Effect of Primary Angioplasty on Total or Subtotal Left Main Occlusion*

Analysis of Incidence, Clinical Features, Outcomes, and Prognostic Determinants

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**Background:** Although acute left main coronary artery (LMCA) occlusion is a rare clinical entity, it carries a very high mortality rate. The purposes of this study were to evaluate the effect of primary angioplasty for a severely obstructed or totally occluded LMCA, and to determine the incidence, clinical features, outcome, and prognostic determinants in this clinical setting.

**Materials and methods:** Between May 1993 and July 2000, a total of 740 patients with acute myocardial infarction underwent primary angioplasty in our hospital. Eighteen of 740 patients (2.4%) with a severely obstructed or totally occluded LMCA constituted the population of this study.

**Results:** Seventeen of 18 patients (94.4%) experienced pulmonary edema (including 14 patients in cardiogenic shock). Six patients (33.3%) sustained sudden death due to malignant ventricular tachyarrhythmias. Coronary angiography showed that there were variable grade flow of intercoronary collaterals in 12 patients (66.7%), a totally occluded LMCA in 8 patients (44.4%), an incompletely occluded LMCA in 10 patients (55.6%), and a dominant right coronary artery (RCA) in 16 patients (88.9%). Primary angioplasty of the LMCA was performed with a 72.2% procedural success rate. Four patients (22.2%) received coronary artery bypass surgery after angioplasty. Six patients (33.3%) died in the hospital. Ten of 18 patients (55.6%) survived in long-term follow-up (mean ± SD, 44 ± 14 months). Those patients who survived to be discharged had significantly higher combined coexisting incidence of intercoronary collaterals, dominant RCA, and incompletely occluded LMCA (100% vs 0.0%, p = 0.0006) than those patients who died in the hospital.

**Conclusions:** Acute obstructive LMCA disease generally presented as pulmonary edema, cardiogenic shock, or sudden death. Only those who had combined coexistence of intercoronary collaterals, a dominant RCA, and an incompletely occluded LMCA could survive to be discharged. Our experience suggests that primary LMCA angioplasty is a feasible and effective procedure, and it may save lives in this clinical setting.

(ORIGINAL VERSION)

Key words: acute myocardial infarction; left main disease; primary angioplasty

Abbreviations: AMI = acute myocardial infarction; CABG = coronary artery bypass surgery; LMCA = left main coronary artery; RCA = right coronary artery; TIMI = Thrombolysis in Myocardial Infarction

Acute left main coronary artery (LMCA) occlusion is a rare angiographic finding.¹² When it takes place, the prognosis is usually extremely poor unless there are substantial preexisting intercollaterals²⁻⁴ and complete reperfusion is rapidly established. Pump failure or refractory ventricular dysrhythmias³,⁵ are the leading causes of death in patients in this clinical condition. This unsavory problem has vexed cardiologists for several decades. With the new concepts of prompt and complete reperfusion salv-

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era,6–8 and increasing operator experience, evaluation of safe and efficacious management for patients with acute myocardial infarction (AMI) has been carried out in these past few years, and results have been impressive and promising.6–8 However, discordant results have been reported2,9,10 in the subgroup of patients with acute LMCA occlusion. Even nowadays, there is still no consistent method for the management of this very high-risk subgroup of patients. Therefore, cardiologists are still searching for the most promising treatment strategy for these patients. The purposes of this study were to evaluate the effect of primary angioplasty for severely obstructed or totally occluded LMCA, and to determine the incidence, clinical features, outcome, and prognostic determinants in this clinical setting.

**Materials and Methods**

*Patient Population*

Between May 1993 and July 2000, emergency cardiac catheterization was performed in 751 patients of any age who presented with AMI of < 12-h duration in our hospital (patients in cardiogenic shock within 18 h were also enrolled into the study). Eleven of 751 patients (1.5%) were excluded due to either the AMI caused by coronary artery spasm (3 patients) or the culprit lesion < 60% of stenosis with normal coronary flow (6 patients). Therefore, primary angioplasty was performed in 740 consecutive patients. Of these 740 patients, 18 patients (2.4%) with acute extensive anterior wall myocardial infarction caused by at least an 80% stenosis or total occlusion of the LMCA constituted the population of this study.

*Definitions*

AMI was defined as: (1) typical chest pain lasting for > 30 min with ST-segment elevation > 1 mm in two consecutive precordial leads, or (2) typical chest pain lasting for > 30 min with a new onset of complete left bundle-branch block. Procedural success was defined as a reduction to residual stenosis of < 50% by balloon angioplasty or successful stent deployment at the desired position with a residual stenosis < 30% followed by Thrombolysis in Myocardial Infarction (TIMI) study11 grade 3 flow in the infarct-related artery.

