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THE EFFICACY OF THROMBECTOMY IN REDUCING THE NO-REFLOW PHENOMENON IN STEMI PATIENTS UNDERGOING PERCUTANEOUS CORONARY INTERVENTION: A RETROSPECTIVE COHORT STUDY

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Abstract:

Background

The no-reflow phenomenon, characterized by inadequate myocardial perfusion despite successful recanalization of the coronary artery, remains a significant complication during primary percutaneous coronary intervention (PPCI) for ST-elevation myocardial infarction (STEMI). Manual aspiration thrombectomy has been proposed as a potential intervention to reduce no-reflow by preventing distal embolization of thrombus during PPCI.

Objective

This study aimed to assess the effectiveness of manual aspiration thrombectomy in reducing the incidence of the no-reflow phenomenon in STEMI patients undergoing PPCI.

Methods

We conducted a retrospective cohort study of 311 STEMI patients who underwent PPCI at a tertiary care center from January 1, 2023, to December 31, 2023. Of these, 156 patients received thrombectomy before PPCI, while 155 underwent PPCI without thrombectomy. The primary outcome was the incidence of the no-reflow phenomenon, defined as a post-PPCI TIMI (Thrombolysis in Myocardial Infarction) flow grade less than 3. Secondary outcomes included left ventricular ejection fraction (LVEF) and 30-day all-cause mortality. Data were analyzed using multivariate logistic regression to adjust for potential confounders.

Results

The no-reflow phenomenon occurred in 12.2% of patients in the thrombectomy group compared to 25.8% in the control group ($p = 0.003$). LVEF was significantly higher in the thrombectomy group (54.3% ± 7.9%) compared to the control group (49.6% ± 8.2%, $p < 0.001$). There was a non-significant trend toward lower all-cause mortality in the thrombectomy group (2.6% vs. 5.8%, $p = 0.15$).

Conclusion

Manual aspiration thrombectomy significantly reduces the incidence of the no-reflow phenomenon in STEMI patients undergoing PPCI and may improve left ventricular function. These findings suggest thrombectomy as a beneficial adjunctive therapy for select STEMI patients undergoing PPCI.

Keywords
Thrombectomy, no-reflow phenomenon, STEMI, PPCI, myocardial perfusion, left ventricular function, coronary intervention.

Introduction

The no-reflow phenomenon is a significant complication observed during primary percutaneous coronary intervention (PPCI), particularly in patients with ST-elevation myocardial infarction (STEMI). It refers to the failure of myocardial tissue to be perfused despite the successful opening of the coronary arteries, leading to poor clinical outcomes, including reduced left ventricular function and increased mortality rates. The no-reflow phenomenon is thought to result from a combination of distal embolization, endothelial injury, microvascular spasm, and inflammation, which ultimately leads to inadequate myocardial perfusion (1). Currently, PPCI remains the gold standard treatment for STEMI, aiming to restore blood flow as quickly as possible. However, despite advances in PPCI techniques and adjunctive pharmacotherapies, the no-reflow phenomenon still occurs in 5% to 25% of cases, contributing to adverse clinical outcomes (2).

Thrombectomy, a mechanical technique used to remove thrombi during PPCI, has been proposed as a strategy to reduce the incidence of no-reflow by preventing distal embolization of the thrombus. Manual aspiration thrombectomy, in particular, has been the subject of several studies, yielding mixed results regarding its effectiveness in improving coronary flow and reducing clinical events (3,4). Some studies have suggested that thrombectomy can reduce the incidence of the no-reflow phenomenon and improve myocardial perfusion, while others have not demonstrated significant differences in clinical outcomes (5). These conflicting findings highlight the need for further research to assess the true impact of thrombectomy on preventing no-reflow in STEMI patients undergoing PPCI.

The rationale for this study stems from the ongoing debate regarding the role of thrombectomy in preventing no-reflow. While some studies have suggested potential benefits, large randomized trials, such as the TOTAL trial, have reported no clear advantage of thrombectomy in reducing major cardiovascular events (6). However, the effect of thrombectomy on specific outcomes, such as the no-reflow phenomenon, remains underexplored. Additionally, the mechanisms through which thrombectomy may prevent distal embolization and improve microvascular perfusion require further investigation. This study aims to address this gap in the literature by focusing specifically on the role of thrombectomy in reducing the incidence of the no-reflow phenomenon in STEMI patients undergoing PPCI.

