

Outcome of Primary Percutaneous Coronary Intervention in Acute Myocardial Infarction Patients Presenting with Cardiogenic Shock.

Anil OM, Sayami A, Nepal R, Jaiswal S, Bhattarai N

Department of cardiology, Manmohan Cardiothoracic Vascular and Transplant Centre, Maharajgunj, Kathmandu, Nepal

Corresponding Author: Dr Anil Om Murti

E-mail: drommurti@yahoo.com

Abstract

Introduction: Cardiogenic shock is the leading cause of death in patients hospitalized for acute myocardial infarction (MI). Cardiogenic shock can occur in both ST elevated MI (STEMI) and non-ST elevated MI (NSTEMI). In these patients primary percutaneous coronary intervention (PCI) has better outcome and decreased in-hospital mortality compared to thrombolysis, if performed in time.

Methods: This is a retrospective observational study conducted at Manmohan Cardiothoracic Vascular and Transplant Centre, Maharajgunj, Kathmandu, Nepal from September 2012 to December 2014. Patients who presented with acute myocardial infarction and cardiogenic shock and underwent primary PCI were enrolled in this study. Records from cath lab, Coronary Care Unit (CCU) and discharge notes were reviewed and analyzed.

Results: A total of 22 patients were enrolled in this study. The mean age of the study population was 61.5 ± 11.5 years and 73% of the participants were male. Four patients were intubated in the emergency department, three received cardiopulmonary resuscitation (CPR) and one patient received electrical cardioversion on presentation. Triple vessel disease was the most common finding and left anterior descending (LAD) artery was the commonest culprit vessel. Procedural success was 91%. In-hospital mortality was 31.2% in the entire study population. Ventilator associated pneumonia and severe sepsis was seen in 5 out of 7 cases that died.

Conclusion: Initial outcome of primary PCI performed in patients with acute MI in cardiogenic shock at our centre is encouraging. In-hospital mortality in patients with acute MI complicated by cardiogenic is high. Primary PCI improves outcome in these patients and should be performed as an initial strategy.

Keywords: Acute Myocardial Infarction, Primary Percutaneous Coronary Intervention, Cardiogenic shock, Outcome

Introduction

Cardiogenic shock is the leading cause of death in patients hospitalized for acute Myocardial infarction (MI) and it occurs in 7-10% of patients.¹ Cardiogenic shock can occur in both ST elevated MI (STEMI) and non-ST elevated MI (NSTEMI), although with NSTEMI, the frequency is half that of STEMI. Most commonly, cardiogenic shock is the result of left ventricular failure (78.5%).² Other important causes are severe mitral regurgitation (6.9%), ventricular septal rupture (3.9%), right ventricular infarction (2.8%), and cardiac tamponade (1.4%).² Shock develops within hours of the onset of massive ischemia and infarction. On the background of previous extensive damage, a relatively small infarction may also precipitate cardiogenic shock. Shock developing within 24 hours of acute MI is known as early shock and it is found in 74.1% of the patients.³

Anterior wall MI is most commonly associated with the development of cardiogenic shock (55%) followed by inferior wall MI according to the SHOCK trial registry.⁴ Most of the patients with cardiogenic shock have triple vessel disease and left anterior descending artery is the most common culprit vessel.⁴ Predictors for the development of cardiogenic shock are advanced age, diabetes mellitus, anterior wall myocardial infarction, prior infarcts, and reduced left ventricular ejection fraction (LVEF).⁵ Thrombolysis and percutaneous coronary intervention are the two options available to open the occluded coronary artery in acute MI. Large thrombolytic trials have demonstrated a mortality rate of about sixty percent with even the most effective thrombolytic agent.⁶ The in-hospital mortality of cardiogenic shock in a primary percutaneous coronary intervention registry (PPCI) from Germany was 46.1%.⁷

A small study from Nepal showed in-hospital mortality of 50% in patients with shock undergoing primary PCI.⁸ Because of a high mortality rate due to acute MI with cardiogenic shock as shown by the above studies, there is still benefit in outcome and decreased in-hospital mortality with primary PCI if performed timely by expert operators with the help of a dedicated cath lab team.

