Outcomes of Primary Percutaneous Coronary Intervention in Acute Myocardial Infarction at Tehran Heart Center

Mohammad Alidoosti Mojtaba Salarifar Alimohammad Hajizeinali
Seyed Ebrahim Kassaian Davood Kasemisaleh Hamidreza Goodarzynejad

Tehran Heart Center, Tehran University of Medical Sciences, Tehran, Iran

Key Words

Primary percutaneous coronary intervention • ST-segment myocardial infarction • Major adverse cardiac events

Abstract

Objective: To describe our experience of primary angioplasty in ST-segment elevation myocardial infarction. **Subjects and Methods:** During a period of 2 years (April 2003 to May 2005), 83 high-risk patients presenting with acute ST-segment elevation myocardial infarction underwent primary angioplasty subject to availability of balloon dilation within 90 min of admission. In total, 73 stents were implanted; 69 were bare metal stents, while the remaining 4 were paclitaxel-eluting stents. Of the 83 patients, 8 presented with cardiogenic shock. Follow-up was for a period of 9 months. All angiographic, in-hospital and clinical outcomes were recorded on a database. **Results:** The procedure was successful in 79 of the 83 patients (95%) and unsuccessful in 4 (5%). Of these 4 patients, 3 died and 1 was treated medically. In 65 patients with zero perfusion, angioplasty was successful in 61 (93.8%), while it was completely successful (100%) in the remaining 18 patients with thrombolysis in myocardial infarction grade 3 perfusion. Vessel patency was achieved in 95% with thrombolysis in myocardial infarction grade 3 flow present in 93%. A total of 7 (8.5%) patients died while in the hospital. Of the 8 with initial cardiogenic shock on presentation, 4 (50%) died in the hospital and of the remaining 4, 1 was lost at 9-month follow-up. In-hospital reocclusion and

reinfarction did not occur in any patient. **Conclusion:** The results suggest that primary angioplasty is logistically feasible in our center with good clinical outcomes.

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Introduction

Reperfusion therapy is the cornerstone in treatment of patients with acute ST-segment elevation myocardial infarction (STSEMI). Primary angioplasty without antecedent thrombolytic therapy, an effective means of achieving coronary reperfusion in patients presenting with an acute STSEMI, has been described by Meyer et al. [1] and Hartzler et al. [2]. For over 20 years, primary percutaneous coronary intervention (primary PCI) has been advocated for treatment of STSEMI. An updated comprehensive meta-analysis of 23 multicenter randomized trials indicates that primary PCI is superior to thrombolysis, resulting in a markedly lower occurrence of short-term major adverse cardiac events (MACEs), including death, in individuals with STSEMI. Moreover, these favorable results were sustained during long-term follow-up [3]. Primary PCI has been associated with an improved clinical outcome compared to thrombolytic therapy, irrespective of the type of thrombolytic regimen used. Furthermore, most STSEMI patients are not candidates for fibrinolytic therapy, either because they have bleeding risks or shock, or do not have diagnostic electrocardio-

grams [4, 5]. The invasive approach can be applied to almost all of these patients at interventional centers. In addition, primary angioplasty may be more cost-effective than fibrinolytic therapy [6, 7]. Therefore, primary PCI is widely regarded as the reperfusion strategy of choice in STSEMI if it can be performed within 2 h of presentation to the hospital (door-to-balloon time <2 h).

A major disadvantage of primary PCI in comparison with thrombolysis has been the limited access resulting in a time delay until treatment. Other limitations of primary angioplasty include critical dependence on operator experience and longer time to treatment [8]. Since 2003, facilities have been provided and protocols established at Tehran Heart Center to regularly perform primary angioplasty in a timely fashion (door-to-balloon time <90 min). Therefore, the objective of this study was to report the initial and long-term outcomes of patients who underwent primary PCI at Tehran Heart Center, a large institution performing more than 1,500 elective angioplasties per year.

