
Original Article

Aspiration of Thrombus in ST Segment Elevation Myocardial Infarction

Tariq Ashraf, Syed Ishtiaq Rasool, Tahir Saghir, Syed Nadeem Hassan Rizvi, Nadeem Qamar, Khan Shah Zaman, Mohammad Ishaque, Asadullah Kundi
Catheterization Laboratory, National Institute of Cardiovascular Diseases, Karachi.

Abstract

Objective: To evaluate the impact of Export Aspiration Catheter with restoration of ECG changes, arterial flow and myocardial perfusion in patients with ST segment elevation Myocardial Infarction undergoing Percutaneous Coronary Intervention (PCI).

Methods: A total of 40 consecutive patients with ST Segment Elevation Myocardial Infarction (STEMI) were selected. They underwent treatment according to the surgeon's discretion to either standard PCI or PCI with thrombus aspiration Catheter. Primary end points of the study were ST Segment resolution (STR) > 70% and myocardial blush grade (MBG) > 2.

Results: The base line clinical and procedural characteristics were same for both the groups. In the post intervention comparison the thrombus aspiration group was found to have significantly better outcomes as compared to the standard PCI group with regards to TIMI flow grade ($p = 0.009$) and myocardial blush grade ($p = 0.001$). Considering the criteria for MBG and STR together, the thrombus aspiration was found to have significantly better outcome than the standard PCI group ($p = 0.017$).

Conclusion: This non-randomized study shows that Export Aspiration Catheter group with STEMI undergoing primary PCI is feasible and results in better angiographic ECG and myocardial perfusion rates compared with standard PCI. Role of export catheter in rescue PCI and thrombus Saphenous Venous Graft (SVG) as primary PCI is questionable and needs larger randomized studies to prove its efficacy (JPMA 57:359:2007).

Introduction

In the United States coronary heart disease is the leading cause of death with myocardial infarction as one of its presentation. In 2006, 1.2 million Americans sustained a myocardial infarction with one quarter to one third with ST-Segment Elevation.¹

Thrombus formation after plaque rupture causes vessel closure in acute myocardial infarction and contributes to compromised flow in unstable angina. Percutaneous transluminal coronary angioplasty and stenting are options for managing acute coronary syndrome and are associated with higher patency rates of coronary arteries than medical therapy in patients with ST-elevation myocardial infarction (STEMI).² The primary goal of primary angioplasty is immediate restoration of normal flow in the infarcted artery. Although thrombolysis in MI (TIMI) grade 3 flow is necessary it is not sufficient to ensure myocardial salvage. The microcirculation is

affected during acute MI by both ischaemic death and micro-embolization from ruptured plaque and accompanying platelet and fibrin thrombus demonstrated when embolic protection devices are used.³

Data from different groups^{4,5} have suggested that thrombus aspirating devices might reduce the culprit coronary lesion, thrombus burden and facilitate myocardial perfusion. We have performed single centre study to evaluate the benefit of export aspiration catheter during primary percutaneous coronary intervention (PCI) rescue PCI and PCI in saphenous venous graft (SVG) in the setting of ST segment elevation MI to see if it decreases clot burden, improves TIMI 3 flow, myocardial blush grade and ST-Segment resolution in ECG.

Patients and Methods

All patients with STEMI within 12 hours of chest pain referred for primary or rescue PCI were taken to our catheterization laboratory in coordination with emergency

room of our institution between January 2005 and November 2005. Non affording patients were excluded from the study and given thrombolytic therapy. Selection of cases for standard PCI and with export aspiration catheter was made on surgeon's discretion.

Export Aspiration Catheter (Medtronic) is 6 French compatible and 145 cm in length. Distal port has two lumen, one for 0.014" exchange guide wire at its tip having a lumen of 0.042" (1mm) and a spade like crater proximal to wire lumen marked by a radio opaque marker. The aspiration system consist of 20cc syringe connected to the proximal hub for thrombus aspiration with aspiration rate of 1cc / sec.

