ROLE OF ASPIRATION THROMBECTOMY IN PRIMARY PCI FOR STEMI - MYTH OR REALITY?

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ABSTRACT

Objective: The objective of the study was to determine the outcome of thrombus aspiration in Primary coronary intervention (PCI) for ST elevation myocardial infarction (STEMI).

Design: Case Series

Place and Duration of Study: The study was carried out in Armed Forces Institute of Cardiology – National Institute of Heart Diseases (AFIC-NIHD) over a period of twelve months from January 2013 to December 2013.

Patients and Methods: Data of 30 patients who underwent aspiration thrombectomy during primary PCI for STEMI by the transradial approach was collected. Inclusion criteria were chest pain suggestive of myocardial ischemia lasting longer than 30 min accompanied by ST- segment elevation or new left bundle branch block on the ECG within 12 h of symptom onset. Patients with previous CABG, cardiogenic shock or requiring TPM placement were excluded from this study. A 6F sheath was placed inside the radial artery, and cardiac catheterization was performed. Angiographic and electrocardiographic signs of myocardial reperfusion were assessed. Study endpoints included TIMI III flow and ST-segment resolution at the end of the procedure.

Results: Mean age of the patients was 52 years (range 37-77 yrs) and 63% (n= 19) were males and 37% (n=11) were females. The right radial artery was used in 90% of cases. Thrombus aspiration catheter used was 6 F Thrombuster II (70%) and Hunter (30%).There was significant improvement in markers of myocardial reperfusion with achievement of ST-segment resolution and TIMI 3 flow in 28 patients (93%). No case of vascular complications such as major access site bleeding, vascular perforation, radial artery occlusion, forearm ischemia, compartment syndrome or MACE was observed.

Conclusion: Thrombus aspiration (TA) is applicable in the majority of patients undergoing primary PCI for myocardial infarction with ST-segment elevation, and it improves early markers of myocardial reperfusion.

Keywords: Primary PCI, Thrombectomy, Myocardial infarction, STEMI.

INTRODUCTION

Coronary artery plaque rupture and the subsequent formation of an occlusive thrombus are central to the pathophysiology of the majority of ST-segment elevation myocardial infarction (STEMI) cases. Prompt and expertly performed Mechanical reperfusion with primary percutaneous coronary intervention (PPCI) has emerged as the preferred strategy to achieve the immediate restoration of coronary blood flow and limit myocardial infarction (MI)[1]. Numerous procedural and technical innovations have contributed to improved results with primary PCI. These include potent adjunctive pharmacotherapy (glycoprotein IIb/IIIa receptor inhibitors, direct thrombin inhibitors, and new thienopyridines), new devices such as drug-eluting stents and those for hemodynamic support, and new access sites (radial). Despite these innovations, numerous challenges remain, and room for improvement remains. Particularly challenging and frustrating to the operators has been the inability to prevent and treat the no-reflow phenomenon (defined as diminished or absent antegrade coronary flow despite the presence of a patent epicardial artery). Numerous factors can contribute to no reflow because acute myocardial infarction is the end result of complex epicardial, microcirculatory, and myocyte interactions[2]. These factors include macro- or microembolization of thrombus, release of cytokines and vasoactive molecules, and intense microcirculatory spasm. Because thrombus is

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ubiquitous in STEMI, whether it can be visualized angiographically, numerous mechanical approaches for prevention of no reflow have been tried. During PPCI, distal embolization of plaque fragments and thrombus may lead to microvascular occlusion, no-reflow and failure to achieve normal flow in the infarct-related artery[3]. Manual thrombus aspiration has been shown to improve coronary perfusion as assessed by thrombolysis in MI (TIMI) flow and time to ST-segment resolution (STR).

