International Journal of Cardiology 97 (2004) 73–76

International Journal of Cardiology

www.elsevier.com/locate/ijcard

Early and late clinical outcomes after primary stenting of the unprotected left main coronary artery stenosis in the setting of acute myocardial infarction☆

Seung-Whan Lee, Myeong-Ki Hong, Cheol Whan Lee, Young-Hak Kim, Jae-Hyeong Park, Jae-Hwan Lee, Ki-Hoon Han, Jae-Joong Kim, Seong-Wook Park, Seung-Jung Park*

Department of Internal Medicine, University of Ulsan College of Medicine, Asan Medical Center, 388-1 Poongnap-dong, Songpa-gu, Seoul 138-736, South Korea

Received 7 April 2003; received in revised form 4 July 2003; accepted 25 July 2003

Abstract

Background: Acute left main coronary artery occlusion is a dramatic condition with very high mortality. The study was aimed to evaluate the effect of primary stenting in patients with left main coronary artery (LMCA) disease in the setting of acute myocardial infarction (AMI). *Methods:* Between June 1997 and April 2002, primary stenting for left main coronary artery disease was performed in 18 patients with acute myocardial infarction. We evaluated early and late clinical outcomes, and prognostic determinants in this clinical setting. *Results:* Mean ages of patients were 59 ± 12 years. Fourteen patients had cardiogenic shock on admission. Angiographic success (TIMI flow ≥2 and diameter stenosis <30% after stenting) was achieved in 17 patients (94%). In-hospital death occurred in eight patients (44%). Two patients (11%) received emergent bypass surgery because of hemodynamic instability after primary stenting. On univariate analysis, good pre-intervention TIMI flow (grade ≥2) was identified as a good prognostic determinant of in-hospital survival. During mean follow-up of 39 ± 22 months, there was no late death and one patient received bypass surgery. Probability of freedom from death at 3-year was 56 ± 12%. *Conclusion:* Primary stenting is a valuable therapeutic strategy for left main coronary disease in the setting of acute myocardial infarction, and it might save the life especially in patients with good pre-intervention TIMI flow (grade ≥2). Long-term clinical outcome of patients surviving to hospital discharge is favorable.

Keywords: Stent; Acute myocardial infarction; Coronary artery disease

1. Introduction

Acute myocardial infarction (AMI) caused by left main coronary artery (LMCA) occlusion is complicated by high mortality that result from pump failure and malignant ventricular tachyarrhythmias [1,2]. Despite various kinds of reperfusion strategies for LMCA disease in patients with AMI such as intracoronary thrombolysis, primary balloon angioplasty, primary stenting, and emergency coronary artery bypass grafting (CABG), previous studies reported very high rate of in-hospital mortality [2–6]. Primary balloon angioplasty or stenting has emerged as a valuable reperfusion strategy for the management of acute myocardial infarction [7–9]. Recently, several studies have assessed the efficacy of primary balloon angioplasty or stenting for LMCA stenosis in patients with AMI and have provided conflicting results [2,5,10–13]. Therefore, we retrospectively evaluated early and late clinical outcomes after primary stenting for LMCA stenosis in patients with AMI.

2. Methods

2.1. Patient population

The inclusion criteria for primary angioplasty was as follows: (1) typical chest pain >30 min and presentation <12 h after symptom onset, and (2) ST-segment elevation >0.1 mV in two contiguous electrocardiographic leads. Between June 1997 and April 2002, primary angioplasty was performed in 332 patients and out of these, 18 (5.4%)

☆ This study was supported by the Cardiovascular Research Foundation, Seoul, Korea.

* Corresponding author. Tel.: +82-2-3010-4818; fax: +82-2-475-6898.
E-mail address: sjpark@amc.seoul.kr (S.-J. Park).

0167-5273/$ - see front matter © 2003 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.ijcard.2003.07.034

consecutive patients underwent primary stenting for LMCA. Three of eighteen patients in our study were enrolled in the Unprotected Left Main Trunk Intervention Multicenter Assessment (ULTIMA) registry [11,14].

2.2. Primary stenting procedure

Primary stenting was performed with a goal of residual diameter stenosis $<30\%$. Stents were deployed using standard techniques [15]. Heparin was given as an initial bolus of 10,000 U during the procedure, followed by continuous infusion for 3 days. Aspirin and ticlopidine were used in all patients. Abciximab was administered at the discretion of the operator.

