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Predictive Factors of No Reflow during Primary Angioplasty

Mouhaman-Inouwa Kpelafia[1], Ikram Chamtouri[2], Abdou Razak Moukaila[3], Ben Hamda Khaldoun[2], Walid Jomaa[2], Faouzi Maatouk[2]

[1]Cardiology Department, CHU Campus, Lomé, Togo
[2]Cardiology Department B, Fattouma Bourguiba University Hospital, Monastir, Tunisia
[3]Internal Medicine Department, Sylvanus Olympia University Hospital, Lomé, Togo
Email: kpelafiamohamed@yahoo.fr

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Abstract

Introduction: No reflow during primary angioplasty is associated with a poor prognosis despite the reopening of the culprit coronary. The aim of our work was to determine the predictive factors of no reflow. **Methodology**: Single-center retrospective analytical study from June 2000 to December 2016 that included patients presenting with STEMI took care of by primary angioplasty. No reflow was defined according to angiographic criteria: a TIMI flow < 3 (regardless of the Myocardial Blush Grade) or TIMI flow at 3 with MBG ≤ 1, patients were divided into two groups, one group with no reflow and a second group without no reflow. Clinical and angiographic data were compared between the two groups. Univariate and multivariate analysis was performed to determine the predictors of no reflow. **Results**: The prevalence of no reflow was 24%. In univariate analysis mean age, diabetes, hypertension, tachycardia, hypotension, killip stage 4 left ventricular failure, hyperglycemia > 11, renal failure, left ventricular dysfunction, tritruncal status, common trunk involvement, initial TIMI flow at 0, significant thrombotic load, delay to angioplasty > 6 hours, and predilation were all correlated with no reflow with a p < 0. 05. In multivariate analysis age > 75 years [OR = 6.02, 95% CI 1.4 - 27, p = 0.014], tachycardia [OR = 4.3, 95% CI 1.6 - 7.4, p = 0.037], delay to angioplasty > 6 hours [OR = 1.3, 95% CI 1.1 - 2.1, p = 0.003] and high thrombotic load [OR = 1.5, 95% CI 1.3 - 3.2, p = 0.02] were independent predictors of no reflow. **Conclusion**: No reflow is associated with a poor short-term prognosis. Its care requires knowledge of predictive factors, prevention and treatment.

Keywords

No Reflow, Primary Angioplasty, STEMI, Thrombus

1. Introduction

The challenge for the interventional cardiologist during primary angioplasty is to reopen the culprit coronary with the goal of removing the ischemia in order to reduce the size of the infarct as much as possible. However, in some cases, re-canalization of the culprit coronary is not followed by myocardial reperfusion. This early complication of angioplasty is no reflow described for the first time by Kloner in 1974 after his experiment on dogs [1].

No reflow is a multifactorial phenomenon that includes 5 pathophysiological mechanisms, namely: pre-existing microvascular dysfunction, distal embolization, ischemia lesions, reperfusion lesions and individual susceptibility [2].

The starting point of this phenomenon would be related to poor microvascular reperfusion of the myocardial tissue. This made Kloner and Rezkalla predict: "If the last two decades have been the decade of epicardial large trunk reperfusion, we predict that the first decade of the new millennium will be the decade of microvascular perfusion" [3].

In all studies, no reflow is a poor prognostic factor in the short and long term [1]-[10]; as it leads to poor infarct healing and left ventricular remodeling, increasing the risk of major cardiac events, including congestive heart failure and death [4].

Many of the well-accepted risk factors for no reflow are similar to other well-accepted cardiovascular risk factors, such as hypertension, smoking, dyslipidemia, diabetes, and other inflammatory processes [4].

It is therefore important to know its predictive factors in order to prevent complications related to no reflow and to ensure a better prognosis for patients. It is in this context that our work was carried out with the objective of determining the predictive factors of no reflow during short-term primary angioplasty.

2. Methodology

2.1. Study Framework

The collection of patient records took place in the B cardiology department of the Fattouma Bourguiba University Hospital.

2.2. Type and Period of Study

Analytical retrospective monocentric study from June 2000 to December 2016.

