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Praveen Chacko

Government Medical College - India

Kesavapillai Jayaprakash

Government Medical College - India

Kamarudheenkunju Jameelabeevi Raihanathul Misiriya

Government Medical College - India

Suresh Madhavan

Government Medical College - India

Vasantha Sudha Kumary

Government Medical College - India

See next page for additional authors

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Authors

Praveen Chacko, Kesavapillai Jayaprakash, Kamarudheenkunju Jameelabeevi Raihanathul Misiriya, Suresh Madhavan, Vasantha Sudha Kumary, Narayanapillai Jayaprasad, Vaikathusseril Lembodaran Jayaprakash, and Raju George

Effect of thrombus aspiration on angiography and outcome in patients undergoing primary coronary angioplasty

Praveen Chacko, MD, DM, Kesavapillai Jayaprakash, MD, DM, Kamarudheenkunju Jameelabeevi Raihanathul Misiriya, MD, DM, Suresh Madhavan, MD, DM, Vasantha Sudha Kumary, MD, DM, Narayanapillai Jayaprasad, MD, DM, Vaikathusseril Lembodaran Jayaprakash, MD, DM, and Raju George, MD, DM

Thrombus exerts a major impact on the performance and outcome of primary and rescue interventions in acute ST-elevation myocardial infarction. Although the optimal treatment of thrombotic lesions is still controversial, thrombus aspiration provides an effective method to achieve successful reperfusion during primary angioplasty. We compared clinical and angiographic outcomes in 286 patients with acute ST-elevation myocardial infarction undergoing primary percutaneous transluminal coronary angioplasty (PTCA) and thrombus aspiration with those who underwent conventional PTCA without thrombus aspiration. Thrombus aspiration during primary percutaneous coronary intervention in patients with high thrombus burden resulted in better Thrombolysis in Myocardial Infarction (TIMI) 3 flow in the infarct-related artery and helped achieve faster ST-segment resolution on the electrocardiogram compared with conventional angioplasty without thrombus aspiration.

Thrombus is a hallmark constituent of active, unstable atherosclerotic plaques commonly found in patients with acute coronary syndromes. Over the past three decades, percutaneous coronary intervention (PCI) has achieved high success rates with the ever-increasing inclusion of complex target lesions (1). However, despite this impressive progress, one critical component, thrombus, remains a formidable obstacle to revascularization. Thrombus exerts a major impact on the outcome of primary and rescue interventions. The optimal treatment of thrombotic lesions is still enigmatic and controversial. Still thrombus aspiration provides an effective method to achieve successful reperfusion in primary angioplasty. The present study aimed to compare clinical and angiographic outcomes in patients with acute ST-elevation myocardial infarction undergoing primary percutaneous transluminal coronary angioplasty (PTCA) with and without thrombus aspiration.

METHODS

The study included 344 patients with a history and electrocardiographic changes suggestive of acute ST-elevation myocardial infarction, who presented within 12 hours of symptom onset and were admitted to the cardiology department. Patients with previous myocardial infarction and those undergoing rescue PCI after thrombolysis were excluded from the study. Coronary angiography with the standard angiographic projections was done in these patients. The images were critically analyzed

for the presence and severity of any obstructive coronary arteries in all the coronary arterial territories. Other angiographic features were noted, including the vessel diameter, lesion morphology, tortuosity, ectasia, dissection, calcification, and thrombus. The infarct-related artery was identified and evaluated for the above angiographic characteristics, including the vessel and lesion morphology, with special focus on the presence or absence of intracoronary thrombus, the Thrombolysis in Myocardial Infarction (TIMI) thrombus score, and the antegrade flow (TIMI grade).

In patients showing thrombus in the initial angiogram, further management was planned according to the patient's clinical status and the operator's discretion, which was based on the TIMI thrombus grade and other angiographic characteristics of the infarct-related vessel and the morphology of the culprit lesion. Patients with low thrombus burden (TIMI thrombus grades 1 and 2, $n = 36$) were excluded from further analysis.