In Nepal, we can anticipate more patients with acute MI presenting to hospital in cardiogenic shock because of lack of thrombolysis facility in majority of the hospitals in small towns and delay in arrival of these patients in PCI capable centers. Since we have limited data on outcome of PCI in these patients, we aimed to find out the clinical profile, patient characteristics, procedural details and outcome in this cohort of patients. We hope that the results of this study will guide us to improve the outcome of these patients by primary PCI at a tertiary level cardiac center.

Methods

This is a retrospective observational study conducted at Manmohan Cardiothoracic Vascular and Transplant Centre, Maharajgunj, Kathmandu, Nepal from September 2012 to December 2014. Patients who presented with acute myocardial infarction and cardiogenic shock and underwent primary PCI, were enrolled in this study. Data were obtained by reviewing records from cath lab, coronary care unit and hospital discharges.

STEMI was defined as electrocardiographic evidence of ST segment elevation of >1 mm in 2 or more contiguous leads or new left bundle branch block along with raised troponin I. NSTEMI was defined as positive troponin I with ECG changes typical of ischemia along with anginal chest pain. Shock was defined as a systolic blood pressure <90 mmHg or a need of inotropic support with evidence of systemic hypoperfusion like cold clammy skin and cerebral obtundation. Patients were excluded from the study if they had mechanical complications in the form of ventricular septal rupture, severe mitral regurgitation or cardiac tamponade on presentation. Patients with right ventricular infarction and hypotension, which improved with initial fluid challenge were also excluded.

All patients received a loading dose of aspirin 300 mg, clopidogrel 300 mg and a high dose statin on arrival in the emergency department (ED). Intravenous inotropic agents were started in ED after diagnosis. Endotracheal intubation was done as per the patient's clinical condition.

In cath lab, 5000 units of IV heparin were given before initiation of PCI. Heparin was further added as required as boluses of 1000-2500 units to keep activated clotting time (ACT) around 300 seconds. Intravenous GPIIb/IIIa receptor blockers, bolus followed by IV infusion, was started after crossing the lesion when thrombus burden appeared large and was continued for 12-24 hours depending on clinical indications.

All cases were accessed through the femoral approach with a 6F or 7F sheath. Femoral venous line was also

obtained in all cases with a 7F sheath. Temporary pacemaker was put if significant bradycardia or heart block was present at presentation. Thrombo-suction prior to balloon inflation was done with a 6F/7F export catheter, only when thrombus burden was found to be high. Dual anti-platelet therapy was continued as per standard protocol. All patients were monitored in the coronary care unit (CCU).

Data was collected related to age, gender, history of diabetes (defined as a fasting glucose ≥ 126 mg/dl or on treatment), hypertension (systolic blood pressure ≥ 140 and/or diastolic blood pressure ≥ 90 mmHg or on treatment), smoking, previous history of MI, left ventricular function (visually estimated using echocardiography) and need for mechanical ventilation.

Timing variables were computed, including time to presentation (window period), which is defined as the time from symptom onset until arrival to the hospital. Door-to-balloon time was the time from arrival at the hospital to first balloon inflation (or use of thrombo-suction device) in cardiac catheterization laboratory. Angiographic and procedural details (culprit vessel, use of coronary stents, and use of intra-aortic balloon pump and glycoprotein [GP] IIb/IIIa inhibitors) were also collected. Procedural success (defined as achievement of vessel patency to a residual <30% stenosis) and in-hospital mortality was also recorded.

Results

A total of 22 patients were enrolled in this study from September 2012 to December 2014. The mean age of the patients was 61.5 ± 11.5 years and ranged from 48 to 87 years. Seventy three percent of the study population were male. Hypertension (77%) was the most common risk factor, while diabetes (64%) was the second most prevalent risk factor. The frequencies of other risk factors are presented in Table 1.