Inclusion criteria

Included in our study were all patients, regardless of age or gender coming to our center for STEMI who have been managed by primary angioplasty.

Exclusion criteria

Were excluded from our study: any patient who had not undergone an angioplasty during STEMI or who had been thrombolysed.

Judgement criteria

The search for predictive factors of no reflow in the acute phase of the infarc-

tion, was carried out using angiographic criteria as the judgment criteria in particular the **TIMI flow and the Myocardial Blush Grade (MBG) which are used together to define angiographic no reflow with a TIMI flow < 3 (whatever the MBG grade) or a TIMI flow of 3 with MBG at 0 or 1** at the end of the angioplasty.

2.3. Parameters Studied

A standardized data collection sheet was designed and used as support for data collection. The parameters studied were:

- **Sociodemographic data:** age (in years), gender (male or female), occupation and insured or uninsured status.
- **The reason for hospitalization:** chest pain, time of its onset, dyspnea.
- **Anthropometric parameters**: weight (kg), height (cm), body mass index (kg/m^2), waist circumference (cm) and systolic (SBP) and diastolic (DBP) blood pressure.
- **History and risk factors for coronary artery disease:** smoking, high blood pressure, diabetes, dyslipidemia, history of PAD, history of angioplasty, and family history of coronary artery disease or stroke.
- **The current treatment**
- **Data from the physical examination**: heart rate, blood pressure, left heart failure, global heart failure and shock.
- **Electrical anomalies** especially the sus shift of ST, its amplitude. The type of sus shift, the Q wave of necrosis.
- **Cardiac ultrasound data:** segmental kinetics disorders (akinesia, hypokinesia or dyskinesia), left ventricular systolic function.
- **Biological parameters:** blood sugar, creatinine and creatine kinase.
- **Coronary angiography parameters:** pre-treatment, status, culprit coronary, lesion length, thrombus load, initial TIMI flow, initial blush.
- **Angioplasty data:** time, type and length of stent, Direct stenting, pre-dilation, post-dilation, final TIMI flow, final blush.
- Complications: shock, rhythmic, mechanical, death.
- **The clinical and paraclinical evolution** during the same hospitalization.

2.4. Data Analysis

Data were entered and analyzed using SPSS software version 21. Categorical variables, presented as numbers and percentages, were compared using the Chi^2 test or Fisher's exact test. The continuous variables, presented as means and standard deviations, were compared by the Kruskall-Wallis test:

- If the p-value is equal to 0.001 then the difference between the two qualitative variables is highly significant when the study population is distributed according to these variables.
- If it is less than 0.02 then the difference between the two variables is very significant.

- If p is between 0.02 and 0.05 then the difference between the two variables is significant.
- When the p-value is greater than 0.05 then there is no significant difference between the two variables when the study population is divided according to these variables.

3. Results

During our study period, 354 patients underwent primary angioplasty during an acute coronary syndrome with ST-segment elevation including 297 men (84%) and 57 women (16%), *i.e.* a sex ratio of 5.2. The mean age was 60 ± 11 years, with extremes of 24 and 86 years. The age group between 50 and 64 years was the most represented at 40.7%. The cardiovascular risk factors (CRFs) found were active smoking (54.8%), diabetes (34.3%), hypertension (31%) and dyslipidemia (11%). Sixteen percent had a coronary history of which 7% had already undergone angioplasty and 4% coronary artery bypass grafting. Six point eight percent had a history of atrial fibrillation, 6.5% had stroke, 7% had peripheral artery disease (PAD) and 4.2% had a history of heart failure.

Eighty percent of patients were admitted within the first 6 hours of pain onset. On admission, 13% were in shock while fourteen percent had hypotension. Eighty-eight percent were in sinus rhythm, 22% had tachycardia, 72% had an elevation between 2 and 5 mm, 76.8% had a mirror and 8% had atrioventricular blok (AVB): second degree (2%) and third degree (6%). The inferior territory was the most affected in 47.8% of patients followed by the anterior territory in 45.5%. Hyperglycemia greater than 11 mmol was found in 129 patients (36.4%), 11.6% had renal failure (**Table 1**).