For all patients, the first procedural step was the passing of a floppy, steerable guidewire through the target lesion. In patients in the thrombus aspiration group, this step was followed by the advancing of a 6Fr Thrombuster II Aspiration Catheter (crossing profile, 0.07 in/1.78 mm) into the target coronary segment during continuous aspiration. When necessary for stent delivery, balloon dilation was performed before stenting (*Figure 1*). Patients in the conventional PCI group were treated without thrombus aspiration, and balloon dilation to establish antegrade flow was done after crossing the culprit lesion with the guidewire. In all patients, after the restoration of antegrade flow, intracoronary nitroglycerine was given to ensure maximal epicardial vasodilation, in order to determine the size and length of the stent and to facilitate stent placement. Drug-eluting stents (sirolimus or everolimus) were used for all patients.

Those who underwent balloon angioplasty alone without implantation of a stent because of various reasons such as small vessels, calcified lesions, or nondilatable lesions ($n = 22$) were excluded from the study. Of the remaining 286 patients, 155 patients receiving primary PTCA with thrombus aspiration and stent implantation were in the treatment group and

From the Department of Cardiology, Government Medical College, Kottayam, Kerala, India.

Corresponding author: K. Jayaprakash, MD, DM, Government Medical College, Kottayam, Kerala, India PIN 686008 (e-mail: jayaprakashpillai@gmail.com).

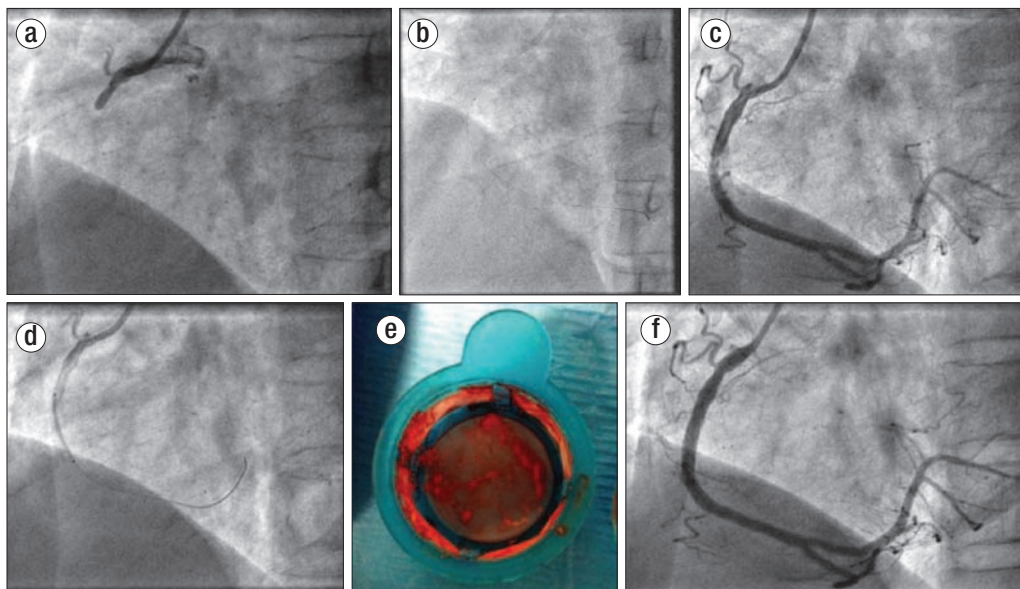


Figure 1. Procedural steps in the thrombus aspiration group. (a) Angiogram showing total occlusion of the proximal right coronary artery with thrombus. (b) Thrombus aspiration in progress. (c) Postthrombus aspiration. (d) Stenting in progress. (e) Aspirated thrombus material. (f) Final angiogram.

131 patients receiving conventional PCI with stenting without thrombus aspiration were in the control group (Figure 2).

Pharmacologic treatment before PCI included aspirin (a loading dose of 325 mg), heparin (5000 IU), clopidogrel (a loading dose of 600 mg), and atorvastatin (80 mg). Standard therapies after PCI included aspirin, clopidogrel, beta-blockers, and lipid-lowering agents according to current guidelines.