Subjects and Methods

Study Population and Protocol

The study was conducted from April 2003 to May 2005. A total of 512 patients with STSEMI were admitted during the study period. Inclusion criteria were the presence of symptoms consistent with acute myocardial infarction (AMI) for at least 30 min but less than 12 h, the presence of ST-segment elevation in at least two contiguous leads or left bundle-branch block and the feasibility of performing balloon dilation within 90 min of admission ('door-to-balloon time' <90 min). The clinical exclusion criteria were: inability to provide informed consent; pulseless femoral arteries; nonischemic heart disease and noncardiac disease associated with a life expectancy of less than 12 months; females of child-bearing age, unless the result of a recent pregnancy test was negative; those with known contraindications to aspirin, heparin, ticlopidine or clopidogrel (Plavix).

Angiographic criteria for exclusion from PCI were stenosis of the left main coronary artery of more than 70% (not protected by collateral circulation), presence of critical three-vessel disease (with $\geq 70\%$ stenosis in each vessel) or morphologic features of the lesion known to indicate high risk [9]. Bypass surgery was recommended for these high-risk patients. Patients were also excluded if they seemed unlikely to benefit from PCI because the infarct-related vessels were small, there was stenosis of less than 70% with thrombolysis in myocardial infarction (TIMI)-3 flow, or the infarct-related vessel could not be identified. Most exclusions, however, were due to unavailability of the service in a timely fashion in terms of operator and laboratory requirements, since primary PCI has not yet become the 'default' treatment during off-hours, and currently the program operates exclusively during the day, on weekdays for patients who arrive during the time when the program is being offered.

Of a total of 512 patients, 429 were excluded for the following reasons: 316 patients received thrombolytic therapy due to unavailability of the catheterization laboratory during off hours; in 101 patients more than 12 h had elapsed from the onset of chest pain, and in 12 patients coronary anatomy was not suitable for angioplasty or the involved vessel supplied a small territory of myocardium considered for medical treatment. The remaining 83 patients provided written informed consent and in the case of the patient's inability, informed consent was obtained from the relatives. Nineteen patients (23%) were >65 years of age and 8 presented with cardiogenic shock. The mean duration of chest pain before arriving at the Emergency Department was 204 min. Anterior and inferior infarctions were noted in 55 and 28 patients, respectively. Seventy patients (84%) had single vessel disease with a mean age of 51.54 ± 14.43 vs. 57.08 ± 9.60 years in patients with multivessel disease ($p = 0.55$). In two thirds of the cases, the target vessel was left anterior descending (LAD). Additionally, in 7 patients, a second critically stenotic vessel was treated – five diagonals, one LAD, and one left circumflex. In total, 73 stents were implanted; 69 (95%) bare metal and 4 paclitaxel-eluting stents. The stent diameter was 3.08 ± 0.38 mm while the length was 19.96 ± 5.79 mm.

Catheterization Procedure and Medications

Before undergoing catheterization, patients received 325 mg of chewable aspirin, 300 mg of Plavix orally, and a 5,000-unit bolus of heparin. Patients immediately underwent diagnostic catheterization. In patients with TIMI grade 3 flow in an infarct-related vessel upon first angiography, percutaneous intervention was performed in the case of a residual critical stenosis ($\geq 70\%$) accompanied with signs and symptoms of ongoing or remittent ischemia, high-risk lesion morphology for reocclusion and/or presence of a large myocardial territory in jeopardy. If the patient was eligible for PCI, additional heparin was administered (5,000–10,000 units), and angioplasty procedure was performed using standard techniques. After the intervention, patients received 325 mg of aspirin daily, as well as beta-blockers and angiotensin-converting enzyme inhibitors, provided that these agents were not contraindicated. Sixty-nine (69) patients who received bare metal stents were given 75 mg of Plavix per day or 250 mg of ticlopidine twice daily for 4 weeks, while 4 patients who received drug-eluting stents continued to take Plavix or ticlopidine for 6–12 months. Follow-up visits were scheduled at 1, 4, and 9 months.

Data Collection and Management

The following data were collected: baseline demographics, medical history, medications, procedures, complications, and clinical events. Follow-up was performed during office visits to physicians or obtained by means of telephone interview. Data from completed collection forms were entered into an Access database. All angiographic films were reviewed for accuracy by a single cardiologist who was unaware of patients' clinical outcomes. The left ventricular ejection fraction and regional wall motion were determined using either echocardiography or contrast ventriculography during the procedure.