2.3. Angiographic analysis

Angiograms were reviewed by two experienced angiographer unaware of the study purpose. Lesion length and reference diameter were measured using a quantitative angiographic analysis system (ANCOR V2.0, Siemens, Germany). Successful angiographic result was defined as $<30\%$ residual diameter in LMCA lesions with TIMI flow ≥ 2. Angiographic collateral vessels were graded according to Rentrop's classification [16], and antegrade flow was measured using the TIMI flow scale [17].

2.4. In-hospital events and follow-up

In-hospital complications included death, reinfarction, and emergency CABG. Follow-up information was obtained by hospital chart review and telephone interview. All patients were requested to visit the outpatient clinic at regular intervals. The occurrence of major adverse cardiac events including death from any cause, nonfatal myocardial infarction, and target lesion revascularization were recorded.

2.5. Statistical analysis

Data were expressed as mean ± S.D. for continuous variables, and as frequencies for the categorical variables. In order to evaluate the predictors of survival, comparison of clinical and angiographic parameters was performed between the survival and mortality groups. The Mann–Whitney test was used for continuous variables. The chi-square test or Fisher's exact test was used for categorical variables. A probability of $p<0.05$ was considered statistically significant. Survival curve was generated by using Kaplan–Meier methods.

Table 1
Baseline clinical characteristics of study patients

	Group ($n=18$)	Survival ($n=10$)	Mortality ($n=8$)	P value
Male/female	16/2	8/2	8/0	0.47
Age (years)	59 ± 12	59 ± 9	59 ± 17	0.97
Hypertension	4 (22%)	2 (20%)	2 (25%)	0.80
Hypercholesterolemia (>200 mg/dl)	7 (39%)	4 (40%)	3 (38%)	0.91
Smoking	10 (56%)	5 (50%)	5 (63%)	0.66
Diabetes mellitus	3 (17%)	1 (10%)	2 (25%)	0.56
Prior myocardial infarction	1 (6%)	0	1 (13%)	0.44
Mechanical ventilator care	7 (39%)	2 (20%)	5 (63%)	0.15
Cardiogenic shock	14 (78%)	6 (60%)	8 (100%)	0.43

Table 2
Angiographic and procedural data

	Group ($n=18$)	Survival ($n=10$)	Mortality ($n=8$)	P value
Angiographic success	17 (94%)	9 (90%)	8 (100%)	0.99
Lesion length (mm)	12.9 ± 6.7	12.8 ± 7.3	13.0 ± 6.2	0.95
Reference vessel size (mm)	3.9 ± 0.3	3.9 ± 0.3	3.8 ± 0.3	0.56
Pain to reperfusion (h)	3.1 ± 1.2	3.4 ± 0.8	2.7 ± 1.6	0.20
Left main site				0.51
Ostium	1 (6%)	0	1 (13%)	
Body	7 (38%)	4 (40%)	3 (38%)	
Bifurcation	10 (56%)	6 (60%)	4 (50%)	
Pre-intervention TIMI flow ≥2	8 (44%)	7 (70%)	1 (13%)	0.03
Post-intervention TIMI 3 flow	13 (94%)	9 (90%)	4 (50%)	0.19
Angiographic collaterals (≥ grade 2)	2 (11%)	1 (10%)	1 (13%)	0.99
Dominant right coronary artery	7 (38%)	3 (30%)	4 (50%)	0.39
Other major epicardial coronary artery disease	13 (72%)	8 (80%)	5 (63%)	0.60
Combined right coronary artery stenosis	7 (38%)	4 (40%)	3 (38%)	0.91
Intra-aortic balloon pump	14 (72%)	6 (60%)	8 (100%)	0.43
Abciximab treatment	12 (67%)	6 (60%)	6 (75%)	0.63

3. Results

3.1. Baseline characteristics of study patients

Baseline clinical characteristics of the study group are listed in Table 1. As shown, 14 patients (78%) had cardiogenic shock on admission. There were no statistically significant differences in the baseline clinical characteristics between the survival (10 patients) and mortality group (8

Table 3
In-hospital and long-term clinical outcomes

	($n=18$)
In-hospital outcomes	
Death	8 (44%)
Bypass surgery	
Elective	2 (11%)
Emergency	2 (11%)
Reinfarction	0
Long-term outcomes	
Mean follow-up duration (months)	39 ± 22
Target lesion revascularization	1 (6%)
Reinfarction	0
Death	0