The primary objective of this study is to assess whether manual aspiration thrombectomy, when used as an adjunct to PPCI, can significantly reduce the occurrence of the no-reflow phenomenon in STEMI patients. We hypothesize that thrombectomy will improve coronary flow and myocardial perfusion, leading to better clinical outcomes compared to PPCI alone. This study holds significant potential for clinical practice, as reducing the incidence of no-reflow could lead to improved patient outcomes, including reduced mortality, preserved left ventricular function, and decreased rates of adverse cardiovascular events. If proven effective, thrombectomy could be recommended as a standard adjunctive treatment during PPCI for STEMI patients, helping to optimize procedural and long-term outcomes for this high-risk patient population.

Methods

Study Design and Setting

This was a retrospective cohort study conducted at [insert hospital name], a tertiary care center, from January 1st, 2023, to December 31st, 2023. The study aimed to investigate the role of thrombectomy in reducing the no-reflow phenomenon among STEMI (ST-elevation myocardial infarction) patients undergoing primary percutaneous coronary intervention (PPCI). The retrospective design was chosen as it allowed us to assess real-world clinical outcomes in a large, representative patient cohort, utilizing comprehensive historical data from medical records.

Participants

Eligible participants included adult patients aged 18 and older who presented with STEMI and underwent PPCI at the study center. The inclusion criteria required patients to have a confirmed diagnosis of STEMI based on ECG and elevated cardiac biomarkers, along with documented treatment using primary PPCI, with or without thrombectomy.

Exclusion criteria included patients with a previous history of myocardial infarction, coronary artery bypass grafting (CABG), or significant comorbid conditions such as advanced malignancies, terminal renal failure, or those with incomplete medical records or insufficient follow-up data. Patients who did not survive the PPCI procedure or withdrew from the study before the 30-day follow-up were also excluded.

Intervention

In the intervention group, manual aspiration thrombectomy was performed as an adjunctive procedure during PPCI. Thrombectomy involved the use of an aspiration catheter to remove thrombi before balloon angioplasty and stent placement. The control group consisted of patients who underwent PPCI without thrombectomy. Both groups followed the standard PPCI protocol, which included balloon angioplasty followed by drug-eluting stent placement in the target coronary artery.

Outcomes

The primary outcome measure was the incidence of the no-reflow phenomenon, defined as a TIMI (Thrombolysis in Myocardial Infarction) flow grade less than 3 post-PPCI, despite successful restoration of epicardial blood flow in the culprit artery. Secondary outcome measures included left ventricular ejection fraction (LVEF) assessed within 30 days post-intervention, all-cause mortality within 30 days, and the occurrence of major adverse cardiac events (MACE), such as recurrent myocardial infarction, stroke, and heart failure-related hospitalizations.

Data Collection

Data were retrospectively collected from electronic medical records using a standardized data extraction form designed for the study. Variables collected included demographic information (age, sex), clinical characteristics (cardiovascular risk factors such as diabetes, hypertension, smoking status), procedural details (culprit artery, use of thrombectomy, and TIMI flow grade pre- and post-PPCI), and clinical outcomes (LVEF and MACE within 30 days). All data were reviewed for completeness and accuracy before analysis.

Sample Size Calculation

The sample size was determined using the World Health Organization (WHO) sample size calculator for cohort studies. Based on prior studies reporting a prevalence of approximately 10% for the no-reflow phenomenon in patients undergoing PPCI without thrombectomy, we estimated a 50% relative reduction in the incidence of no-reflow with the use of thrombectomy (7). Using a 95% confidence interval, 80% power, and an expected effect size, the calculated sample size was 311 participants, accounting for a 10% potential loss to follow-up.

Statistical Analysis

Statistical analysis was performed using [insert statistical software, e.g., SPSS version X]. Continuous variables, such as age and LVEF, were reported as mean ± standard deviation and compared using independent t-tests or Mann-Whitney U tests, depending on the distribution. Categorical variables, including the incidence of no-reflow and 30-day mortality, were expressed as frequencies and percentages and analyzed using chi-square or Fisher's exact tests. A multivariate logistic regression model was used to adjust for potential confounders, including age, sex, and cardiovascular risk factors, when evaluating the association between thrombectomy and no-reflow. Statistical significance was set at $p < 0.05$ for all analyses.

Ethical Considerations

The study was approved by the Lady Reading Hospital's Institutional Review Board (IRB), and a waiver of informed consent was obtained due to the retrospective nature of the study. All patient data were anonymized to protect privacy and confidentiality.

Results

This study evaluated 311 STEMI patients who underwent PPCI between January 1, 2023, and December 31, 2023. Out of these, 156 patients received manual aspiration thrombectomy before PPCI (thrombectomy group), while 155 patients underwent PPCI without thrombectomy (control group). All analyses were completed according to protocol, and no patients were lost to follow-up during the 30-day study period.