All patients were given Clopidogrel loading dose 600 mg and Dispirin 300 mg in Emergency room before shifting to Cath. Lab. Heparin was given as 10,000U in cases where GPIIa IIIb receptor blockade was not used and 3000 to 5000U of heparin in cases where aggrastat (tirofiban) was used as initial bolus of 10ug / kg over 3 minutes. This was followed by maintenance infusion of 0.15 ug/kg/min. in primary PCI and PCI in SVG and on operators discretion in cases of rescue PCI.

In patients receiving standard PCI, after crossing with the guide wire, either the lesion was pre-dilated with a balloon before stent implantation or direct stent implantation was done.

Clinical data were collected in the emergency room by a senior cardiologist. Pre and post intervention Electrocardiograms were analyzed. ST segment elevation was measured 20 milliseconds after the end of QRS complex in lead I, avl and V1 to V6 for Anterior and lead II, III, avf, V5 and V6 for non-anterior MI. ECG was defined as:

1. Normalized if no residual ST segment elevation.
2. Improved if residual ST segment elevation <70%.
3. Unchanged if residual ST Segment elevation >70% of that on first ECG⁴

Ante grade coronary flow was rated using thrombolysis in Myocardial Infarction (TIMI) criteria.⁶ Myocardial Blush Grade (MBG) was evaluated according to Vant Hof et al.⁷

The primary end points of the study were ST segment resolution > 70% and MBG > 2 between patients selected for standard PCI and those to aspiration thrombus Export Catheter. In post hoc analysis, a combination of MBG > 2 and STR > 70% was used to compare the rate of patients with optimal reperfusion. Secondary end points were TIMI flow grade 3 and slow flow TIMI flow grade 2.

The data was collected on a standardized data extraction form which recorded all the relevant variables for

the research objectives. The data was edited and then entered on MS Excel program and analyzed using Epi-info V6 .04b software.

The numerical variables such as age, symptom to angiography time, procedure time and stent length was compared using the student's t-test. The categorical variables such as gender, risk factors, site of MI, severity of stenosis, vessels involved and angiographic success, were confirmed using that of proportions or chi - square test where appropriate. The TIMI flow grades, MBG and ST segment resolution variables were compared using the Chi-Square test. In all the statistical tests, p-value of less than 0.05 was considered to be statistically significant.

Results

Forty patients were selected for the study, 20 were assigned to the thrombus aspiration (TA) group and 20 to the standard PCI (SPCI) group. In the final analysis three cases were excluded from the TA group (two cases of saphenous venous graft and one case of rescue angioplasty).

The baseline characteristics of the two groups are shown in Table 1. The two groups were similar with regards to age, gender, risk factors, site of MI, severity of the stenosis and vessels involved. The pre-intervention TIMI flow grade was the same in both groups with all the patients having 0 or 1 TIMI flow grade. The post-intervention TIMI flow grade was significantly improved for the thrombus aspiration group ($p = 0.009$), 13 out of 17 in the TA group had improved TIMI flow grade of 3 while only 6 out of 20 in the SPCI group had improved flow grade of 3.

Table 2 shows that the procedural characteristics regarding angiographic success, procedure time, number of stents and total stent length were the same for both the groups. The MBG was the same for both the groups at pre-intervention, while was significantly improved for the TA group after intervention ($p = 0.001$), 13 (75%) out of 17 had

Table 1. Clinical Characteristics of Patients Undergoing Standard PCI and PCI with Thrombus Aspiration Export Catheter.

Variable	Thrombus Aspiration (n=17)	Standard PCI (n=20)	p-value
Age (Years)	50 ± 5.3	50.3 ± 5.6	0.87
Gender:			
Males	13 (76%)	16 (80%)	
Females	4 (24%)	4 (20%)	0.89
Risk Factors:			
Hypertension	9 (53%)	8 (40%)	0.43
Diabetes	4 (53%)	4 (20%)	0.89
Hypercholesterolemia	11 (65%)	14 (70%)	0.73
Family History of IHD	6 (35%)	7 (35%)	0.99

Table 2. Procedural Characteristics of Patients with Standard PCI and PCI with Thrombus Aspiration Export Catheter.