The femoral approach was predominant in 76% of patients. Fifty-nine percent of patients had monotruncular, 29% bitruncular and 12% tritruncular involvement. LAD was guilty in 46.5%, RCA 40.3%, Cx 11.2% and TCG 2%. Before the passage of the guide, the TIMI 0 flow was found in 67.2%, the TIMI 2 and TIMI 3 flows in 13.3% each and the TIMI 1 flow in 6.2% (**Table 2**). The thrombotic load was low in 43%, absent in 41%, and significant in 16%. Seventy-one percent of our patients had undergone angioplasty within the first 6 hours of pain onset. During the angioplasty procedure, direct stenting was performed in 47%, predilation in 40%, and thromboaspiration in 2%. Seventy-six percent of patients had received one stent and 15% had two stents. The mean stent length was 18.26 ± 7.32 mm.

At the end of angioplasty (TCA), 78.7% had TIMI 3, TIMI 0 (16.1%) TIMI 2 (5.2%), and TIMI 1 (0%) flow while the final blush was MBG 3 (69%) MBG 2 (15.8%) MBG 0 (9%) and MBG 1 (6.2%). Pain had regressed in 82% of patients, while it was persistent in 18%. The elevation was reduced by more than 50% in 53% of patients while it persisted in 47%. LVEF was less than or equal to 40% in 24% and moderate in 31%. There were 24% complications including 11% post angioplasty shock and 11.8% intra-hospital death (**Table 3**).

Table 1. General characteristics of the population.

Variable	General population	No reflow	Absence no reflow	p
Mean age	60 (24 - 86)	63 (24 - 83)	59 (29 - 86)	0.03
Age > 75 years	30 (8.4%)	11 (13%)	19 (7%)	0.03
Male	297 (84%)	70 (82.3%)	227 (84.4%)	0.61
Diabetes	115 (34.3%)	35 (41.2%)	80 (29.7%)	0.04
Hypertension	104 (31%)	34 (40%)	70 (26%)	0.01
Dyslipidemia	39 (11%)	6 (7%)	33 (12.3%)	0.19
Active smoking	195 (54.8%)	44 (51.8%)	150 (55.8%)	0.07
History of Coronary	58 (16.4%)	15 (17.6%)	43 (16%)	0.2
History of PAC	15 (4.2%)	4 (5%)	11 (4%)	0.5
History of CI	15 (4.2%)	4 (5%)	11 (4%)	0.5
History of stroke	23 (6.5%)	5 (5.9%)	18 (6.7%)	0.7
History of PAD	24 (6.8%)	6 (7%)	18 (6.7%)	0.9
History of FA	24 (6.8%)	7 (8%)	17 (6%)	0.3
Tachycardia	71 (20%)	29 (34.1%)	42 (15.6%)	0.0001
Hypotension	37 (10.5%)	19 (22.3%)	18 (6.7%)	0.0001
LVF admission	149 (42%)	58 (68.2%)	91 (33.8%)	0.01
Killip 1	98 (27.6%)	32 (37.6%)	66 (24.5%)	-
Killip 2	9 (2.5%)	2 (2.3%)	7 (2.6%)	-
Killip 3	7 (1.9%)	3 (3.5%)	4 (1.4%)	-
Killip 4	35 (9.8%)	21 (24.7%)	14 (5.2%)	0.0001
Hyperglycemia > 11	129 (36.4%)	37 (43.5%)	92 (34.2%)	0.005
Average CPK peak	2586	2785	2515	0.4
Renal insufficiency	41 (11.6%)	15 (17.6%)	26 (9.6%)	0.009
LV dysfunction	88 (25%)	33 (38.8%)	55 (20.4%)	0.02
MI location				
Anterior	161 (45.5%)	41 (48.2%)	120 (44.6%)	0.7
Inferior	169 (47.8%)	36 (42.3%)	133 (49.4%)	0.8
Lateral	17 (4.8%)	7 (8.2%)	10 (3.7%)	0.6

Table 2. Coronarographic aspects.