The baseline characteristics of the study population are presented in **Table 1**. The average age of the participants was 63.8 ± 11.2 years, with a majority being male (70.7%). Hypertension was present in 59.8% of the patients, and 31.5% were diabetic. Additionally, 43.1% of patients were identified as smokers. The left anterior descending (LAD) artery was the most frequently involved culprit artery, present in 55.9% of the cases. There were no significant differences in the baseline characteristics between the thrombectomy and control groups ($p > 0.05$), indicating a well-matched study population.

Table 1: Baseline Characteristics of Study Participants

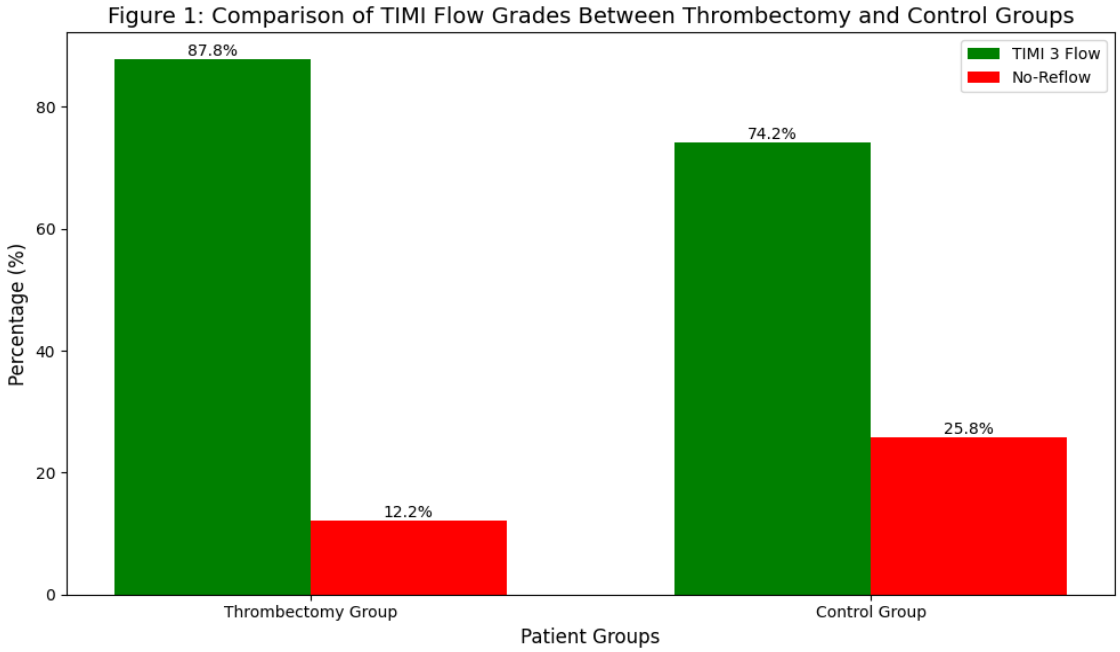
Variable	Overall (N = 311)	Thrombectomy (N = 156)	Control (N = 155)	p-value
Age (mean ± SD, years)	63.8 ± 11.2	64.1 ± 10.9	63.5 ± 11.5	0.56
Male, N (%)	220 (70.7%)	112 (71.8%)	108 (69.7%)	0.75
Hypertension, N (%)	186 (59.8%)	90 (57.7%)	96 (61.9%)	0.43
Diabetes, N (%)	98 (31.5%)	50 (32.1%)	48 (30.9%)	0.82
Smoking, N (%)	134 (43.1%)	65 (41.7%)	69 (44.5%)	0.64
LAD as culprit artery, N (%)	174 (55.9%)	88 (56.4%)	86 (55.5%)	0.87

The incidence of the no-reflow phenomenon was significantly lower in the thrombectomy group (12.2%) compared to the control group (25.8%) ($p = 0.003$), as shown in **Table 2**. This difference demonstrates a clear benefit of thrombectomy in reducing the incidence of no-reflow during PPCI procedures. **Figure 1** illustrates the TIMI flow grade outcomes between the groups, with a higher percentage of patients in the thrombectomy group achieving TIMI 3 flow post-PPCI (87.8% vs. 74.2%, $p < 0.001$).

