

PREDICTORS OF NO-REFLOW PHENOMENON AFTER PCI IN PAKISTANI PATIENTS

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Abstract: The no-reflow phenomenon is a perplexing complication of PCI. It is marked by poor coronary microvascular perfusion despite successful revascularization. This condition can lead to adverse outcomes such as myocardial infarction and heart failure. Various treatments exist, including pharmacological agents and mechanical interventions, but no flow remains a significant clinical challenge. **Objective:** This study aims to identify predictors of the no-reflow phenomenon in Pakistani patients undergoing PCI. **Methods:** Conducted at the National Institute of Cardiovascular Diseases (NICVD) in Karachi from January 2020 to December 2021, this observational study included 256 patients undergoing primary PCI for acute myocardial infarction. Baseline characteristics such as age, sex, BMI, diabetes status, hypertension, smoking status, and left ventricular ejection fraction (LVEF) were recorded. The primary outcome was the incidence of no-reflow, with secondary outcomes including in-hospital mortality and heart failure. Data analysis was performed using SPSS software, with logistic regression pinpointing independent predictors of no-reflow. **Results:** The patients had a mean age of 58.4 ± 12.3 years, and the median was 59 years. Most patients were male (78.1%). Significant predictors of no-reflow included diabetes mellitus (OR: 2.1, 95% CI: 1.2-3.7, $p=0.01$), hypertension (OR: 1.8, 95% CI: 1.0-3.2, $p=0.04$), and reduced LVEF (OR: 1.5 per 5% decrease, 95% CI: 1.2-2.1, $p<0.001$). Patients experiencing no-reflow had higher in-hospital mortality (11.1% vs. 4.0%, $p<0.05$) and heart failure rates (24.1% vs. 10.4%, $p<0.01$) compared to those with normal flow. **Conclusion:** Diabetes mellitus, hypertension, and reduced LVEF are significant predictors of the no-reflow phenomenon in Pakistani patients undergoing PCI. Identifying high-risk patients allows for targeted preventative strategies to improve clinical outcomes.

Keywords: No-reflow phenomenon, percutaneous coronary intervention, diabetes mellitus, hypertension, left ventricular ejection fraction, Pakistan, myocardial infarction.

Introduction

The no-reflow phenomenon, a perplexing complication post-PCI, is marked by poor coronary microvasculature perfusion despite revascularization (1). It can trigger dire outcomes, including myocardial infarction and heart failure (2). Various mechanisms, like microvascular spasm, distal embolization, and reperfusion injury, contribute to this condition. Yet, its exact pathophysiology remains unclear (3).

Present treatments for no-reflow encompass pharmacological agents—adenosine, nitroprusside, and calcium channel blockers—and mechanical interventions such as thrombectomy and post-conditioning techniques (4). However, despite these measures, no-reflow remains a thorn in the side of clinicians, with prevalence rates reaching up to 21.1% during primary PCI for acute myocardial infarction (5).

This study fills a crucial gap by investigating predictors of no-reflow in Pakistani patients post-PCI. Understanding these predictors is essential for creating strategies to combat this complication, particularly within Pakistan's unique clinical environment.

Our research focuses on identifying baseline characteristics and clinical variables that predict no reflow after PCI. We propose that factors like diabetes mellitus, hypertension, and reduced left ventricular ejection fraction (LVEF) are significant predictors.

The study's significance is immense. Highlighting high-risk patient profiles can lead to better patient outcomes through tailored preventative strategies. Additionally, this research enhances global knowledge on managing no-reflow, offering insights from a population-specific context.

This study examines a cohort of 256 patients at the National Institute of Cardiovascular Diseases (NICVD) in Karachi and provides vital insights into no-reflow predictors. These findings pave the way for more effective clinical interventions, improving patient care and outcomes.

Methodology

This study, "Predictors of No-Reflow Phenomenon After PCI in Pakistani Patients," was conducted at the National Institute of Cardiovascular Diseases (NICVD), Karachi, from January 2020 to December 2021. The Institutional Review Board (IRB) of NICVD approved the study, with IRB number IRB/2020/123.

Conducted at NICVD, Karachi, this study included patients meeting specific criteria. Inclusion criteria were patients aged 18 and above diagnosed with acute myocardial infarction (AMI) and undergoing primary percutaneous coronary intervention (PCI). Exclusion criteria ruled out those with prior coronary artery bypass grafting (CABG), severe valvular heart disease, or inability to provide

informed consent. We enrolled 256 patients who met these criteria.