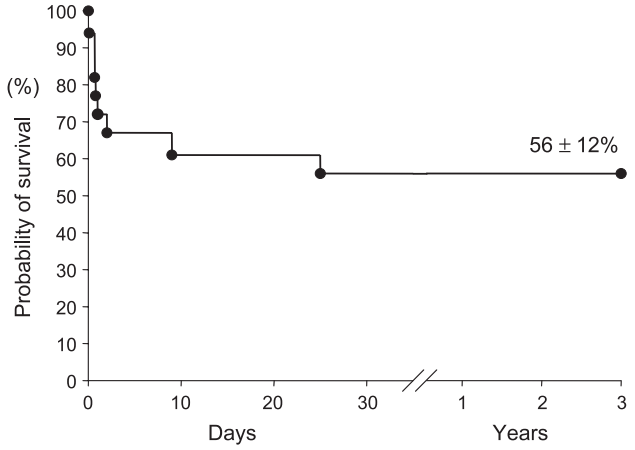

Fig. 1. Three-year survival curve.

patients). As shown in Table 2, the incidence of intercoronary collaterals ≥grade 2 (10% in survival group vs. 13% in mortality group, $p=0.99$), dominant RCA (30% vs. 50%, respectively, $p=0.39$), and cardiogenic shock (60% vs. 100%, respectively, $p=0.43$) was similar between the survival group and mortality group. However, the survival group had a higher frequency of good pre-intervention TIMI flow (grade ≥2, 70% vs. 13%, $p=0.03$) than the mortality group.

3.2. Angiographic and procedural characteristics

As shown in Table 2, angiographic success was not different between the survival and mortality group. Intra-aortic balloon pump (IABP) was placed in all of patients with cardiogenic shock. Seven patients (39%) required mechanical ventilator support. Abciximab was used in 12 patients (67%). Other major epicardial coronary artery diseases were observed in 13 patients (72%). Stenting in other major epicardial coronary artery segment was performed in six patients (33%).

3.3. In-hospital events and long-term clinical outcome

In-hospital death occurred in eight patients (44%), and in six was due to refractory cardiogenic shock, while two patients died on the 9th day and 25th day due to multiorgan failure.

Two patients underwent emergent CABG for recurrent ischemia due to multivessel disease in one case, and for primary failure due to undilatable lesion in the second one. Two patients (11%) who had severe triple vessel disease underwent elective CABG for complete revascularization. All four patients who received CABG survived to be discharged. There were no late deaths after discharge during a mean follow-up of 39 ± 22 months (Table 3). One patient underwent elective CABG at 6 months due to angiographic restenosis. The probability of freedom from death at 3 years was 56 ± 12% (Fig. 1).

4. Discussion

Acute myocardial infarction caused by LMCA occlusion is often associated with extensive myocardial infarction, cardiogenic shock and death because of the large amount of myocardium affected. It is well known that the extent of myocardial salvage during AMI depends on the quality of coronary flow restored by reperfusion therapy [18,19]. Thus, prompt complete reperfusion of the occluded coronary artery is important to improve clinical outcome. Several attempts to improve the clinical outcomes of patients undergoing revascularization of LMCA stenosis in the setting of AMI have been made [2,4,6,20]. However, definite reperfusion modality of LMCA stenosis in the setting of AMI has not been established.

Previous two studies demonstrated that in-hospital mortality rate was very high in patients undergoing primary balloon angioplasty for LMCA stenosis in the setting of AMI, ranging from 83% to 100% [5,10]. However, recently published two studies from the Unprotected Left Main Trunk Intervention Multicenter Assessment (ULTIMA) registry [11] and Neri et al. [13] reported much reduced rate of in-hospital mortality (50–55%) and good mid-term clinical outcomes. Neri et al. suggested that better clinical outcomes could be attributed to the use of stents, antiplatelet therapy, and mechanical support. The ULTIMA registry also demonstrated that primary stenting improved the 12-month clinical outcomes compared with primary balloon angioplasty [11]. In the present study, the in-hospital mortality rate was 44% and the long-term survival rate was 56 ± 12%. These findings are consistent with those of previously published studies [11,13]. This result supports that primary stenting of LMCA in the setting of AMI might be a valuable therapeutic option in this clinical setting.