Variable	General population	No reflow	Absence no reflow	p
Coronary status				
Monotruncular	208 (58.8%)	42 (49.4%)	166 (61.7%)	0.08
Bitruncular	104 (29.3%)	27 (31.8%)	77 (28.6%)	0.08

Continued

Tritroncular	42 (11.9%)	16 (18.8%)	26 (9.7%)	0.03
LAD culprit	157 (46.5%)	38 (45.8%)	119 (46.7%)	0.8
Culprit RCA	135 (40%)	31 (37.3%)	104 (40.8%)	0.5
CX culprit	38 (11.2%)	8 (9.6%)	30 (11.8%)	0.3
TCG culprit	7 (2%)	5 (6%)	2 (0.8%)	0.004
Initial TIMI flow				
TIMI 0	238 (67.2%)	65 (76.5%)	173 (64.3%)	0.009
TIMI 1	22 (6.2%)	7 (8.2%)	15 (5.6%)	0.16
TIMI 2	47 (13.3%)	7 (8.2%)	40 (14.9%)	0.11
TIMI 3	47 (13.3%)	6 (7.1%)	41 (15.2%)	0.11

Table 3. Characteristics of angioplasty.

Variable	General population	No reflow	Absence no reflow	p
Thrombotic load	208 (58.7%)	65 (76.5%)	143 (53.2%)	0.0001
TCA delay > 6 H	160 (45.2%)	47 (55.3%)	113 (42%)	0.018
Direct Stenting	151 (47%)	20 (23.5%)	131 (48.7%)	0.18
Predilation	136 (40%)	41 (48.2%)	95 (35.3%)	0.001
Thromboaspiration	8 (2%)	4 (4.7%)	4 (1.4%)	0.3
Number of Stents				
1 stent	251 (70.9%)	53 (62.3%)	198 (73.6%)	0.6
2 stents	53 (15%)	15 (17.6%)	38 (14.1%)	0.16
Mean stent length	18.26 ± 7.3	20.91 ± 8.2	17.63 ± 6.8	0.12
Final TIMI flow	267 (75.4%)	57 (67%)	210 (78%)	
TIMI 0	43 (16.1%)	43 (75.4%)	0 (0%)	0.0001
TIMI 1	0 (%)	0 (0%)	0 (0%)	
TIMI 2	14 (5.2%)	3 (30.5%)	11 (6.7%)	0.11
TIMI 3	210 (78.7%)	11 (5.8%)	199 (98.8%)	0.11
Final Blush				
Blush 0	32 (9%)	32 (37.6%)	0 (0%)	0.0001
Blush 1	22 (6.2%)	22 (25.9%)	0 (0%)	0.0001
Blush 2	56 (15.8%)	5 (5.9%)	51 (19%)	0.08
Blush 3	244 (69%)	26 (30.6%)	218 (81%)	0.19
Persistent pain post TCA	34 (9.6%)	16 (19%)	18 (6.7%)	0.008
Elevation regression < 50%	67 (18.9%)	38 (44.7%)	29 (10.7%	0.0001

No reflow defined according to angiographic criteria was present in 85 patients, *i.e.* a prevalence of 24% in our population. By correlating according to the presence or absence of no reflow and the different variables, we obtained in univariate analysis: Sex (p = 0.61) was not correlated while age and especially advanced age over 75 years were well correlated with a p = 0.03. The risk factors, diabetes (p = 0.04) and hypertension (p = 0.01) were correlated while dyslipidemia (p = 0.19) and active smoking (p = 0.07) were not. Clinically, tachycardia (p = 0.0001), hypotension (p = 0.0001) and shock on admission at Killip stage 4 (p = 0.0001) were highly significant. Paraclinically, hyperglycemia greater than 11 (p = 0.005), renal failure (p = 0.005) and LV dysfunction (p = 0.02) were correlated with no reflow.

With regard to angiographic parameters, the tritruncular status (p = 0.03), the culprit coronary when it came to TCG (p = 0.004) and the significant thrombotic load (p = 0.0001) were correlated with no reflow.

Delay to angioplasty beyond 6 hours (p = 0.018) was also correlated with no reflow. Predilation (p = 0.001) was strongly correlated with the occurrence of no reflow, whereas direct stenting (p = 0.18) was not.