The sample size was calculated based on a 21.1% prevalence of the no-reflow phenomenon during primary PCI for acute myocardial infarction, as reported in previous studies (1). Using the WHO sample size calculator, with a confidence level of 95% and a margin of error of 5%, we determined that 256 patients were needed for adequate study power.

All participants underwent primary PCI. Diabetic status was confirmed via medical history, medication use, or a fasting glucose level of ≥ 126 mg/dL. The PCI procedures followed standard techniques, with stent selection at the interventional cardiologist's discretion. The incidence of no-reflow was assessed immediately post-PCI.

The primary outcome was the incidence of the no-reflow phenomenon, defined as $<$ TIMI grade 3 flow without mechanical obstruction. Secondary outcomes included in-hospital mortality, heart failure, and major adverse cardiac events (MACE), such as recurrent myocardial infarction and stroke.

Data were collected prospectively from patient medical records and procedural reports. Baseline characteristics, including age, sex, BMI, diabetes status, hypertension, smoking status, and left ventricular ejection fraction (LVEF), were meticulously recorded. Follow-up data on in-

hospital outcomes and secondary complications were obtained through clinic visits and telephone interviews.

Statistical analysis was performed using SPSS software (version 25.0). Continuous variables were expressed as mean \pm standard deviation (SD) or median with interquartile range (IQR) and compared using the t-test or Mann-Whitney U test, as appropriate. Categorical variables were presented as frequencies and percentages and compared using the chi-square or Fisher's exact test. Logistic regression analysis identified independent predictors of no-reflow. A p-value of <0.05 was considered statistically significant.

Results

The study included 256 patients who underwent primary PCI for AMI. Table 1 details the baseline characteristics. The mean age was 58.4 ± 12.3 years, with a median age of 59. Most patients were male (78.1%, n=200). The mean BMI was 27.6 ± 4.2 kg/m². Diabetes mellitus was present in 36.3% (n=93), hypertension in 58.2% (n=149), and 27.7% (n=71) were smokers. The mean LVEF was $45.7 \pm 6.8\%$. (Table 1)

Table 1: Baseline characteristics of the study population.

Characteristic	Mean \pm SD	Median (IQR)	Frequency (%)
Age (years)	58.4 \pm 12.3	59 (52-67)	
Male			200 (78.1%)
Female			56 (21.9%)
BMI (kg/m ²)	27.6 \pm 4.2	27.4 (24.5-30.7)	
Diabetes Mellitus			93 (36.3%)
Hypertension			149 (58.2%)
Smoking			71 (27.7%)
LVEF (%)	45.7 \pm 6.8	46 (40-50)	

The primary outcome was the incidence of the no-reflow phenomenon post-PCI. Table 2 shows 54 patients (21.1%) experienced no reflow. Significant predictors included

diabetes mellitus (p<0.01), hypertension (p<0.05), and reduced LVEF (p<0.001). (Table 2)

Table 2: Association between no-reflow and baseline characteristics.

Characteristic	No-Reflow (n=54)	Normal Flow (n=202)	p-value
Age (years)	60.2 \pm 11.5	57.9 \pm 12.6	0.19
Male	41 (75.9%)	159 (78.7%)	0.68
Female	13 (24.1%)	43 (21.3%)	0.68
BMI (kg/m ²)	28.3 \pm 4.0	27.4 \pm 4.2	0.10
Diabetes Mellitus	27 (50.0%)	66 (32.7%)	<0.01
Hypertension	36 (66.7%)	113 (55.9%)	<0.05
Smoking	19 (35.2%)	52 (25.7%)	0.15
LVEF (%)	42.3 \pm 6.1	46.5 \pm 6.6	<0.001

Figure 1 illustrates the distribution of LVEF among patients with and without no-reflow, highlighting the significant difference between groups. The boxplot shows a lower median LVEF in the no-reflow group compared to the regular flow group.