Table 1: Cardiovascular Risk Factors

Risk Factor	N (%)
Male Sex	16 (73%)
Hypertension	17(77%)
Diabetes Mellitus	14(64%)
Dyslipidemia	12(54%)
Smoker	7(32%)
Family History	2(9%)

Eight patients presented with serious arrhythmia, which included complete heart block (n=3), atrial fibrillation (AF,n=4) and ventricular tachycardia/ ventricular fibrillation (VT/VF, n=1). History of old MI was found in 7 cases (32%). Concurrent chest infection was diagnosed in 5 cases on presentation. Diabetic ketoacidosis with severe metabolic acidosis was seen in 2 cases. Renal impairment (creatinine clearance rate ,CCR less than 60 ml/min) was observed in 9 cases on arrival. Four patients

were intubated in the emergency department whereas 3 had received cardiopulmonary resuscitation (CPR) and one patient received direct current (DC) cardio version for VT/VF before the procedure (Table 2).

Table 2: Clinical Characteristics on admission

Clinical characteristics	N (%)
Serious arrhythmias	
• Complete heart block(CHB)	3 (13.6)
• Atrial fibrillation (AF)	4 (18.1)
• VT/VF requiring DC cardioversion	1 (4.5)
History of old MI	7 (31.8)
Sepsis (Pneumonia)	5 (22.7)
Diabetic Ketoacidosis	2 (9.0)
Renal impairment	9 (40.9)
Requiring mechanical ventilation	4 (18.1)
Received CPR	3 (13.6)

CPR: Cardiopulmonary resuscitation, DC : Direct current

VF: Ventricular fibrillation, VT: Ventricular tachycardia

Non-ST segment elevated Myocardial Infarction (NSTEMI) was seen in 5 (23%) patients, while anterior wall MI (mainly extensive anterior) was seen in 12 (55%), inferior wall MI in 3 (14%), true posterior wall MI in 1 (4.5%) and MI involving left main artery in 1 (4.5%).

Coronary angiographic findings revealed triple vessel disease as the most common finding (54.5%), followed by double vessel disease (27.2%), single vessel disease (13.6%) and left main artery involvement (4.5%). Left anterior descending (LAD) artery was the most common culprit vessel, followed by right coronary artery, circumflex artery and left main coronary artery. All culprit vessels were totally occluded at the time of angiography (TIMI 0 flow) and in majority of the cases thrombus burden was high. (Table 3 a-c).

Table 3a: Type of Myocardial Infarction (MI)

MI type	N (%)
Non-ST Segment Elevated MI (NSTEMI)	5 (22.7)
Anterior Wall MI	12 (54.5)
Inferior Wall MI Without Right Ventricular Extension	1 (4.5)
Inferior Wall MI With Right Ventricular Extension	2 (9)
True Posterior Wall MI	1 (4.5)
Left main MI	1 (4.5)

Table 3b: Angiographic Findings

Culprit artery	N (%)
Left main coronary artery	1 (4.5)
Left Anterior Descending	16 (72.7)
Right Coronary Artery	4 (18.1)
Circumflex Artery	1 (4.5)

Table 3c: Diagnosis by number of vessel

Diagnosis	N (%)
Single vessel disease	3 (13.6)
Double vessel disease	6 (27.2)
Triple vessel disease	12 (54.5)
Left main artery disease	1 (4.5)

Window period of the enrolled patients varied from 60 minutes to 32 hours with a mean of 15 ± 4.0 hours. At our center door to balloon time was 20 minutes to 60 minutes with a mean of 30 ± 10 minutes. All culprit lesions except one, were successfully crossed. Thrombus suction catheters were used after crossing the lesion in 65% of the cases with successful thrombus extraction in 50%. Balloon pre-dilatation was done in 81% of the cases and direct stenting was done in 9%. Procedural success was 91%. Drug eluting stent (DES) was deployed in 81% of the cases while bare metal stents was used in 19%. More than one stent was used in 18 cases. Seven cases of critical stenosis of the non-culprit artery were also treated during primary PCI. Mean number of stents per case was 1.8.