PATIENTS AND METHODS

This descriptive study was carried out in Armed Forces Institute of Cardiology – National Institute of Heart Diseases (AFIC-NIHD) spanning over a period of twelve months from January 2013 to December 2013. Patients with chest pain suggestive of myocardial ischemia lasting longer than 30 min accompanied by ST-segment elevation or new left bundle branch block on the ECG within 12 h of symptom onset were included. Exclusion criteria were patients with previous CABG with LIMA grafting, cardiogenic shock or requiring TPM placement. Thirty patients fulfilling inclusion criteria were included in the study. Our preference was to use the right radial artery whenever possible as it was nearest to where the operator stood while facing the cardiac monitors. Before the procedure, all patients were treated with aspirin 300 mg and loading dose of clopidogrel 600 mg and received an adjunctive bolus of heparin according to body weight (70 IU/kg). Activated clotting time (ACT) was measured at 30 minutes interval during the procedure and was maintained greater than 300s with additional heparin as necessary. Glycoprotein IIb/IIIa inhibitors (weight-adjusted intracoronary or intravenous dose) were administered to majority of the patients in the absence of any contra-indications. Radial artery was punctured with a 21 gauge needle and was cannulated with a 45 cm, 0.019 inch straight wire. A 6 Fr radial sheath (11 cm) was then inserted into the artery using the Seldinger technique. A 260 cm long guidewire was used in catheter exchange to facilitate the procedure and minimize catheter manipulation into the aortic arch and ascending aorta. Diagnostic angiography was performed by using 6 Fr Judkins catheter or Tiger catheter. Coronary intervention (PCI) was performed using 6 Fr guiding catheters including Judkins, Amplatz, XB or EBU guiding catheters. All thrombus aspiration was performed manually using 6F thrombus aspiration catheters, Thrombuster II (Medtronic) and Hunter (IHT). Intracoronary Adenosine was also used to minimize no re-flow. At the completion of the procedure, pressure was applied over the puncture site with a gauze roll and crape bandage dressing for approximately six hours to achieve haemostasis. The pressure dressing and sheath were removed after 6 hours.

Data collected had been analyzed through SPSS version 17. Descriptive statistics were used to describe the results.

RESULTS

The baseline demographic and clinical characteristics of the patients are detailed in Table I. Mean age of the patients was 52 years (range 37-77 yrs) and 63% (n= 19) were males and 37% (n=11) were females. The right radial artery was used in 90% of cases. Procedural success was achieved in 100% cases. CV risk profile revealed hypertension 70%, diabetes mellitus 57%, dyslipidemia 80% and smoking in 53% cases. Serum creatinine levels above 1.1 mg/dl were seen in 47% cases. Procedural success was achieved in 100% cases with no cross over to transfemoral access. Right TR approach was used in 90% cases and a 6F sheath was used in all cases (100%). The procedural characteristics are shown in Table II. BMS was used in majority of the cases (93%) where as DES was used in 7% cases. Target vessel for primary PCI was LAD 47%, RCA 33% and LCX in 20% cases. Thrombus aspiration catheter used was Thrombuster II (70%) and Hunter (30%). There was improvement in markers of myocardial reperfusion with achievement of ST-segment resolution and TIMI 3 flow in 28 patients (93%). (Table-2)