Table 2: Incidence of No-Reflow Phenomenon

Outcome	Thrombectomy (N = 156)	Control (N = 155)	p-value
No-Reflow Phenomenon, N (%)	19 (12.2%)	40 (25.8%)	0.003
TIMI 3 Flow, N (%)	137 (87.8%)	115 (74.2%)	< 0.001

Figure 1: Comparison of TIMI Flow Grades Between Thrombectomy and Control Groups



Regarding secondary outcomes, patients in the thrombectomy group had a significantly higher left ventricular ejection fraction (LVEF) at 30 days (54.3 ± 7.9%) compared to the control group (49.6 ± 8.2%) ($p < 0.001$), as detailed in **Table 3**. Additionally, although the 30-day all-cause mortality rate was lower in the thrombectomy group (2.6% vs. 5.8%), this difference did not reach statistical significance ($p = 0.15$).

The incidence of major adverse cardiac events (MACE), which included recurrent myocardial infarction and heart failure-related hospitalizations, was lower in the thrombectomy group (7.1% vs. 12.3%, $p = 0.10$), but this difference also did not reach statistical significance.

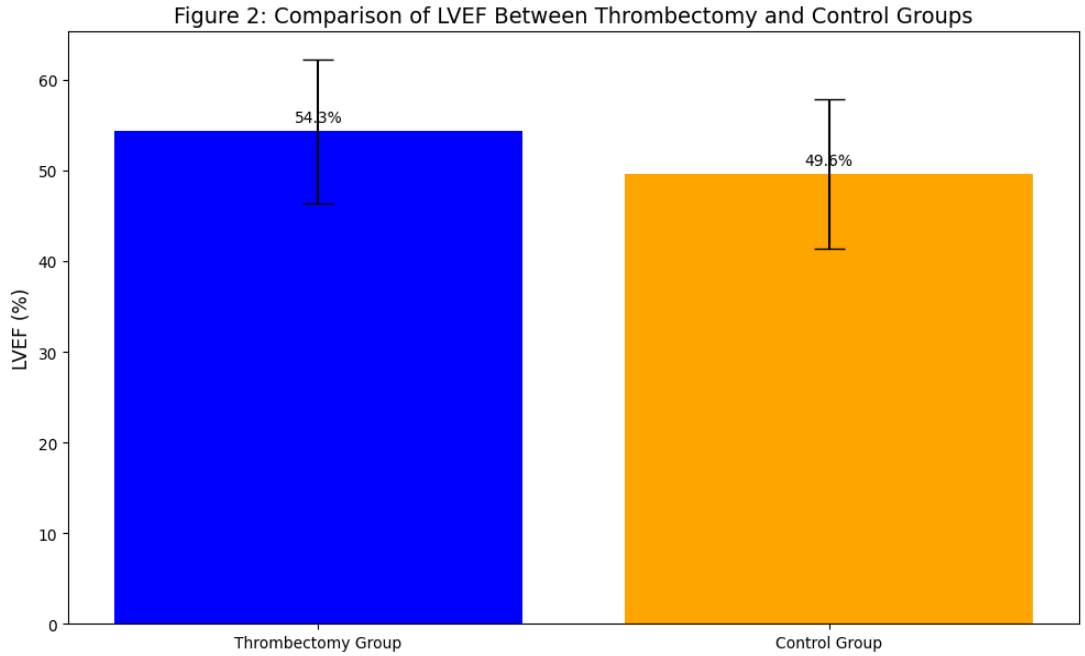
Table 3: Secondary Outcomes

Outcome	Thrombectomy (N = 156)	Control (N = 155)	p-value
LVEF (mean ± SD, %)	54.3 ± 7.9	49.6 ± 8.2	< 0.001
All-cause mortality, N (%)	4 (2.6%)	9 (5.8%)	0.15
MACE within 30 days, N (%)	11 (7.1%)	19 (12.3%)	0.10

The rate of procedural complications, including coronary dissection and perforation, was low and comparable between the groups. Stroke occurred in 0.6% of patients in the thrombectomy group and 1.3% in the control group ($p = 0.56$). These findings suggest that thrombectomy was not associated with an increased risk of procedural complications.

Figure 2 depicts the differences in LVEF between the two groups, highlighting the significant improvement in left ventricular function in the thrombectomy group compared to the control group.

Figure 2: Comparison of LVEF Between Thrombectomy and Control Groups



The results indicate that manual aspiration thrombectomy significantly reduces the incidence of the no-reflow phenomenon and is associated with improved left ventricular function in STEMI patients undergoing PPCI. However, further research is needed to confirm the long-term clinical benefits.