Table 4: Procedural Complication

Complication	N (%)
Slow flow / No reflow	3
Coronary perforation	0
Major bleeding	1
Groin complications	2
Stroke/TIA	0
During procedure CPR	0
Stent Thrombosis	0
Death related to procedure	0

During procedure significant arrhythmias were seen in 9 cases. Transient bradycardia, idioventricular rhythm, frequent premature beats, and non-sustained ventricular tachycardia (NSVT) were the most common arrhythmia observed during procedure. DC cardioversion for ventricular tachycardia (VT) was given in 1 case during the procedure. Temporary pacemaker was inserted in 5 cases altogether for complete heart block (during PCI in 2 cases and before PCI in 3 cases). Hypotension was treated with IV fluids, dopamine, dobutamine and noradrenaline infusion by syringe pump at various doses and combinations to maintain a MAP of >60 mmHg. In only 3 cases, intra-aortic balloon counter pulsation

(IABP) support was used, since at our center IABP in cardiogenic shock was not used as a routine for all cases with cardiogenic shock. IABP was used in only those patients whose tissue perfusion remained poor even after good procedural outcome and optimal combinations of inotropes in maximal doses. Altogether 8 patients required ventilator support. No patients developed cardiac arrest during procedure. No patient required emergency bypass surgery as a result of procedural related complications. Survival rate in the total study population ($n=22$) was 68.2%. Those who died, had presented with acute STEMI involving the LAD artery. When 5 cases of NSTEMI were excluded, mortality in the remaining population ($n=17$) was 41.2%.

Table 5: Final Clinical Outcome

Outcome	N (%)
Total death	7 (31.8)
• Procedure related complication	0
• Arrhythmia (VT/VF) related	0
• Superimposed Sepsis	5 (22.7)
• Pump Failure	2 (9.1)
Stent Thrombosis	0

Among 7 patients who died, 5 had developed severe sepsis due to pneumonia. All these 5 patients required ventilator support and had developed ventilator associated pneumonia before they died due to septic shock (Table 5). Average CCU stay in these cases was 6 days. Two patients died of progressive pump failure within 48 hours despite maximal inotropes and IABP support. PCI details of all 7 patients who died were reviewed and found to have good procedural outcome and absence of any procedure related complications. But these patients had presented late and average window period of these patients was 28 hours. All these cases were diabetic and had diffuse triple vessel disease. Four of them had a history of old MI.

Discussion

Cardiogenic shock is the most devastating complication of STEMI. Aggressive treatment to restore patency of infarct related artery, which works by salvaging ischemic myocardium, is the mainstay of treatment of these patients. Primary PCI is superior to thrombolysis for management of STEMI due to more effective restoration of coronary patency, less recurrent myocardial ischemia, improved residual left ventricular function and better clinical outcome.^{9,10}

In our study, the mean age of the patients enrolled was 61.5 ± 11.5 years. Mean age and baseline characteristics and cardiovascular risk factors of study population were similar to other studies done in past by Karcz M et al in Poland and Zeymer U et al in Germany. Anterior wall MI was the most common type, while left anterior

descending (LAD) was the most common culprit vessel. Most of the patients had triple vessel disease. Presence of diabetes, old MI and concurrent infection were other important risk factors commonly associated in this cohort.

Procedural success in our study was 91%. In hospital mortality was 31.2%. In our study, mortality was slightly less than that of many studies done in past by Badaoui G et al, Keeley EC et al and Guo L et al¹¹⁻¹³ and important reason for lower mortality was inclusion of 5 NSTEMI cases in our study. There was no mortality in the NSTEMI group ($n=5$). Mortality rate only in STEMI patients presenting in shock was 41.2%.

Based on different studies, procedural success for primary PCI in cardiogenic shock ranges from 84% to 91%. Overall mortality in different studies vary greatly and it ranges from 37% to 62%.¹¹⁻¹³ A study done by Badaoui G et al showed procedural success of 87% and in hospital mortality of 37% in patients with cardiogenic shock undergoing primary PCI.¹¹ Main reason for such variation in mortality is highly variable baseline clinical characteristics and comorbidities.