After PCI, TIMI flow was reassessed and graded. A 12-lead electrocardiogram was acquired at presentation and 90 minutes after PCI, and the ST segments on the postprocedural electrocardiogram were compared with those on the electrocardiogram at presentation. The degree of resolution of ST segment elevation was categorized as either >70% or <70%. The presence or absence of pathologic Q waves was also recorded. Echocardiographic evaluation and reassessment of left ventricular func-

tion were done at the time of discharge and compared with baseline parameters.

The primary endpoint was a postprocedural TIMI flow grade of 3 in the infarct-related artery. Secondary endpoints were electrocardiographic ST segment resolution and major adverse coronary events (recurrent angina, reinfarction, heart failure, major bleeding, disabling stroke, or death) during the period of hospitalization.

Statistical analysis was performed using SPSS Version 14.0 statistical software. A chi-square test was used to assess the significance of observed differences between the two methods. A probability value

<0.05 was considered statistically significant.

RESULTS

After exclusion of patients with minimal thrombus burden and patients ineligible for stent implantation, 286 patients were included in the final analysis: 155 patients in the thrombus aspiration group and 131 cases in the conventional PCI group. The pattern of coronary artery involvement in the thrombus aspiration group is shown in Figure 3.

There was a statistically significant difference ($P = 0.01$) in TIMI flow, with post-PCI TIMI flow of 3 in 132 patients (85.1%) in the thrombus aspiration group and 96 patients (73.3%) in the conventional PCI group (Figure 4a). ST resolution >70% was observed in 122 patients (78.7%) in the thrombus aspiration group but only 89 patients (67.9%) in the conventional PCI group (Figure 4b). This secondary endpoint was also statistically

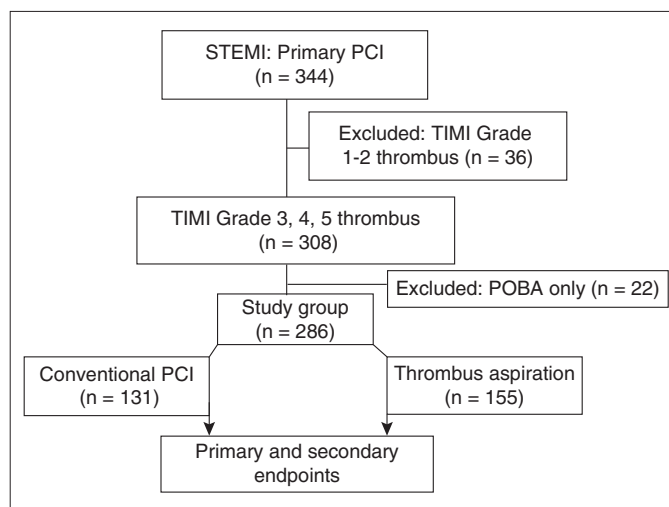


Figure 2. Study design. PCI indicates percutaneous coronary intervention; STEMI, ST-elevation myocardial infarction; TIMI, Thrombolysis in Myocardial Infarction; POBA, plain old balloon angioplasty.

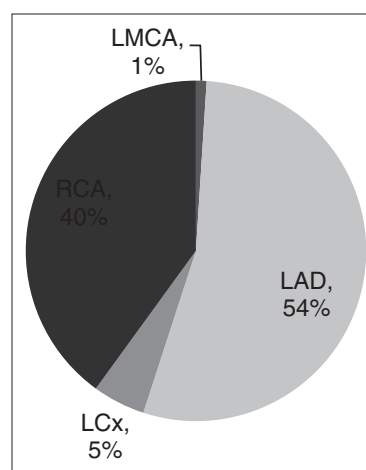


Figure 3. Pattern of coronary artery involvement. LMCA indicates left main coronary artery; LAD, left anterior descending artery; LCx, left circumflex artery; and RCA, right coronary artery.

