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Original Article

Outcomes of Primary PCI With Thrombus Aspiration Versus No Aspiration in Patients Presenting With ST-Elevation Myocardial Infarction (STEMI): A Comparative Study

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ABSTRACT

Background: Thrombus aspiration during primary percutaneous coronary intervention (PCI) in ST-elevation myocardial infarction (STEMI) has been proposed to enhance reperfusion by reducing thrombus burden. However, its clinical benefit remains uncertain.

Aim: To compare angiographic, electrocardiographic, and early in-hospital outcomes between STEMI patients undergoing primary PCI with thrombus aspiration versus no aspiration.

Materials and Methods: A prospective comparative study was conducted on 100 STEMI patients undergoing primary PCI. Patients were assigned to Group A (n = 50; PCI with thrombus aspiration) or Group B (n = 50; PCI without aspiration). Primary endpoints included TIMI 3 flow, myocardial blush grade (MBG), and ST-segment resolution. Secondary endpoints included no-reflow, distal embolization, and in-hospital major adverse cardiac events (MACE).

Results: TIMI 3 flow was achieved more frequently in Group A (88%) than Group B (72%) (p = 0.04). MBG 3 occurred in 56% versus 34% (p = 0.02). Complete ST-segment resolution was higher with aspiration (68% vs 42%, p = 0.01). No-reflow and distal embolization were lower in the aspiration group, though not statistically significant (8% vs 20%, p = 0.08). In-hospital MACE and mortality showed nonsignificant trends favoring aspiration.

Conclusion: Thrombus aspiration during primary PCI improves angiographic and electrocardiographic reperfusion in STEMI patients. Although early clinical outcomes were comparable, the overall reperfusion benefits support selective use of thrombus aspiration in patients with high thrombus burden.

Keywords: *STEMI, primary PCI, thrombus aspiration, TIMI flow, myocardial blush grade, reperfusion.*

INTRODUCTION

ST-elevation myocardial infarction (STEMI) represents the most severe clinical manifestation of acute coronary syndrome and remains a major global cause of morbidity and mortality despite substantial therapeutic advances[1]. Early and effective reperfusion is critical to salvaging myocardium and improving clinical outcomes. Primary percutaneous coronary intervention (PCI) is the preferred reperfusion strategy owing to its ability to restore epicardial blood flow rapidly and reduce short- and long-term mortality[2].

A significant challenge in primary PCI is the presence of **large intracoronary thrombus burden**, which is common in STEMI due to complete occlusion of the infarct-related artery[3]. High thrombus burden predisposes patients to distal embolization, impaired microvascular perfusion, and the **no-reflow phenomenon**, leading to larger infarct size and adverse outcomes[4]. Poor myocardial reperfusion, despite successful epicardial flow restoration, is associated with increased morbidity, ventricular dysfunction, and mortality[5].

Manual thrombus aspiration (TA) was introduced as a simple adjunctive technique to aspirate thrombus before balloon dilatation or stent implantation. Early observational studies demonstrated improved coronary flow and myocardial blush after thrombus aspiration[6]. A landmark randomized study, the TAPAS trial, showed that routine TA before stenting

resulted in significantly improved myocardial reperfusion and unexpectedly reduced 1-year mortality[7]. These findings generated widespread enthusiasm and led to increased global adoption of thrombus aspiration.

However, subsequent large multicenter trials challenged this practice. The **TASTE** trial, conducted in a real-world setting across Scandinavian countries, showed no significant difference in 30-day or 1-year mortality between thrombus aspiration and conventional PCI[8]. The even larger **TOTAL** trial found no reduction in cardiovascular outcomes and raised concerns about a higher risk of stroke associated with aspiration[9]. Based on these contradictory results, international guidelines downgraded the routine use of thrombus aspiration, recommending it only in selected patients with large thrombus burden or refractory no-reflow[10].

Despite this, thrombus aspiration continues to be practiced selectively, especially in centers dealing with late presenters, high thrombus loads, resource limitations, and varying population characteristics. Moreover, angiographic and electrocardiographic markers often demonstrate better reperfusion in patients undergoing aspiration, even when mortality differences are not statistically significant[11].

Given the ongoing debate and variations in practice patterns, it remains relevant to evaluate the role of thrombus aspiration in contemporary STEMI management in different clinical settings. This study aims to compare angiographic, electrocardiographic, and in-hospital outcomes of primary PCI performed with versus without thrombus aspiration in patients presenting with STEMI.

Study Design and Setting
This was a **prospective, comparative, observational study** conducted in the Department of Cardiology at a hospital over a period of 18 months. The study enrolled consecutive patients presenting with ST-elevation myocardial infarction (STEMI) who underwent primary percutaneous coronary intervention (PCI). Ethical approval was obtained from the Institutional Ethics Committee, and informed consent was obtained from all participants.

Study Population
A total of **100 patients** fulfilling diagnostic criteria for STEMI were included and divided into two equal groups:
- **Group A (n = 50):** Primary PCI with manual thrombus aspiration
- **Group B (n = 50):** Primary PCI without thrombus aspiration

The grouping was based on operator decision considering angiographic thrombus burden and institutional protocol.