DISCUSSION

PPCI remains the most effective treatment strategy for patients presenting with STEMI. However, despite the established merits of this reperfusion strategy, it fails to restore optimal myocardial reperfusion in a relatively large proportion of patients (i.e, no-reflow). It has become apparent that patency of epicardial infarct related coronary arteries (IRA) after reperfusion is not a guarantee for adequate microvascular perfusion. Therefore, optimizing tissue-level reperfusion is an important therapeutic goal in the setting of PPCI. High thrombus burden is known to be associated with an increased incidence of distal embolization, a significant pathogenetic component of no-reflow, and may limit reperfusion at tissue level as measured by thrombolysis in MI (TIMI)[3] flow and ST-segment resolution (STR). Moreover, high thrombus burden is associated with a higher frequency of major adverse cardiac events (MACE) and is a strong independent predictor of long-term mortality. Accordingly, several therapeutic strategies have been studied that aim to reduce thrombus burden and consist of pharmacological (eg, glycoprotein IIb/IIIa inhibitors) and mechanical (eg, embolic protection devices, manual or mechanical thrombectomy devices) approaches. This study of STEMI patients undergoing Primary PCI demonstrates that thrombus aspiration is associated with an increase in the rate of post-PPCI TIMI 3 flow and ST resolution translating into significant reduction in mortality. One reason why simple aspiration may be too good to be true is that at times thrombectomy may be incomplete. Optical coherence tomography has demonstrated that substantial amounts of residual thrombus may be still present in most patients after aspiration, even if not angiographically evident. Aspiration catheters have relatively small inner diameters, and may fail to retrieve thrombus from diffusely diseased vessels or distally located lesions, or if coronary perfusion pressure is reduced or the the thrombus partially organized. Several randomized control trials have confirmed the beneficial effect of thrombus aspiration (TA) during PPCI on improving coronary flow and myocardial perfusion. We found that thrombus aspiration was less likely to be used in culprit lesions in smaller diameter arteries and in older patients. Features including calcification, tortuosity and diffuse disease reduce the likelihood of successful delivery of the thrombectomy catheter and their greater prevalence in elderly population could explain the reduced usage in this subgroup. In addition, patients with pre-PPCI TIMI 2 or 3 flow are less likely to undergo thrombus aspiration due to a lower visible thrombus burden in these patients as compared to those with pre-PPCI TIMI 0 or 1 flow. Achieving post-PPCI TIMI 3 flow grade is a strong predictor of clinical outcomes in in PPCI-treated STEMI patients[4]. Mortality rate is significantly lower in post- PPCI TIMI 3 flow grade patients as compared to those with post-PPCI TIMI 0/1/2 flow[4]. Several randomized trials have evaluated the use of different aspiration thrombectomy devices in STEMI. Primary endpoints were typically related to angiographic and electrocardiographic findings. To date, the thrombus aspiration during percutaneous coronary intervention in acute myocardial infarction (TAPAS) study remains the largest of these trials. Although TAPAS failed to demonstrate a significant benefit for thrombectomy on the secondary endpoints of post-PPCI TIMI flow grade or 30-day mortality, there was a significant reduction in all-cause and cardiac 1-year mortality with thrombus aspiration[5]. This late mortality benefit may be explained by the beneficial effect of thrombectomy on LV remodeling and infarct size. The TAPAS results suggest that TA decreased microvascular obstruction and increased myocardial reperfusion. The randomized evaluation of the effect of mechanical reduction of distal embolization by thrombus aspiration In primary and rescue angioplasty (REMEDIA) trial has shown improvement in the primary endpoints of ST-

segment resolution (STR) ≥ 70% and TIMI ≥ 2 (STR: 44.9% vs 36.7%, *p* = 0.02; TIMI: 68.0% vs 58.0%, *p* = 0.034) using the Diver CE device (Invatec, Brescia, Italy)[6]. In a 50-patient myocardial contrast echocardiography substudy, TA reduced microvascular obstruction acutely and demonstrated a trend to a decrease in 6-mo adverse left ventricular remodeling[7]. In a similar study design, De Luca and colleagues have shown, in 76 anterior STEMI patients, STR in 81.6% of TA vs 55.3% of non-TA patients (P = 0.02), and TIMI 3 of 36.8% for TA and 13.1% for non-TA patients[8]. Kaltoft et al have randomized 215 STEMI patients to PCI with or without TA

Table-1: Description of demographic characterstics (n = 30)

AGE (Yrs)	53 + 16.8
GENDER	
Male	19 (63 %)
Female	11 (37 %)
Hypertension	21 (70 %)
Diabetes Mellitus	17 (57 %)
Dyslipidemia	24 (80 %)
BMI > 25	23 (77 %)
Renal Dysfunction (S.Creat> 1.1 mg/dl)	14 (47%)
Smoking History	16 (53 %)
Previous PTCA	4 (13 %)

PTCA = Percutaneous transluminal coronary angioplasty.