The persistence of pain after angioplasty (p = 0.008) as well as the regression of the elevation when it was less than 50% were strongly correlated.

Intra-hospital mortality (p = 0.0001) was 2.2 times higher in the population with no reflow than in the population without no reflow.

In multivariate analysis, four variables remained significant, namely advanced age (OR: 6.02; IC: 1.4 - 27; p: 0.014), tachycardia (OR: 4.3; CI: 1.6 - 7.4; p: 0.037), delay to angioplasty greater than 6 hours (OR: 1.3; CI: 1.1 - 2.1; p: 0.036) significant thrombotic load (OR: 1.5; CI: 1.3 - 3.2; p: 0.02) (**Table 4**). These four variables remaining significant in regression logistics were associated with a poor reperfusion and were also independent predictors of no reflow.

4. Discussion

The prevalence of no reflow will depend on the implementation of predictive factors in the population and the evaluation method. In our study, the prevalence was 24% using the TIMI score and the Myocardial Blush Grade (MBG), *i.e.* 16.4% according to the TIMI alone and 22.6% according to the MBG. This result is consistent with the prevalence of no reflow described in the literature, which varies between 5% and 60% depending on the evaluation method [5] [6]. In 2010,

Table 4. Multivariate analysis of the different variables.

Independent factors	Odds ratio	95% CI	p
Age > 75 years	6.02	1.4 - 27	0.014
Tachycardia	4.3	1.6 - 7.4	0.037
TCA delay > 6 H	1.3	1.1 - 2.1	0.036
Significant thrombotic load	1.5	1.3 - 3.2	0.02

Rezkalla *et al.* found a prevalence of 32% according to the diagnosis based on the TIMI score and 57% based on the MBG [7]. M Chettibi *et al.* [8] in Algeria in 2014 had found a prevalence of 38.8% in their study, in which the judgement criterion was based on the resolution of the elevation (less than 50%) after thrombolysis and primary angioplasty. Our prevalence was lower than that of Rezkalla and M Chettibi. S Charfeddine *et al.* [9] in their series between 2012 and 2013 in Sfax in Tunisia had found a prevalence of 8% of angiographic no reflow while Hua Zhou [10] had found a prevalence of 17.3% in China in his work in which the judgement criterion was based solely on the TIMI score. Our prevalence was higher than that of S Charfeddine and Hua Zhou.

In our study, the mean age was 60 years in our population, patients with no reflow were older with a mean age of 63 years (p = 0.03) compared to 59 years in patients without no reflow. No reflow was correlated with age in univariate analysis; this was not the case in multivariate analysis. However, age over 75 years (p = 0.03) remained significant in multivariate analysis with an odd ratio of 6.26, a 95% confidence interval (CI) OR 1.44 - 27.10 and a p = 0.014.

In Gupta's meta-analysis [2], an age greater than or equal to 60 years was correlated with no reflow. In M Chettibi's series [8], patients with poor myocardial reperfusion were older with a mean age of 59 years (p = 0.08) compared to the group of patients with good regression of ST, this age is lower than ours. In Jonny K's meta-analysis [11], the mean age of patients with no reflow was 63.3 years (p = 0.0001), identical to our mean age. Indeed, age is widely recognized as one of the risk factors for coronary disease [12].

However, understanding of the relationship between age and no-reflow is limited. This mechanism would probably be related to pre-existing microvascular dysfunction [2]. Advanced age is one of the major risk factors as aging has an important role in the occurrence of vascular endothelial dysfunction and elastic arteries stiffness. These pathological changes are related to advanced age, lack of ischemic preconditioning and collateral circulation, and altered neurohormonal and autonomic influences. They may contribute to distal embolization during primary angioplasty, leading to no reflow [13].

Diabetes is a powerful risk factor predictor of poor prognosis in acute coronary syndrome [14]. This is because diabetic patients are characterized by a pro-atherosclerotic and prothrombotic state, with an increased risk of inflammation-related plaque rupture, endothelial dysfunction, platelet activation, disruptions of the coagulation cascade, as well as inhibition of the endogenous thrombolytic system [15]. Diabetes (p = 0.04) was significantly correlated with no reflow in our univariate analysis work. However, in multivariate analysis it was not. M Chettibi [8] and Jonny [11] found a correlation between diabetes and no reflow in univariate and multivariate analysis respectively OR = 1.87, 95% CI [1.2 - 3.0] and a p = 0.008 and OR = 1.45 95% CI [1.16 - 1.81], p = 0.0010. Our result remains consistent with the literature data.