Variable	Thrombus Aspiration (n=17)	Standard PCI (n=20)	p-value
Angiographic Success (%)	17 (100%)	19 (95%)	0.35
Procedure time (min)	35 ± 11	45.5 ± 19	0.16
(mean + sd)			
Number of Stents per Lesion	1 ± 0	1.2 ± 0.4	
Total Stent Length (mm)			
(mean + sd)	16.8 ± 6	20.2 ± 7.9	0.15
Slow flow (%)	1 (6%)	11 (55%)	0.001
Myocardial Blush Grade			
(Pre-Intervention):			
0	11 (65%)	14 (70%)	
1	6 (35%)	6 (30%)	0.73
2	0 -	0 -	-
3	0 -	0 -	-
Myocardial Blush Grade			
(Post-Intervention):			
0	0 -	7 (35%)	
1	4 (23%)	9 (45%)	
2	12 (65%)	3 (25%)	0.001
3	1 (35%)	2 (5%)	
ST-Segment Resolution:			
> 70% (%)	8 (47%)	5 (25%)	0.16
< 70% (%)	9 (53%)	15 (75%)	

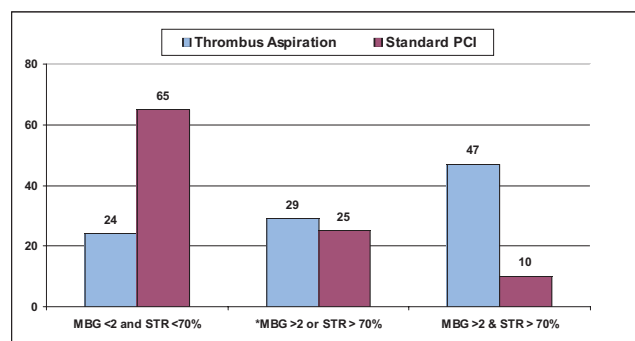


Figure. Distribution of Patients According to the Combination of MBG and STR Showing Improved Outcome in the Thrombus Aspiration Group.

* P-Value = 0.017.

MBG of 2 or more as compared to only 4 out of 20 in the SPCI group. The ST Segment resolution was the same in both groups (p = 0.16).

The outcome criteria were evaluated after combining MBG and ST-resolution (STR) for the two groups. MBG > 2 and STR of > 70% were considered to be favourable (Figure 1). It was seen that 8 (47%) out of 17 patients in the TA group had improvements in both MBG and STR as compared to only 2 (10%) of 20 patients in the SPCI group.

Another 5 (29%) out of 17 patients in the TA group had improvement in either MBG or STR as compared to 5 (25%) out of 20 patents in the SPCI group. The two criteria combined showed a significantly better outcome for TA group (p = 0.017) (Figure).

Discussion

In patients with acute myocardial infarction restoration of epicardial blood flow has been shown to be the important predictor of clinical and angiographic outcome.⁸ The goal of reperfusion therapy should be to restore not only epicardial patency but also improving myocardial tissue perfusion.⁹ A number of intracoronary medications have been shown to improve myocardial perfusion. Wang et al.¹⁰ showed that intracoronary administration of propranolol protects the myocardium during PCI reducing the incidence of myocardial infarction and improving short term clinical outcomes. Other studies¹¹⁻¹³ using intracoronary adenosine and verapamil have demonstrated a reduction in reperfusion injury. These studies do not address intracoronary thrombus burden compared to pharmacological approaches. Previous studies have demonstrated that TIMI3 flow could be achieved in > 85% of patients using mechanical reperfusion strategies.¹⁴⁻¹⁶ In our study TIMI3 flow in thrombus aspiration group was 75% at the end of PCI procedure.