Sample Size Justification
Based on prior studies showing a 15–20% difference in TIMI 3 flow between groups, with $\alpha = 0.05$ and power = 80%, the required sample size was calculated as **48 per group**. Therefore, 50 patients were included in each group.

Inclusion Criteria
Patients were eligible if they met the following criteria:
1. Age 18 to 80 years
2. Presentation within **12 hours of symptom onset**
3. Diagnostic ECG showing ST-segment elevation ≥1 mm in at least two contiguous leads or new LBBB
4. Undergoing **primary PCI** as the initial reperfusion strategy

Exclusion Criteria
Patients were excluded if they had:
1. Cardiogenic shock at presentation
2. Prior percutaneous coronary intervention or coronary artery bypass grafting
3. Known bleeding disorders or active internal bleeding
4. Severe renal impairment (eGFR < 30 mL/min/1.73m²)
5. Left main coronary artery STEMI
6. Severe calcified lesions or anatomical conditions precluding thrombectomy
7. Known intolerance or contraindication to antiplatelet therapy

Diagnosis of STEMI
Diagnosis was based on ACC/AHA/ESC guidelines:
- Chest pain ≥30 minutes
- ST-elevation in contiguous leads
- Elevated cardiac biomarkers (for confirmation, not inclusion)

Pre-PCI Management
All patients received guideline-directed therapy:
- **Aspirin:** Loading dose 300 mg

- **P2Y12 inhibitor:** Ticagrelor 180 mg or Clopidogrel 600 mg
- **Unfractionated heparin:** 70–100 U/kg IV bolus
- **Nitrates, morphine**, and **beta-blockers** as clinically indicated
- Optional **Glycoprotein IIb/IIIa inhibitors** (abciximab/eptifibatide) were used at operator discretion.

Intervention Procedure

1. Coronary Angiography

Performed using standard Judkins technique via radial or femoral access.
The **infarct-related artery (IRA)** was identified based on ECG, angiographic appearance, and clinical presentation.

2. Thrombus Aspiration (Group A)

Manual thrombus aspiration was performed using standard aspiration catheters (e.g., Export®, Eliminate®).

Procedure steps included:
- Crossing the lesion with a guidewire
- Advancement of aspiration catheter to thrombus site
- 1–3 passes of aspiration under continuous negative pressure
- Visual assessment of retrieved thrombus material

3. PCI Procedure

PCI was performed in both groups using:
- Predilatation only when required
- Drug-eluting or bare-metal stent as per operator choice
- Post-dilatation based on stent expansion
- Final angiographic check confirming TIMI flow

The use of aspiration did not alter the stent implantation strategy.

Outcome Measures

Primary Outcomes

1. **TIMI (Thrombolysis in Myocardial Infarction) Flow Grade** post-PCI
2. **Myocardial Blush Grade (MBG)**
3. **ST-segment resolution** at 90 minutes (>70% considered complete)

Secondary Outcomes

1. **No-reflow phenomenon**
2. **Distal embolization**
3. **In-hospital Major Adverse Cardiac Events (MACE)** including:
   - Death
   - Recurrent myocardial infarction
   - Target vessel revascularization (TVR)
   - Heart failure

Thrombus Burden Assessment
- Assessed using **TIMI Thrombus Grade 0–5 system**
- High thrombus burden: TIMI Thrombus Grade ≥ 4

Angiographic Analysis
- All angiograms were reviewed by **two senior interventional cardiologists**, blinded to group allocation.
- Disagreements were resolved by consensus.
- TIMI flow and MBG were assessed using standardized definitions.

Electrocardiographic Assessment

ST-segment resolution was measured at **90 minutes post-PCI**, categorized as:
- **Complete:** >70% reduction
- **Partial:** 30–70% reduction
- **None:** <30% reduction

Statistical Analysis: Statistical analysis was performed using **SPSS version 20.** Continuous variables were expressed as **mean ± SD** and compared using the **unpaired t-test**. Categorical variables were expressed as proportions (%) and analyzed using the **Chi-square test** or **Fisher's exact test**, as appropriate. A **p-value < 0.05** was considered statistically significant.

RESULTS

A total of 100 STEMI patients underwent primary PCI, with 50 in each study group. Baseline demographic and clinical variables were comparable between both groups, with no significant differences in age, sex, comorbidities, or Killip class ($p > 0.05$). This indicates well-balanced groups suitable for outcome comparison.as shown in Table 1

Table 1. Baseline Demographic and Clinical Characteristics

Parameter	Group A (TA)n = 50	Group B (No TA)n = 50	p-value
Age (years)	58.3 ± 10.2	59.1 ± 9.8	0.68
Male sex	38 (76%)	36 (72%)	0.64
Hypertension	24 (48%)	22 (44%)	0.68
Diabetes	18 (36%)	17 (34%)	0.84
Smoking	30 (60%)	28 (56%)	0.68
Killip Class ≥ II	8 (16%)	9 (18%)	0.79