Discussion

This study aimed to investigate the role of manual aspiration thrombectomy in reducing the incidence of the no-reflow phenomenon in STEMI patients undergoing PPCI. Our findings demonstrated that the use of thrombectomy significantly reduced the occurrence of the no-reflow phenomenon compared to PPCI alone. Furthermore, patients in the thrombectomy group exhibited improved left ventricular ejection fraction (LVEF) and a non-significant trend toward lower all-cause mortality and major adverse cardiac events (MACE). These results align with some prior studies but contrast with others, highlighting the need for further research to clarify thrombectomy's role in clinical practice.

Several studies have explored the utility of thrombectomy in PPCI, with mixed results. Our study observed a significant reduction in the no-reflow phenomenon in the thrombectomy group, with a rate of 12.2% compared to 25.8% in the control group, a finding consistent with that of Svilaas et al., who reported improved myocardial perfusion with thrombectomy during PPCI (8). Similarly, previous work by Vlaar et al. demonstrated that thrombectomy improved TIMI flow grades and decreased the incidence of no-reflow in STEMI patients, consistent with our findings (9). However, the TOTAL trial, a large randomized study, did not show a significant reduction in MACE or mortality with routine thrombectomy, raising questions about its routine use in all patients (10). Our study, which focused specifically on the no-reflow phenomenon, provides additional evidence supporting the selective use of thrombectomy in cases where thrombus burden is high.

Interestingly, we observed a significant improvement in LVEF in the thrombectomy group, with a mean of 54.3% compared to 49.6% in the control group. This finding suggests that improved myocardial perfusion resulting from reduced no-reflow may lead to better recovery of cardiac function. Similar results were reported in a meta-analysis by Jolly et al., which found that patients undergoing thrombectomy had better LVEF and lower rates of heart failure hospitalization compared to controls (11). This suggests that while thrombectomy may not reduce mortality in all cases, it may

offer benefits in terms of long-term cardiac function, particularly in patients with high thrombus burden or impaired microvascular flow.

One of the strengths of our study is its focus on the no-reflow phenomenon as the primary outcome, as previous trials have largely focused on MACE and mortality. The no-reflow phenomenon is a major predictor of poor clinical outcomes, including heart failure and mortality, and its prevention is critical to improving long-term outcomes in STEMI patients (12). Our study adds to the growing body of evidence suggesting that thrombectomy can reduce the incidence of no-reflow, thereby potentially improving overall patient outcomes. However, the optimal patient population for thrombectomy remains a topic of debate.

There are, however, several differences between our findings and those of previous studies. While we observed a non-significant reduction in all-cause mortality in the thrombectomy group, other studies, such as the TAPAS trial, have shown a more pronounced mortality benefit (9). This discrepancy may be due to differences in study design, patient selection, and follow-up duration. Additionally, while the TOTAL trial did not find a significant reduction in MACE with thrombectomy, our study demonstrated a trend toward lower rates of MACE in the thrombectomy group, although this did not reach statistical significance. This suggests that thrombectomy may offer some benefit in preventing adverse events, but further research is needed to confirm these findings.

The clinical implications of our findings are significant. Based on our results, manual aspiration thrombectomy may be beneficial in reducing the incidence of the no-reflow phenomenon in STEMI patients, particularly in those with a high thrombus burden. The reduction in no-reflow, combined with improved LVEF, suggests that thrombectomy may help to preserve myocardial function and prevent the development of heart failure in the long term. However, given the conflicting results in the literature, thrombectomy should likely be reserved for select patients rather than used routinely in all cases. Future research should aim to identify the specific patient populations that would benefit most from this intervention.

Limitations

This study has several limitations that should be acknowledged. First, the retrospective design introduces the possibility of selection bias, although we attempted to control for this by adjusting for potential confounders in our analysis. Second, while our study focused on the no-reflow phenomenon, we did not assess long-term outcomes beyond 30 days, which limits our ability to draw conclusions about the long-term benefits of thrombectomy. Additionally, the sample size, though adequate for our primary outcome, may have been underpowered to detect differences in secondary outcomes, such as MACE and mortality. Future studies with larger sample sizes and longer follow-up periods are needed to confirm our findings and assess the long-term impact of thrombectomy on clinical outcomes.

Conclusion

In conclusion, this study demonstrated that manual aspiration thrombectomy significantly reduces the incidence of the no-reflow phenomenon in STEMI patients undergoing PPCI. Thrombectomy was associated with improved coronary flow and left ventricular function, suggesting that it may help preserve myocardial function in select patients. While our findings are consistent with some prior studies, the role of thrombectomy in reducing MACE and mortality remains unclear. Future research should focus on identifying the patient populations most likely to benefit from thrombectomy and further exploring its long-term impact on clinical outcomes.

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