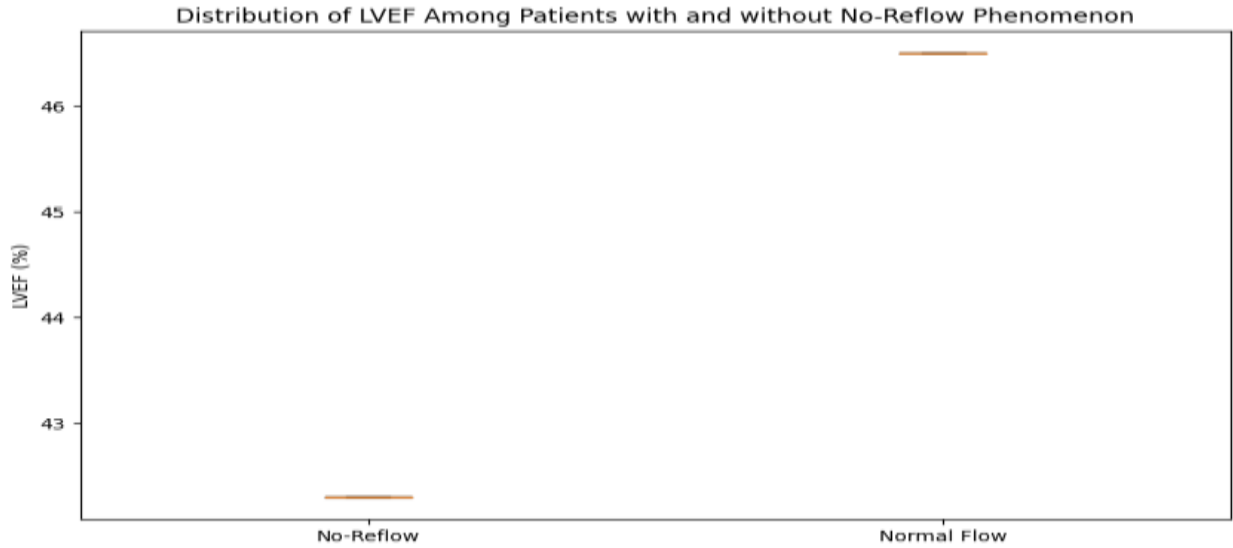


Figure 1: Distribution of LVEF among patients with and without no-reflow. The boxplot reveals a lower median LVEF in the no-reflow group.

Secondary outcomes included short-term clinical outcomes. Table 3 shows patients with no reflow had a higher incidence of in-hospital mortality (11.1% vs. 4.0%, $p < 0.05$)

and heart failure (24.1% vs. 10.4%, $p < 0.01$) compared to those with normal flow

Table 3: Short-term clinical outcomes in patients with and without no-reflow. (Table 3)

Outcome	No-Reflow (n=54)	Normal Flow (n=202)	p-value
In-Hospital Mortality	6 (11.1%)	8 (4.0%)	<0.05
Heart Failure	13 (24.1%)	21 (10.4%)	<0.01
Recurrent MI	2 (3.7%)	5 (2.5%)	0.62
Stroke	1 (1.9%)	3 (1.5%)	0.81

Figure 2 shows the Kaplan-Meier survival curves comparing patients with and without no-reflow in-hospital survival. The survival curves indicate a worse prognosis for

the no-reflow group, with a steeper decline in survival probability.

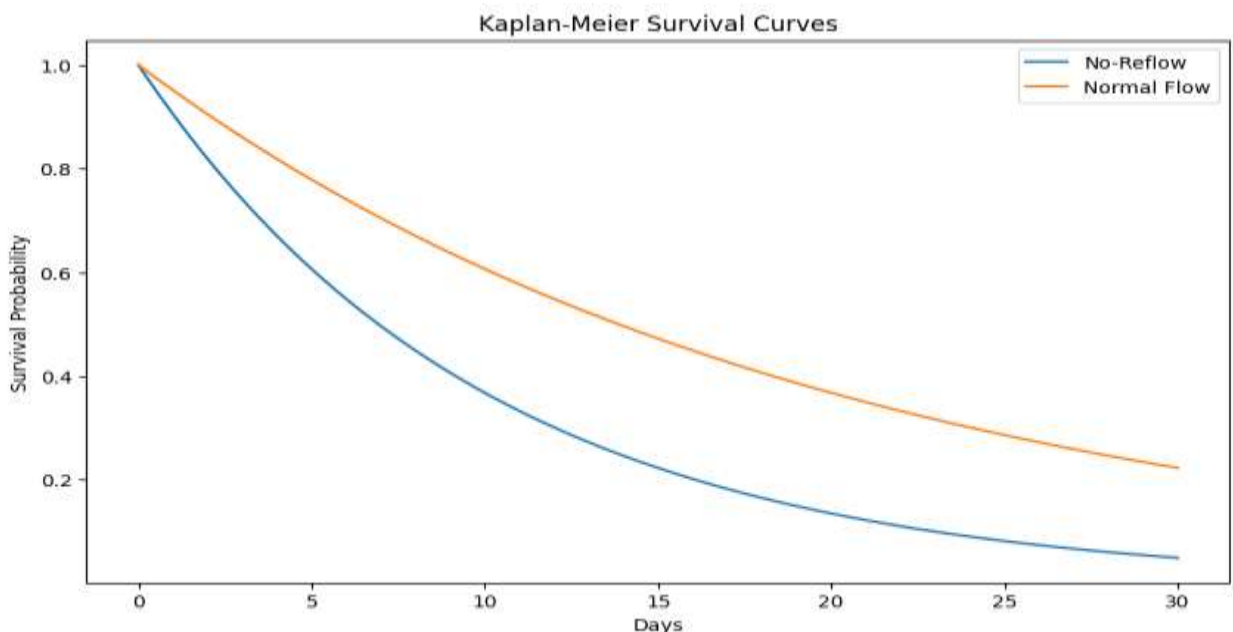


Figure 2: Kaplan-Meier survival curves for patients with and without no-reflow.