The results of this study showed that thrombus aspiration with export catheter is feasible with STEMI and improves angiographic and ECG changes. The rate of patients with MBG > 2 increased by 13% and STR > 70% increased by 8% in the aspiration catheter group compared to standard PCI.

Myocardial blush grade is an important predictor of infarct size and survival.⁷ It is also a strong angiographic predictor of mortality in patients with TIMI3 flow after angioplasty.^{7,17} There are a number of studies using thrombus extraction devices and distal protection devices demonstrating conflicting results in improving myocardial perfusion and patient outcome.^{16,18}

The data is comparable with the results reported by Napo damo et al¹⁹ and by Francesco Burzotta et al²⁰ but differ with the enhanced myocardial efficacy and recovery by aspiration of liberated debris in the (EMERALD) trial²¹ which showed that removal of thrombus with Percuturge Guard Wire (Medtronic Inc.) did not result in improvement of myocardial reperfusion and reduced infarct size. The distal occlusion protection implies abolition of coronary flow during PCI while thrombus aspiration usually improves ante grade flow and probably low risk of distal embolization.⁷

Regarding composition of aspirated material, it was

visualized only in eight patients out of seventeen in export aspiration catheter. Very early data suggested that lower fibrin levels are associated with better myocardial reperfusion.²²

There was failure of aspirated material in two SVG and one case of rescue PCI in our study. Other data have shown to have significant improvement in myocardial blush grade with Guard Wire.²³

In the past primary angioplasty achieving a TIMI 3 flow was the main objective for which different devices like balloon and stents were used in different centers of Pakistan.^{2,24} Use of thrombus extraction export catheter has shown promising results in addition to TIMI 3 flow and improving myocardial blush grade.

The limitation of this study is that it is a, non-randomized single centre study and follow up of these patients were not done for major adverse cardiovascular events (MACE) at 1 month and MACE and target lesion revascularization (TLR) up to 6 months. Large prospective studies are needed to observe the long term outcomes.