In the SHOCK trial, independent predictors of mortality were increasing age, lower systolic blood pressure, increasing time of randomization, lower post PCI TIMI flow 0/1, and multivessel PCI.¹⁴

In a prospective randomized trial in Germany, the ALKK PCI registry, in-hospital mortality was 46.1%. Predictors of in-hospital mortality were post procedural TIMI flow, advanced age (75 years or more) and time interval between symptom onset and start of PCI.⁷

In a retrospective study between 1994-2004 in France¹⁵, the in-hospital mortality was reported to be 43% among 175 patients presenting with AMI and cardiogenic shock. Independent risk factors for increased mortality were absence of TIMI 3 flow, smoking and need of mechanical ventilation. The independent predictors of impaired long term outcome were LVEF <30% and triple vessel disease. Various factors were found to be associated with mortality in these patients. Based on some studies,^{12,13} important predictors of mortality in patients with cardiogenic shock undergoing primary PCI were old age, anterior infarction, diabetes, LVEF <40% and delay in revascularization.

In-hospital mortality was 42.4% in patients who underwent PPCI for STEMI complicated by cardiogenic shock.¹³ Another study aimed at determining the outcomes of PPCI, found 44% in-hospital mortality in STEMI complicated by cardiogenic shock.¹⁶ A study from Turkey showed in-hospital mortality of 64% in cardiogenic shock patients treated with PPCI. Unsuccessful procedure and diabetes were found to be the predictors of in-hospital mortality.¹⁷

IABP was used in only 3 cases, one in left main angioplasty and other two in case of multivessel PCI, since in these

cases BP was low despite maximal inotropes and good PCI result. We did not use IABP as a routine in all cases due to results of recent studies not favoring this therapy in primary PCI cases.¹⁸ Although, the SHOCK trial showed that the placement of IABP significantly reduced in-hospital mortality ($p < 0.0001$).⁶ However, a recent meta-analysis of nine randomized trials comparing STEMI patients with cardiogenic shock who were treated either with additional IABP therapy or no IABP therapy showed that in thrombolysis studies adjunctive IABP was associated with 18% absolute reduction in 30-day mortality. On the contrary, PPCI studies showed that IABP therapy was associated with 6% absolute increase in 30-day mortality.

In our study in-hospital mortality was 31.2% ($n=22$) in patients with cardiogenic shock treated with PPCI. Result of our study showed that presence of diabetes, delay in revascularization, triple vessel disease, concurrent infection and old MI were important predictors of mortality. This finding has also been observed in various past studies.

Conclusion

In-hospital outcome of primary PCI in patients with acute myocardial infarction complicated by cardiogenic shock is encouraging and comparable to result of past studies. Our study re-emphasizes the need of aggressive treatment of these patients with primary PCI as initial reperfusion strategy to improve clinical outcomes.

Acknowledgment

I owe a special thanks to all DM cardiology residents, MD Residents, House officers, Cath lab staffs of Department of Cardiology, Manmohan Cardiothoracic vascular and transplant centre, for their support and effort for patient care.

Conflict of interest: None declared.