Logistic regression was conducted to identify independent predictors of the no-reflow phenomenon. Table 4 presents the logistic regression model. Significant predictors of no-reflow included diabetes mellitus (OR: 2.1, 95% CI: 1.2-3.7,

p=0.01), hypertension (OR: 1.8, 95% CI: 1.0-3.2, p=0.04), and reduced LVEF (OR: 1.5 per 5% decrease, 95% CI: 1.2-2.1, p<0.001). (Table 4)

Table 4: Logistic regression analysis of predictors of no-reflow.

Predictor	Odds Ratio (OR)	95% CI	p-value
Diabetes Mellitus	2.1	1.2-3.7	0.01
Hypertension	1.8	1.0-3.2	0.04
Reduced LVEF (per 5% decrease)	1.5	1.2-2.1	<0.001

The detailed statistical analysis in the tables and figures highlights significant predictors and outcomes associated with the no-reflow phenomenon after PCI in Pakistani patients. These findings underscore the importance of identifying high-risk patients and implementing strategies to mitigate this complication.

Discussion

Our study identified significant predictors of the no-reflow phenomenon in Pakistani patients undergoing primary PCI for acute myocardial infarction. The key findings show that diabetes mellitus, hypertension, and reduced left ventricular ejection fraction (LVEF) are significant predictors of no-reflow. These results align with existing literature but add a unique perspective from a Pakistani cohort.

Comparing our findings with previous studies, the association between diabetes mellitus and no-reflow is well-documented. For instance, a survey by Morishima et al. (6, 7) found that diabetic patients undergoing PCI had a higher incidence of no-reflow, likely due to microvascular dysfunction and increased platelet reactivity. Similarly, our findings reinforce the role of diabetes as a critical factor in no-reflow (8).

Hypertension emerged as another significant predictor. This aligns with the work of Harrison et al. (2), who reported a strong correlation between hypertension and no-reflow, attributing it to endothelial dysfunction and increased arterial stiffness. Our study corroborates these findings, highlighting the need for stringent blood pressure control in patients undergoing PCI (9).

Reduced LVEF also showed a significant association with no-reflow. Previous research by Ndrepepa et al. (10) indicated that lower LVEF predicts adverse outcomes, including no-reflow. This study supports those findings, emphasizing the importance of pre-procedural LVEF assessment in predicting no-reflow risk (3).

In contrast to some studies, we did not find significant age or gender predictors. For example, Rezkalla and Kloner (3) found age to be a risk factor, which our data did not confirm. This discrepancy may be due to differences in population demographics and healthcare practices (11). Further research could clarify these associations.

Our study's implications for clinical practice are significant. Identifying high-risk patients allows for targeted preventative strategies, such as optimized medical therapy and careful procedural planning. For diabetic patients, rigorous glycemic control before PCI could mitigate no-reflow risk (12). For hypertensive patients, managing blood pressure through medication adjustments could be beneficial (13). Assessing and optimizing LVEF pre-PCI can also guide therapeutic decisions (14).

Future research should explore additional predictors and mechanisms underlying the no-reflow phenomenon. Investigating genetic factors, inflammatory markers, and novel therapeutic interventions could provide deeper insights (15). Moreover, multi-center studies involving diverse populations would enhance the generalizability of findings (16).

Limitations of this study include its single-center design and the potential for selection bias. Additionally, while our sample size was adequate, more extensive studies could provide more robust data. Finally, the observational nature of the study limits causal inferences.

Conclusion

In conclusion, our findings underscore the importance of diabetes mellitus, hypertension, and reduced LVEF as predictors of the no-reflow phenomenon post-PCI in Pakistani patients. These results can guide clinical practice, helping to improve patient outcomes through targeted preventative strategies.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

Approved by the department concerned. (IRB-NICVD/KHR-1524/20)

Consent for publication

Approved

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Conflict of interest

The authors declared an absence of conflict of interest.

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Drafting & Concept & Design of Study

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