Limited data were available about emergency surgical revascularization in patients with LMCA disease and AMI. Nakanishi et al. [21] reported the results of 13 patients undergoing emergency CABG. The mortality rate was 46% for the entire group and 53% for patients in cardiogenic shock. These findings are consistent with our results. However, hemodynamic deterioration and death after AMI caused by LMCA occlusion occurs rapidly. In this regard, there is not enough time to confirm LMCA occlusion and perform emergency CABG. Therefore, in the stent era, percutaneous revascularization may be preferred over emergency CABG in order to achieve prompt reperfusion.

It has been reported that an improved prognosis of LMCA disease in the setting of AMI was significantly associated with the presence of a dominant right coronary artery and intercoronary collaterals [2,12,22]. Some report showed that cardiogenic shock in patients with AMI caused by LMCA occlusion was a poor prognostic factor regardless of management [5]. In the present study, the incidence of intercoronary collaterals ≥grade 2, dominant RCA, and cardiogenic shock was similar between the survival and mortality group. Restoration of TIMI-3 flow after the

procedure was higher in survival group, not to a statistically significant level. In addition, improvement in TIMI flow after the procedure (TIMI 0-to-2 before, TIMI 3 after) was not different between the two groups (seven patients in the survival group and four in the mortality group, $p = 0.63$). However, the survival group had a higher frequency of good pre-intervention TIMI flow (grade ≥ 2) than the mortality group. These findings might be similar to those of previous studies indicating that good pre-intervention antegrade flow (grade ≥ 2) in AMI showed a better clinical outcome after primary angioplasty [23] and that the presence of TIMI 3 flow before intervention was a more powerful predictor of survival than TIMI 3 flow after intervention in AMI [24]. Our results indicate that good pre-intervention antegrade flow may serve as a good predictor of in-hospital survival in patients undergoing primary stenting for LMCA disease in the setting of AMI.

In conclusion, primary stenting is an appropriate therapeutic option for LMCA disease in patients with AMI. It might reduce mortality in patients with good pre-intervention antegrade flow (TIMI flow grade ≥ 2). The long-term clinical outcome of patients surviving to hospital discharge is favorable.

This study has several limitations. First, this was a retrospective study. Second, it is a single center's experience with a small number of patients. Third, it may have a potential selection bias because patients with AMI who died before reaching the hospital were excluded. Thus, our results may not be generalized to all patients undergoing primary stenting for LMCA disease in the setting of AMI. Therefore, further studies are required for confirmation of our results. Fourth, in this study, only two patients received emergency CABG after primary stenting and they survived to discharge. Thus, the role of emergency CABG was not sufficiently evaluated in these high-risk patients. Therefore, a larger series or controlled clinical trials may be required.

References

[1] Goldberg S, Grossman W, Markis JE, Cohen MV, Baltaxe HA, Levin DC. Total occlusion of the left main coronary artery. Am J Med 1978;64:3–8.

[2] Spiecker M, Erbel R, Rupprecht HJ, Meyer J. Emergency angioplasty of totally occluded left main coronary artery in acute myocardial infarction and unstable angina pectoris. Institutional experience and literature review. Eur Heart J 1994;15:602–7.

[3] Hope EJ, Haigney MC, Calkins H, Resar JR. Left main coronary thrombosis after radiofrequency ablation: Successful treatment with percutaneous transluminal angioplasty. Am Heart J 1995;129:1217–9.

[4] DeFeyter PJ, Serruys PW. Thrombolysis of acute total occlusion of the left main coronary artery in evolving myocardial infarction. Am J Cardiol 1984;53:1927–8.

[5] Quigley RL, Milano CA, Smith LR, White WD, Rankin JS, Glower DD. Prognosis and management of anterolateral myocardial infarction in patients with severe left main disease and cardiogenic shock. The left main shock syndrome. Circulation 1993; 88:II65–70.

[6] Christiaens L, Coisne D, Allal J, Barraine R. Emergency stenting for complete thrombosis of an unprotected left main coronary artery in evolving myocardial infarction. J Invasive Cardiol 1997;9:435–7.

[7] Stone GW, Grines CL, Browne KF, Marco J, Rothbaum D, O'Keefe J, et al. Predictors of in-hospital and 6 month outcome after acute myocardial infarction in the reperfusion era: the Primary Angioplasty in Acute Myocardial Infarction (PAMI) trial. J Am Coll Cardiol 1995; 25:370–7.