The primary end point was clinical success. Angiographic success was defined as post-procedure TIMI flow grade more than 2 and a residual stenosis less than 50%. MACEs were defined as the total number of deaths from any causes, reinfarction, and repeated intervention or revascularization of the target vessel as

Table 1. Baseline characteristics of patients

Mean age, years	55 ± 12
Age range, years	21–80
Sex, M/F	64/19 (77/23)
Age ≥65 years	19 (23)
MI location	
Anterior	55 (66)
Inferior	28 (34)
Ischemic time	
Mean, min	204 ± 144
Range, min	60–720
≤2 h	35 (42)
2–4 h	25 (30)
4–6 h	13 (16)
>6 h	10 (12)
Cardiogenic shock	8 (10)
Prior CABG	0
Prior PCI	7 (8)
Diabetes mellitus	16 (19)
Hypertension	31 (37)
Hypercholesterolemia	32 (38)
Previous stroke	0
Previous MI	12 (14)
Ejection fraction	45 ± 12
EF range, %	20–75

Figures in parentheses indicate percentages.

a result of ischemia. Reinfarction was defined as recurrent symptoms of ischemia with new electrocardiographic changes and/or a rise in CK-MB more than twice the normal limits. Revascularization of the target vessel was considered to have been prompted by ischemia if there was evidence of ischemia during functional testing or angina. Clinical success was defined as successful procedure in the absence of in-hospital MACEs.

Statistical analysis was performed with the SPSS software v11.5 statistical package. Continuous data were expressed as mean ± SD and categorical data as percentage. Statistical analyses were completed on the categorical variables using a χ^2 or a Fisher exact test as appropriate. A p value of less than 0.05 was judged statistically significant. Relative risks were calculated with 95% confidence intervals. Differences between means were assessed with the two-tailed Student's t test and differences in outcomes in shock and non-shock patients were computed using the Mantel-Haenszel test.

Results

Patients' demographics and angiographic records are listed in tables 1 and 2. The angioplasty procedure was successful in 79 (95%) of cases, but unsuccessful in 4 (5%). In patients with TIMI grade 0 perfusion (occluded

Table 2. Basic angiographic characteristics

	Patients	
	n	%
Multi vessel disease	13	16
Infarct-related artery		
Left main	1	1
LAD	50	60
LCX	5	6
RCA	27	32
TIMI grade (perfusion) before procedure		
0	65	78
1	8	10
2	5	6
3	5	6
TIMI grade (perfusion) after procedure		
0–1	1	1
2	7	8
3	75	90
Lesion characteristics		
Ostial	6	7
Proximal	25	30
Long (>10, <20 mm)	44	53
Diffuse (≥20 mm)	22	26
Complex lesions ¹	79	95
EF ≤40%	16	19

LCX = Left circumflex; RCA = right coronary artery; EF = ejection fraction.

¹ American Heart Association classification/lesion type B2 and C.

infarct-related artery), the success rate was 93.8% (61 of 65) compared to 100% (18 of 18) in patients with TIMI grade 1 or more perfusion. The angioplasty success rates in patients with single- versus multivessel disease were 95 and 92%, respectively. Of the 4 patients with failed angioplasty, 3 died and 1 was treated medically; no one underwent urgent coronary artery bypass surgery. The mortality rate was relatively low (8.4%; table 3). In 8 patients who presented with cardiogenic shock, the mortality was 50%; in the 75 patients without shock, it was 4%. In-hospital reocclusion and reinfarction did not occur in any patient. There were also no occurrences of stroke or transient ischemic attack. Mechanical support with an intra-aortic balloon pump was used only in 7 patients (6%); 5 were in the (63%) and 2 in the non-shock group (3%).