Regardless of the history of diabetes, hyperglycemia may be associated with altered microvascular function after acute myocardial infarction, leading to

larger infarct size and poorer functional recovery [16] and is associated with increased mortality after myocardial infarction [17]. The reduction in blood sugar, thanks to insulin therapy, during the first 24 hours of acute myocardial infarction decreases mortality in patients with diabetes [18]. The increased mortality in patients with hyperglycemia could be explained by a larger infarct size [19], a high incidence of congestive heart failure and cardiogenic shock [20]. In our study, hyperglycemia above 11 was correlated with no reflow with a p = 0.005 in univariate analysis. In multivariate analysis there was no correlation. Several mechanisms could explain the association between hyperglycemia and no reflow. First, large infarcts are more likely to cause catecholamine release, which is known to affect fatty acid and glucose homeostasis. Acute hyperglycemia also increases levels of intercellular adhesion molecule [21] or P-selectin [22], which would increase leukocyte clogging in capillaries. Leukocytes trapped in coronary capillaries and venules early after coronary reperfusion are observed much more frequently in the diabetic rat heart than in the non-diabetic heart [23]. Clogging of leukocytes in the microcirculation could further contribute to no reflow [24].

Hyperglycemia can also increase thrombus formation. A recent clinical study suggests that a microthrombus in capillaries plays a crucial role in no reflow after myocardial infarction [25]. Blood glucose is an independent predictor of platelet thrombosis, even within the normal range [26]. Hyperglycemia may also attenuate the impact of ischemic preconditioning, which is an independent predictor of no reflow [27]. Acute hyperglycemia is known to abolish the effect of ischemic preconditioning [28], probably by attenuating the activation of mitochondrial adenosine triphosphate-regulated potassium channel [29]. Hyperglycemia could also reduce collateral flow to the area at risk [30], leading to greater myocardial lesion before reperfusion and, subsequently, at no reflow [27].

Heart rate is a known predictor of morbidity and mortality. The *National Health and Nutrition Examination Survey* (NHANES) epidemiological follow-up study (5995 healthy subjects) concluded that increased resting heart rate was an independent risk factor for the incidence of coronary heart disease or death in white and black men and women [31]. As the heart rate increases and especially in the case of tachycardia, the duration of diastolic irrigation decreases and the myocardial oxygen demand increases. Maximum coronary flow increases markedly during diastole, subjecting the coronary arteries to marked endothelial shear stress and pulsatile wall tension. The endothelium under such tension releases growth hormones (e.g., transforming growth factor-beta and insulin-like growth factor-1) and vasoconstrictor peptides (e.g., endothelin), along with the increase of platelet aggregation and a relative deficit in nitric oxide synthesis. Rapid pulsatile changes appear to increase mechanical lesions affecting the endothelium already under tension. All these factors favor the development of atherosclerotic lesions, especially in arterial branches, as well as the occurrence of no reflow during myocardial infarction [32]. In our study, tachycardia was strongly correlated with no reflow in univariate (p = 0.0001) and multivariate analysis OR = 4.3 95% CI [1.6 - 7.4], p = 0.037. M Chettibi [8] and Jonny [11] found the same

results.

Shock on admission or Killip stage 4 left ventricular (LV) failure was very significantly associated with no reflow (p = 0.0001) in univariate analysis. Shock on admission may be due to a larger infarct caused by severe microvascular bed injury as well as decreased coronary perfusion pressure. This explains why these patients had a higher rate of no reflow [10]. Indeed the degree of myocardial dysfunction that triggers cardiogenic shock is often, but not always, severe [33]. LV dysfunction during shock reflects new irreversible damage, reversible ischemia, and damage from a previous infarction. Metabolic changes occur in the distant myocardium and in the infarct region [34]. Decreased cardiac flow results in decreased systemic and coronary perfusion. This exacerbates ischemia and causes cell death in both the infarcted and non-infarcted areas. Hypoperfusion causes the release of catecholamines, which increase contractility and peripheral blood flow, but catecholamines also increase myocardial oxygen demand and have proarrhythmic and myocardiotoxic effects [35]. All this favors the occurrence of no reflow.