[8] Brener SJ, Barr LA, Burchenal JE, Katz S, George BS, Jones AA, et al. Randomized, placebo-controlled trial of platelet glycoprotein IIb/IIIa blockade with primary angioplasty for acute myocardial infarction: ReoPro and Primary PTCA Organization and Randomized trial (RAPPORT) Investigators. Circulation 1998;98:734–41.

[9] Weaver WD, Simws RJ, Betriu A, Grines CL, Zijlstra F, Garcia E, et al. Comparison of primary coronary angioplasty and intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review. JAMA 1997;278:2093–8.

[10] Chauhan A, Zubaid M, Ricci DR, Buller CE, Moscovich MD, Mercier B, et al. Left main intervention revisited: early and late outcome of PTCA and stenting. Catheter Cardiovasc Diagn 1997;41:21–9.

[11] Marso SP, Steg G, Plokka T, Holmes D, Park SJ, Kosuga K, et al. Catheter-based reperfusion of unprotected left main stenosis during an acute myocardial infarction (the ULTIMA experience). Am J Cardiol 1999;83:1513–7.

[12] Yip HK, Wu CJ, Chen MC, Chang H. W., Kai Hsieh KY, Hang CL, et al. Effect of primary angioplasty on total or subtotal left main occlusion: analysis of incidence, clinical features, outcomes, and prognostic determinants. Chest 2001;120:1212–7.

[13] Neri R, Migliorini A, Moschi G, Valenti R, Dovellini EV, Antoniucci D. Percutaneous reperfusion of left main coronary disease complicated by acute myocardial infarction. Catheter Cardiovasc Interv 2002;56:31–4.

[14] Tan WA, Tamai H, Park SJ, Plokker HW, Nobuyoshi M, Suzuki T, et al. ULTIMA Investigators. Long-term clinical outcomes after unprotected left main trunk percutaneous revascularization in 279 patients. Circulation 2001;104:1609–14.

[15] Park SJ, Park SW, Hong MK, Cheong SS, Lee CW, Kim JJ, et al. Stenting of unprotected left main coronary artery stenosis: immediate and late outcomes. J Am Coll Cardiol 1998;31:37–42.

[16] Rentrop KP, Cohen M, Blanke H, Phillips RA. Changes in collateral channel filling immediately after controlled coronary artery occlusion by an angioplasty balloon in human subjects. J Am Coll Cardiol 1985; 5:587–92.

[17] The TIMI study group. The Thrombolysis in Myocardial Infarction (TIMI) trial: phase I findings. New Engl J Med 1985;312:932–6.

[18] Gibson CM. Primary angioplasty compared with thrombolysis: new issues in the era of glycoprotein IIb/IIIa inhibition and intracoronary stenting. Ann Intern Med 1999;130:841–7.

[19] Lie TA, Gurley RJ, Lundstrom RJ, Parmley WW. Primary angioplasty and thrombolysis for acute myocardial infarction: an evidence summary. J Am Coll Cardiol 1996;27:737–50.

[20] Fabbiocchi F, Trabattoni D, Galli S, Bartorelli AL. Emergency stenting of totally occluded left main coronary artery in acute myocardial infarction. J Invasive Cardiol 1999;11:309–12.

[21] Nakanishi K, Oba O, Shichijo T, Nakai M, Sudo T, Kimura K. Study on risk factors and late results of coronary artery bypass grafting for acute myocardial infarction. J Jpn Assoc Thorac Surg 1997;45:950–7.

[22] Hori T, Kuroswa T, Yoshida M, Yamazoe M, Aizawa Y, Izumi T. Factors predicting mortality in patients after myocardial infarction caused by left main coronary artery occlusion. Jpn Heart J 2000; 41:571–81.

[23] Lee CW, Hong MK, Lee JH, Yang HS, Kim JJ, Park SW, et al. Determinants and prognostic significance of spontaneous coronary recanalization in acute myocardial infarction. Am J Cardiol 2001;87:951–4.

[24] Stone GW, Cox D, Garcia E, Brodie BR, Morice MC, Griffin J, et al. Normal flow (TIMI-3) before mechanical reperfusion therapy is an independent determinant of survival in acute myocardial infarction: analysis from the primary angioplasty in myocardial infarction trials. Circulation 2001;104:636–41.