At 9 months, the cumulative incidence of the primary end point – a composite of death, reinfarction, revascularization, or disabling stroke – was 75 and 5.3% in patients who presented with and without shock, respective-

Table 3. In-hospital and late outcomes in patients undergoing primary angioplasty

Outcome	Total (n = 83)	Initial cardio- genic shock (n = 8)	Without shock (n = 75)	p value
In-hospital event rates				
Death	7 (8.4)	4 (50)	3 (4)	0.001
Reinfarction	–	–	–	–
TVR	–	–	–	–
Stroke or TIA	–	–	–	–
Composite end point	7 (8.4)	4 (50)	3 (4)	0.001
At 9-month follow-up				
Death	1 (1.2)	1 (12.5)	–	<0.001
Reinfarction	2 (2.4)	1 (12.5)	1 (1.3)	0.007
TVR	–	–	–	–
Stroke or TIA	–	–	–	–
Composite end point (cumulative)	10 (12)	6 (75)	4 (5.3)	0.007

TVR = Target vessel revascularization; TIA = transient ischemic attack. Figures in parentheses indicate percentages.

ly ($p = 0.007$). Despite a 50% in-hospital mortality rate, only 1 fatality occurred within 9 months after hospital discharge among patients with cardiogenic shock.

Discussion

The success rate of angioplasty in this study (95%) was similar to that in other series [10, 11]; however, in our study, no patient underwent emergency bypass surgery following unsuccessful PCI.

Reperfusion

Coronary patency, defined as the restoration of normal blood flow in the infarct-related vessel, preserves myocardial tissue and results in improved survival. With primary angioplasty, 95% of infarct vessels were successfully reperfused. In contrast, intravenous streptokinase therapy without further intervention leads to an infarct vessel patency rate from 41 to 55% [12, 13]. Although tissue plasminogen activator [12] and various combinations of intravenous thrombolytic agents [14] improve this rate of recanalization, there appears to be a 'pharmacologic intervention plateau' at approximately 75% with respect to acute infarct vessel patency [15].

One of the main findings of the present study is that among patients with STSEMI undergoing primary angioplasty, poor myocardial perfusion is a major explanation of the poor outcome observed in patients with shock

at presentation. Despite the significant improvement in survival of patients undergoing primary angioplasty, the mortality rate in patients with cardiogenic shock at presentation remains disappointingly high [16].

In this series, primary angioplasty for AMI was highly effective in reestablishing infarct-vessel patency resulting in low in-hospital and long-term morbidity and mortality. These findings are particularly notable because in spite of using intra-aortic balloon pump most of the mortalities were among patients presenting with shock to the catheterization laboratory.

Mortality

The in-hospital mortality of 8.4% in this series of patients is similar to the mean in-hospital mortality from other more selected series using primary angioplasty for AMI [15]. This compares favorably with the 11–20% mortality rate in historical control subjects treated with traditional conservative therapy [17]. The in-hospital death rates for patients with successful versus failed angioplasty were 5 and 75%. This finding, corroborated by previous reports [18, 19], suggests that the ability to reopen the infarct artery exerts a powerful influence on subsequent mortality.

In studies assessing intravenous thrombolytic therapy with or without adjunctive coronary angioplasty, where rigid selection criteria were used to exclude patients aged >75 years, those with prior bypass surgery or cardiogenic shock, and those presenting later than 4 h after the on-

set of symptoms, a very low hospital mortality rate (4–7%) has been reported [20, 21].

The excellent long-term outcome seen in this series has also been noted in previous trials using angioplasty for AMI. In a meta-analysis from Keeley et al. [3], 23 randomized trials showed that follow-up mortality for hospital survivors was near 10%. The long-term benefits of direct coronary angioplasty may be the result of many factors, including early myocardial salvage, limitation of ventricular dilatation after infarction [22] or prevention of ventricular dysrhythmias [23].

The main limitation of the study was that while multicenter primary angioplasty trials have included many thousands of acute STSEMI patients undergoing reperfusion therapy, our study included only 83 patients from a single center. However, this center is one of the pioneers in the performance of regular primary PCI in Iran. Dur-

ing the study, abciximab was not used; this additional therapeutic option may have a positive impact on clinical outcome [24].

Conclusion

The outcomes indicate that immediate coronary reperfusion with primary angioplasty can be performed safely and effectively with excellent outcomes in a large high-risk population of patients with acute STSEMI, when appropriate. To keep pace with other modern countries in the routine application of this strategy in patients with STSEMI, more hospitals in Iran should be equipped with facilities for coronary angioplasty, a cardiac catheterization team and an on-call invasive cardiologist experienced in primary angioplasty.

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