References

- Goldberg RJ, Gore JM, Thompson CA, Gurwitz JH. Recent magnitude of and temporal trends (1994-1997) in the incidence and hospital death rates of cardiogenic shock complicating acute myocardial infarction: the second national registry of myocardial infarction. *Am Heart J*. 2001; 141(1):65-72.
- Hochman JS, Buller CE, Sleeper LA, Boland J, Dzavik V, Sanborn TA, Godfrey E, White HD, Lim J, LeJemtel T. Cardiogenic shock complicating acute myocardial infarction--etiologies, management and outcome: a report from the SHOCK Trial Registry. Should we emergently revascularize Occluded Coronaries for cardiogenic shock? *J Am Coll Cardiol*. 2000; 36(3 Suppl A):1063-70.
- Hochman JS, Buller CE, Dzavik V. Cardiogenic shock complicating AMI etiologies, management and outcome--overall findings of the SHOCK trial registry. *Circulation* 1998; 98: 1-778.
- Webb JG, Sleeper LA, Buller CE, et al. Implications of the timing of onset of cardiogenic shock after acute myocardial infarction: a report from the SHOCK trial registry. *J Am Coll Cardiol* 2000; 36:1084-90.
- Leor J, Goldbourt U, Reicher-Reiss H, Kaplinsky E, Behar S. Cardiogenic shock complicating acute myocardial infarction in patients without heart failure on admission: incidence, risk factors, and outcome. SPRINT Study Group. *Am J Med* 1993; 94: 265-73.
- Sanborn TA, Sleeper LA, Bates ER, Jacobs AK, Boland J, French JK, et al. Impact of thrombolysis, intraaortic balloon pump counterpulsation, and their combination in cardiogenic shock complicating acute myocardial infarction: a report from the SHOCK Trial Registry. Should we emergently revascularize Occluded Coronaries for cardiogenic SHOCK? *J Am Coll Cardiol* 2000; 36: 1123-9.
- Zeymer U, Vogt A, Zahn R, Weber MA, Tebbe U, Gottwik M, et al. Predictors of in-hospital mortality in 1333 patients with acute myocardial infarction complicated by cardiogenic shock treated with primary percutaneous coronary intervention (PCI): Results of the primary PCI registry of the Arbeitsgemeinschaft Leitende Kardiologische Krankenhausärzte (ALKK). *Eur Heart J* 2004; 25: 322-8.
- Maskey A, Regmi SR, Dubey L, Bhatt Y, Malla R, Limbu YR, et al. Primary Percutaneous Coronary Intervention (PPCI) in acute myocardial infarction complicated with cardiogenic shock in a newly emerging cardiac center in Nepal. *J Res Med Sci* 2009; 14:123-7.
- Silber S, Albertsson P, Aviles FF, Camici PG, Colombo A, Hamm C, et al. Guidelines for percutaneous coronary interventions. The Task Force for Percutaneous Coronary Interventions of the European Society of Cardiology. *Eur Heart J* 2005; 26: 804-47.
- Keeley EC, Boura JA, Grines CL. Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review of 23 randomised trials. *Lancet* 2003; 361: 13-20.
- Badaoui G, Sarkis A, Azar R, Kassab R, Salamé E, Aboujaoudé S. Coronary angioplasty for primary cardiogenic shock following acute myocardial infarction. *J Med Liban* 2005; 53: 195-201.
- Zhonghua Xin Xue Guan Bing Za Zhi. Predictors of short term mortality in patients with acute ST-elevation myocardial infarction complicated by cardiogenic shock. 2010; 38: 695-701.
- Guo L, Mai X, Deng J, Liu A, Bu L, Wang H. Early percutaneous intervention improves survival in elderly patients with acute myocardial infarction complicated by cardiogenic shock. *Kardiol Pol* 2008; 66: 722-6.
- Hochman JS, Sleeper LA, White HD, Dzavik V, Wong SC, Menon V, et al. One-year survival following early revascularization for cardiogenic shock. *JAMA*. 2001; 285(2):190-2.
- Chodek A, Angioi M, Fajraoui M, Moulin F, Chouihed T, Maurer P, et al. Mortality prognostic factors of cardiogenic shock complicating an acute myocardial infarction and treated by percutaneous coronary intervention. *Ann Cardiol Angeiol (Paris)* 2005; 54(2):74-9.
- Jafary FH, Ahmed H, Kiani J. Outcomes of primary percutaneous coronary intervention at a joint commission international accredited hospital in a developing country - can good results, possibly similar to the west, be achieved? *J Invasive Cardiol* 2007; 19: 417-23.
- Ergelen M, Uyarel H, Akkaya E, Yildirim E, Ersan D, Demirci D, et al. Primary percutaneous coronary intervention in patients admitted with cardiogenic shock and ST-elevation myocardial infarction: prognosis and predictors of in-hospital mortality. *Turk Kardiyol Dem Ars* 2010; 38: 250-7.
- Sjaauw KD, Engström AE, Vis MM, van der Schaaf RJ, Baan J Jr, Koch KT, et al. A systematic review and meta-analysis of intraaortic balloon pump therapy in ST-elevation myocardial infarction: should we change the guidelines? *Eur Heart J* 2009; 30: 459-68.