Thrombus aspiration resulted in significantly better angiographic reperfusion, reflected by higher TIMI 3 flow and MBG 3 rates ($p < 0.05$). Although distal embolization and no-reflow were less frequent in the aspiration group, the differences were not statistically significant but showed a favorable trend as shown in Table 2

Table 2. Angiographic Outcomes

Angiographic Parameter	Group A (TA)	Group B (No TA)	p-value
TIMI 3 flow	44 (88%)	36 (72%)	**0.04**
Myocardial blush grade 3	28 (56%)	17 (34%)	**0.02**
Distal embolization	4 (8%)	10 (20%)	0.08
No-reflow phenomenon	4 (8%)	10 (20%)	0.08

Complete ST-segment resolution was significantly higher with thrombus aspiration ($p = 0.01$), indicating improved myocardial reperfusion. While in-hospital MACE and mortality were numerically lower in the aspiration group, these differences were not statistically significant as shown in Table 3

Table 3. Electrocardiographic and In-Hospital Clinical Outcomes

Outcome	Group A (TA)	Group B (No TA)	p-value
ST-segment resolution >70%	34 (68%)	21 (42%)	**0.01**
In-hospital MACE	3 (6%)	6 (12%)	0.29
In-hospital mortality	1 (2%)	3 (6%)	0.31

DISCUSSION

In this comparative study of STEMI patients undergoing primary PCI, thrombus aspiration demonstrated significantly better angiographic and electrocardiographic markers of reperfusion compared with PCI alone. Patients receiving aspiration therapy showed higher rates of TIMI 3 flow and myocardial blush grade 3, as well as greater ST-segment resolution. These findings support the physiological rationale that removing thrombus before balloon dilation or stent implantation may improve both epicardial flow and downstream microvascular perfusion.

Improvement in **TIMI 3 flow (88% vs 72%)** aligns with earlier evidence suggesting that thrombus aspiration can reduce distal thrombus migration during PCI. Svilaas et al. reported similar enhancement of TIMI flow in the TAPAS trial, where aspiration significantly improved myocardial reperfusion[12]. Enhancing epicardial flow is clinically important because suboptimal TIMI flow following PCI is strongly associated with larger infarct size and higher mortality.

The **superior myocardial blush grade** observed in the aspiration group underscores improved microvascular reperfusion. Microvascular obstruction remains a major determinant of infarct size, left ventricular recovery, and long-term outcomes[13]. By reducing microthrombi, aspiration may limit microvascular plugging and facilitate better tissue-level blood flow. De Luca et al. demonstrated that TA significantly improves MBG and reduces microvascular obstruction on cardiac MRI[14].

Our study also showed **better ST-segment resolution (>70%)** in the aspiration group, reflecting enhanced myocardial salvage. ST-resolution is an established surrogate of microvascular reperfusion and is strongly correlated with infarct size and mortality[15]. Although clinical endpoints such as MACE and mortality did not differ significantly, the favorable directionality suggests a potential clinical benefit with larger sample sizes.

The **lack of significant improvement in hard outcomes**, such as in-hospital MACE and mortality, parallels findings from major randomized controlled trials. The TASTE trial, involving over 7,000 STEMI patients, found no mortality reduction at both 30 days and 1 year with routine thrombus aspiration[16]. Similarly, the TOTAL trial, with over 10,000 patients, reported no benefit in cardiovascular outcomes and identified a small yet concerning increase in stroke rates with routine aspiration[17]. These conflicting results have led guideline committees to recommend against routine aspiration, reserving it only for selected cases with high thrombus burden[18].

Despite these large trials, real-world practice shows considerable heterogeneity, especially in regions where patients present late or have larger intracoronary thrombus burdens. Studies from resource-limited settings have repeatedly shown that aspiration may offer procedural benefits in patients with heavy thrombus loads[19]. In our study, although routine stroke assessment was not conducted beyond hospitalization, no aspiration-related stroke was observed.

The trends toward lower distal embolization and no-reflow in our aspiration group, though not statistically significant, support the mechanical principle behind TA. No-reflow is a devastating complication associated with worse outcomes, driven largely by microvascular obstruction and thrombus embolization[20]. Any intervention that limits thromboembolism may reduce this risk. Our findings therefore suggest that thrombus aspiration may remain beneficial in selected patients, particularly those with large thrombus burden, proximal occlusions, or delayed presentations.

Overall, our study supports a **selective, rather than routine**, role for thrombus aspiration in primary PCI. While it improves reperfusion parameters, consistent survival benefit has not been demonstrated. However, better myocardial perfusion indicators may translate to improved long-term ventricular function—something requiring further follow-up studies.

CONCLUSION

Thrombus aspiration during primary PCI in STEMI significantly improved angiographic and electrocardiographic indicators of reperfusion, including higher rates of TIMI 3 flow, better myocardial blush grade, and greater ST-segment resolution. Although short-term clinical outcomes such as in-hospital MACE and mortality were not significantly different, all trends numerically favored the aspiration group. These findings suggest that thrombus aspiration may offer meaningful procedural and microvascular benefits, particularly in patients with a high thrombus burden. Selective rather than routine use of thrombus aspiration appears appropriate in contemporary STEMI management.

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