References

1. American Heart Association. Cardiovascular Disease Statistics, 2006. (Accessed December 7, 2006, at <http://www.americanheart.org>)
2. Hafizullah M, Hassan M, Iqbal Z. Primary Coronary Angioplasty in Acute Myocardial Infarction. *J. Postgrad. Med. Inst* 2001;15:117-25.
3. Topol EJ, Yadav JS: Recognition of the importance of embolization in atherosclerotic vascular disease. *Circulation* 2000; 101: 570-80.
4. Murakami T, Mizuno S, Takahashi Y, Ohsato K, Moriuchi I, Arai Y et al Intracoronary aspiration thrombectomy for acute myocardial infarction. *Am J Cardiol* 1998; 82: 839-44.
5. Wang HJ, Kao HL, Liao CS, LeeYT. Export aspiration Catheter thrombosuction before actual angioplasty in primary coronary intervention for acute myocardial infarction Catheter Cardiovasc interv 2002; 57: 332-9.
6. The thrombolysis in Myocardial Infarction (TIMI) trial. The TIMI study group. *N Eng. J. Med* 1985; 312: 932 - 6.
7. Van't Hof AW, Liem A, Suryapranata H, Hoorntje JC, de Boer MJ, Zijlstra F. Angiographic assessment of myocardial reperfusion in patients treated with primary angioplasty for acute myocardial infarction. Myocardial blush grade. Zwolle Myocardial Infarction Study group. *Circulation* 1998;97:2302-6.
8. Cannon CP. Importance of TIMI3 flow. *Circulation* 2001;104:624-6.
9. Roe MT, Ohman EM, Maas AC, Christenson RH, Mahaffey KW, Grenger CB et al. Shifting the open artery hypothesis down stream: The quest for optimal reperfusion. *J. Am Coll. Cardiol* 2001;37:9-18.
10. Wang FW, Osman A, Otero J, Stouffer GA, Waxman S, Afzal A et al. Distal myocardial protection during percutaneous coronary intervention with an intracoronary beta-blocker. *Circulation* 2003;107:2914-9.
11. Taniyama Y, Ito H, Iwakura K, Masuyama T, Hori M, Takiuchi S et al. Beneficial effects of intracoronary verapamil on microvascular and myocardial salvage in patients with acute myocardial infarction. *J. Am Coll. Cardiol* 1997;30:1193-9.
12. Marzilli M, Orsini E, Marraccini P, Testa R. Beneficial effects of intracoronary adenosine as adjunct to primary angioplasty in acute myocardial infarction. *Circulation* 2000;101:2154-9.
13. Vijayalakshmi K, Whittaker VJ, Kunadian B, Graham RJ, Wright RA, Hall JA et al. A prospective, randomized, controlled trial to study the effect of intracoronary injection of verapamil and adenosine on coronary blood flow during percutaneous coronary intervention in patients with acute coronary syndrome. *Heart* 2006; 92:1272-84.
14. Constantinides S, LoTS, Been M, Shiu MF. Early experience with a helical coronary thrombectomy device in patients with acute coronary thrombosis. *Heart* 2002;87;455-60.
15. Cura F, L Allier PL, Kapadia SR, Houghtaling PL, Dipaola LM, Ellis SG et al. Predictors and prognosis of suboptimal coronary blood flow after primary coronary angioplasty in patients with acute myocardial infarction. *Am. J. Cardiol* 2001;88:124-8.
16. Angelin A, Rubartelli P, Mistrorigo F, Barbera DM, Abbadesse F, Vischi M et al. Distal protection with a filter device during coronary stenting in patients with stable and unstable angina. *Circulation* 2004;110:515-21.
17. Henriques J, Zijlstra F, Van't Hof A, de Boer MJ, Dambrink JH, Gosselink M et al Angiographic assessment of reperfusion in acute myocardial infarction by myocardial blush grade. *Circulation* 2003;107:2115-9.
18. Grube E, Gerckens U, Yeung A, Rowold S, Kirchhof N, Sedgewick J et al.. Prevention of distal embolization during coronary angioplasty in Saphenous Vein grafts and native vessels using porous filter protection. *Circulation* 2001;104:2436-41.
19. Napolitano M, Pasquetti G, Sacca S, Cernetti C, Scarbeo V, Pascotto P et al. Intracoronary thrombectomy improves myocardial reperfusion in patients undergoing direct angioplasty for acute myocardial infarction. *J. Am. Coll. Cardiol* 2003; 42: 1395 - 1402.
20. Burzotta F, Trani C, Romagnoli E, Mazzari MA, Rebuzzi AG, De Vita M et al. Manual Thrombus Aspiration improves Myocardial reperfusion. The randomized Evaluation of the effect of Mechanical Reduction of distal embolization by thrombus- aspiration in primary and rescue Angioplasty (REMEDIA) trial. *JACC* 2005; 46: 371-6.
21. Stone GW, Webb J, Cox DA, Brodie BR, Qureshi M, Kalynych A et al. Distal microcirculatory protection during percutaneous coronary intervention in acute ST segment elevation myocardial infarction. A randomized controlled trial. *JAMA* 2005; 293: 1063-72.
22. Ferrante G, Burzotta F, Fadda G. Analysis of material aspirated using the Diver CE and myocardial reperfusion in patients with acute coronary syndromes. *Ital Heart J* 2004; 5 Suppl: 39S.
23. Exaire JE, Brener SJ, Ellis SG, Yadav JS, Bhatt DL. Guide Wire Emboli protection device is associated with improved myocardial perfusion grade in Saphenous vein graft intervention. *Am. Heart J* 2004; 148: 1003 - 6.
24. Khan A, Tayyab F, Bashir R, Haq M, Raja K, Yousaf M. Percutaneous Transluminal Coronary Angioplasty. *Pak Armed Forces Med J* 1997;47:77-83.