Reperfusion delay greater than 6 hours was correlated with no reflow with a p = 0.001 in univariate analysis and OR = 1.3, 95% CI [1.1 - 2.1], p = 0.03 in multivariate. Hua Zhou [10] found the same result, *i.e.* p = 0.005 in univariate analysis and OR = 1.27, 95% CI [1.16 - 1.4], p = 0.001 in multivariate. Indeed, myocardial necrosis occurs about 6 hours after the onset of a coronary occlusion. As reported, prolonged ischemia leads to edema of the distal capillary bed, swelling of myocardial cells, clogging of neutrophils, alterations in capillary integrity and disturbance of the microvascular bed, which contribute to the occurrence of no reflow [36]. In the early stages of infarction, the thrombus is rich in thrombocytes and relatively easier to lyse by adjunctive pharmacotherapy [37]. With a longer duration of reperfusion, the thrombus takes up more erythrocytes and becomes more rigid. These thrombi tend to fragment during balloon dilation, which may lead to distal coronary embolization. In addition, delayed reperfusion leads to an older, well-organized intracoronary thrombus. This may increase the risk of distal embolization during angioplasty and reduce the probability of reaching TIMI 3 flow after the procedure [38].

The significant thrombotic load was significantly correlated with no reflow with a p = 0.0001 in univariate analysis as well as in multivariate analysis (OR = 1.5, 95% CI [1.3 - 3.2], p = 0.02). Jonny [11] in his meta-analysis made the same observation: (OR = 3.69, 95% CI [2.39 - 5.68], p < 0.0001). Yip *et al.* [39] demonstrated that in patients with MI who had a significant thrombotic load, the rate of no reflow was lower in those who had received reperfusion in less than 4 hours than the others. This indicates the possible correlation of a thrombus load with the duration of reperfusion. Emboli of different sizes may originate from epicardial coronary thrombus and from atherosclerotic plaques cracked during angioplasty; but spontaneous embolization has also been suspected before vessel manipulation. In some cases, abnormal flow after angioplasty could be due to the dislodgement of an obstructive thrombus distal to the culprit lesion. It should

be noted that this phenomenon is not detectable by angiography, thus requiring other coronary imaging methods, such as IVUS and optical coherence tomography (OCT). In this context, as suggested by a recent OCT study, persistence of thrombus after stenting may lead to distal embolization even after stent deployment [40].

No reflow has a poor prognosis in the short, medium and long term. In our work, intra-hospital mortality was twice as high in the group with no reflow (p = 0.0001) than in the group without no reflow. Choo E Ho [41] showed that the association between no reflow and mortality was significant and stronger for short-term mortality (<30 days) (adjusted HR: 3.11; 95% CI: 1. 91 - 5.05; p < 0.001) but was not significant for long-term mortality (≥30 days; adjusted HR: 1.12; 95% CI: 0.82 - 1.52; p = 0.47). Whereas in the work of Frederic S R [42] long-term mortality was 3 times higher in no-reflow (7.4% vs 2.0%, p < 0.001) and no-reflow remained a strong independent predictor of death or MI after multivariate analysis (odds ratio 3.6; p < 0.001). Indeed, all these predictive factors increase the risk of occurrence of no reflow which in turn increases mortality.

The limits of this study reside in the retrospective nature of this work, especially in the fact that certain parameters studied were not complete in certain patients collected.

5. Conclusion

Our work has shown that in the short term mortality was high in no reflow. The understanding of no reflow is based on its physiopathological mechanisms and its care is based on the knowledge of the predictive factors and its treatment. These predictive factors are numerous and include demographic parameters, cardiovascular risk factors, clinical, biological, coronarographic and procedural parameters. However, no reflow can occur not only during primary angioplasty but also during elective angioplasty. In this case, a score is needed to better predict and prevent this phenomenon.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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