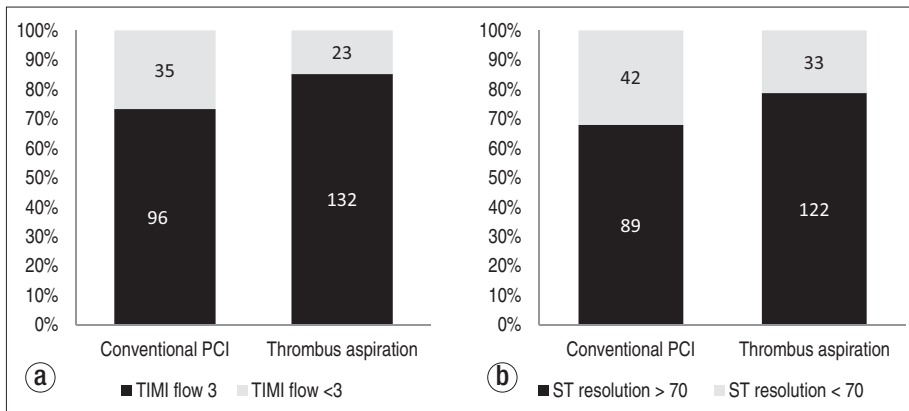


Figure 4. Results for (a) the primary endpoint, TIMI flow grade, and (b) the secondary endpoint, ST resolution in the electrocardiogram.

significant ($P = 0.04$). There were no statistically significant differences in major cardiac events between the two groups after a mean follow-up period of 4 days (Table 1).

DISCUSSION

We compared the outcome of thrombus aspiration and stenting with conventional PCI without thrombus aspiration. The primary endpoint, TIMI flow grade, was found to be higher in patients who had undergone thrombus aspiration: 132 patients in the thrombus aspiration group had a TIMI grade 3 flow compared with 96 patients in the conventional PCI group ($P = 0.01$). ST-segment resolution was also significantly higher in the thrombus aspiration group than in the conventional PCI group ($P = 0.04$). For other secondary endpoints such as recurrent angina, reinfarction, heart failure, major bleeding, disabling stroke, or mortality, there were no statistically significant differences between the two groups.

Our study results corroborate the results of the Thrombus Aspiration during Percutaneous Coronary Intervention in Acute Myocardial Infarction Study (TAPAS), which enrolled 1071 patients (2). That study showed significant improvement in the TIMI blush grade in patients receiving thrombus aspiration. A myocardial blush grade of 0 or 1 occurred in 17.1% of the patients in the thrombus aspiration group and in 26.3% of those in the conventional PCI group ($P < 0.001$). The TAPAS trial also showed a significant difference in the ST-segment deviation in the thrombus aspiration group: complete resolution of ST-segment elevation occurred in 56.6% and 44.2% of patients in the thrombus aspiration group and conventional PCI group, respectively

Table 1. Major cardiac events in the thrombus aspiration group and conventional PCI group

Event	Thrombus aspiration group (n = 155)	Conventional PCI group (n = 131)	P
Reinfarction	5 (3.3%)	8 (6.1%)	0.24
Major bleeding	3 (1.9%)	5 (3.8%)	0.34
Recurrent angina pectoris	11 (7.7%)	14 (11.5%)	0.28
Heart failure	10 (6.5%)	13 (9.9%)	0.29
Death	7 (4.5%)	8 (6.2%)	0.55

($P < 0.001$). Morbidity and mortality were not significantly different between the two groups, as was also found in our study. Other smaller trials like REMEDIA (3) and DEAR-MI (4) also showed significant benefits of thrombus aspiration over routine PCI with regard to postprocedural myocardial blush grade and ST-segment resolution on the electrocardiogram.

In contrast, in the Trial of Routine Aspiration Thrombectomy with PCI versus PCI Alone in Patients with STEMI (TOTAL), which involved 10,732 patients (5), the rate of incomplete ST-segment resolution (<70%) was 27.0% in the

thrombectomy group versus 30.2% in the PCI alone group ($P < 0.001$). Rates of TIMI grade 3 flow after PCI were the same (93.1%) in the two groups ($P = 0.12$). Routine thrombectomy was associated with an increased rate of stroke within 30 days. In contrast, no patient in either group developed stroke in our study. The findings of the TOTAL trial with regard to the efficacy of thrombectomy are consistent with those of the Thrombus Aspiration in ST-Elevation Myocardial Infarction in Scandinavia (TASTE) trial (6) and the Intracoronary Abciximab and Aspiration Thrombectomy in Patients with Large Anterior Myocardial Infarction (INFUSE-AMI) trial (7).

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