Table-2: Description of procedural characterstics of the patients (n = 30)

Procedural Success	30 (100 %)
Types of guiding catheters used	
EBU/ XB	16 (53%)
Judkins	11 (37%)
Amplatz	2 (7%)
Multipurpose	1 (3%)
Site of attempted TR access	
Right radial artery	27 (90%)
Left radial artery	3 (10%)
Types of thrombus aspiration catheters used	
Thrombuster II	21 (70%)
Hunter	9 (30%)
Location of target lesion	
Left anterior descending artery	14(47%)
Left circumflex artery	6 (20%)
Right coronary artery	10 (33 %)
Left main stem	0 (0 %)
Type of stents used	
Bare metal (BMS)	28 (93%)
Drug eluting (DES)	2 (7 %)

using a 4.5 Fr Rescue extraction catheter (Boston Scientific, USA). This study did not show improvement in the primary endpoint of scintigraphic myocardial salvage at 30 day. Although the reason for this latter finding is not certain, the device used in this study was relatively bulky (4.5 Fr), and possibly provoked embolization during its passage[9]. In the dethrombosis to enhance Acute Reperfusion in Myocardial Infarction (DEAR-MI) study, 148 patients with STEMI were randomized to primary PCI without or with TA using the Pronto extraction device (Vascular Solutions, Minneapolis, MN, USA)[10]. There was a significant improvement in the primary endpoints of complete STR (68% vs 50%, $p < 0.05$) and TIMI 3 (88% vs 44%, $p < 0.0001$)[10]. Similarly, our study showed that there was significant improvement in markers of myocardial reperfusion with achievement of ST-segment resolution and TIMI 3 flow in 28 patients (93%).The VAcuuM asPIration thrombus REmoval (VAMPIRE) Trial randomized 355 patients to a single lumen aspiration catheter device (TVAC; Nipro, Osaka, Japan) attached to a motorized vacuum system (n = 180) or conventional PCI without TA (n = 175). There was a trend to improvement with TA with decrease incidence in MACE, less target lesion revascularization (TLR) and repeat PCI[11]. It is well established that timely reperfusion is crucial for restoration of myocardial blood flow during acute infarction to preserve left ventricular (LV) function. Kondo et al[12] in their study found that adverse LV remodeling (defined as an increase in LV end-diastolic volume index by > 20%) was significantly lower in patients treated with TA. In a recent randomized trial of 175 patients with STEMI with PCI, with or without TA, investigators evaluated LV function by contrast-enhanced magnetic resonance imaging (CE-MRI), 3-5 d after PCI and again at 3 month the TA group had significantly greater MBG and ST-segment resolution. CE-MRI showed significantly greater microvascular obstruction in the conventional PCI group as compared with the TA group[13]. At 3 month, the TA group had a significantly smaller infarct size than the conventional PCI group. At 9 month, the TA group had a lower incidence of cardiac death. Mongeon et al performed a Bayesian meta-analysis of 21 individual trials (including 16 with simple aspiration catheters) representing a total of 4299 patients. Use of thrombectomy devices led to large and significant reductions in no-reflow, more ST segment resolution, and better myocardial perfusion[14]. Meta analsis by Bavry et al combined results of 30 trials that enrolled 6415 STEMI patients randomly assigned to an adjunctive aspiration thrombectomy showed significantiy reduced mortality[15]. The American College of Cardiology/American Heart Association guidelines update has recognized this data by making it a Class IIa indication for STEMI[16]. Additional data are required to confirm the salutary effects of routine TA on long-term outcomes of mortality and MACE in order that it be a Class I indication, i.e. the standard of care[17].

CONCLUSION

In STEMI, primary PCI is the standard of care. It is extremely effective in rapidly recanalizing an occluded vessel. However, it may also provoke distal embolization of soft thrombus that may be removed easily by manual aspiration. In our study we concluded that Thrombus aspiration (TA) during PPCI is a quick and simple method associated with a significant increase in post-procedure TIMI 3 flow grade and an early ST- segment resolution on ECG (early markers of reperfusion). The routine use of manual thrombectomy appears an appealing strategy on account of its practical advantages (less thrombus, better visualization, better stent selection) and safety.

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