature, and larger studies are needed to validate these results.
2. They do not represent all-comers who presented with acute STEMI because there are still many patients in our country treated with fibrinolysis only without further PCI because of financial aspect. That is to say, the presumed lower mortality rate of affluent patients and the higher mortality rate of the sicker patients may balance each other out.
3. There is a proportion of the delay to PCI comprises the time taken by patients to decide whether they can proceed with the procedure, based on financial constraints.
4. Our data represent a two-centre experience where the operators are experienced and the hospital has good medical and paramedical team and good ambulance system. Whether these results can be generalized to other hospitals in our country is unclear.
5. Our study was not designed to evaluate safety and efficacy of DES compared to BMS in patients with STEMI and thrombus aspiration compared to direct PCI without thrombus aspiration.

6. Cases of cardiac death were not thoroughly investigated, for example by autopsy, to define well and help to further prevent the causes of in hospital cardiac death post PPCI.
7. We did not follow the no reflow patients after hospital discharge.

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