*Data Collection*

Detailed in-hospital and follow-up data, including age, sex, coronary risk factors, Killip score12 on hospital admission, reperfusion time, TIMI study flow grades, collateral flow grades, angiographic results, number of diseased vessels, and in-hospital adverse events, were obtained. These data were collected prospectively and entered into a computerized database.

*Statistical Analysis*

Data were expressed as mean ± SD. In order to determine whether the existence of collateral flows, a dominant right coronary artery (RCA), or an incompletely occluded LMCA could predict a better outcome, comparison of these parameters was performed between the survival (12 patients) and the mortality (6 patients) groups. Categorical variables were compared by Fisher’s Exact Test.

**Results**

*Characteristics of Patients and Initial Clinical Presentations*

The patients’ ages ranged from 43 to 87 years (mean, 67 ± 12 years). None of the patients had undergone previous coronary artery bypass surgery (CABG). Coronary risk factors included diabetes mellitus in 16.7% of patients, hypertension in 44.4%, hypercholesterolemia in 50.0%, and current smoking in 50.0%. Three patients (16.7%) had a previous myocardial infarction, and 2 patients (11.1%) had a previous stroke. Fourteen patients (77.8%) were in cardiogenic shock. 3 patients (16.7%) had a Killip score of 3, and 1 patient (5.6%) had a Killip score of 2 (Table 1). Seventeen patients (94.4%) presented with acute pulmonary edema as documented by chest radiography. Sixteen patients (88.9%) developed acute respiratory failure and required mechanical ventilatory support. Seventeen patients (94.4%) required intra-aortic balloon pump support to stabilize the patients for acute pulmonary edema or cardiogenic shock. Six patients (33.3%) sustained sudden death due to malignant ventricular tachyarrhythmias and required prompt cardioversion/defibrillation. Twelve patients (66.7%) had a history of preinfarction angina.

*Angiographic Findings and Reperfusion Status*

Table 1 showed the angiographic findings and reperfusion status of the 18 patients. Different LMCA obstructive levels were found, including an ostial lesion in one patient (5.6%), proximal LMCA obstruction in four patients (22.2%), mid-LMCA obstruction in five patients (27.8%), and distal LMCA obstruction in eight patients (44.4%). Eight patients (44.4%) had a totally occluded LMCA (Fig 1), and 10 patients (55.6%) had an incompletely occluded LMCA (80 to 95% stenosis) with variable TIMI study grade flow before angioplasty. A dominant RCA was noted in 16 patients (88.9%; Fig 1). Fifteen patients (83.3%) were found to have other coronary artery disease, and this included single-vessel disease in 4 patients (22.2%), two-vessel disease in 9 patients (50.0%), and triple-vessel disease in 2 patients (11.1%). Twelve patients (66.7%) with a history of preinfarction angina were found to have variable-grade flow of intercoronary collaterals. Balloon angioplasty of the LMCA was performed in 8 patients (44.4%) patients, and MCA stenting was performed
in 10 patients (55.6%). The procedural success rate was 72.2% (13 of 18 procedures). All of the survival patients achieved TIMI study grade flow after coronary angioplasty.

**Clinical Outcome**

The in-hospital, first 30-day, and long-term outcomes of the 18 patients are summarized in Table 1. Two patients died in the cardiac catheterization laboratory during the procedure due to profound shock and refractory ventricular fibrillation. Two patients with incomplete coronary reperfusion (the obstruction was opened with TIMI study grade 1 flow) with persistent shock (families refused emergent surgical intervention) died in the hospital 6 h after admission to the coronary care unit. One patient (patient 5) who received emergent CABG after unsuccessful primary angioplasty (the lesion with heavy calcification and postdilation with severe dissection) also died in the hospital due to pump failure. Another patient (patient 10) who achieved complete coronary reperfusion died in the hospital on the seventh day due to severe sepsis and multiorgan failure. Therefore, the in-hospital mortality rate was 33.3% (6 of 18 patients). Three patients who received elective CABG due to severe multivessel disease after complete revascularization of the LMCA were discharged uneventfully. There were two late deaths. One patient (patient 13), who refused elective CABG, died suddenly due to ventricular tachycardia/fibrillation on the 21st day after discharge. Another patient (patient 3), who had recurrent chest pain and refused cardiac catheterization study, died suddenly at home 8 months later. Therefore, the overall mortality was 44.4% (8 of 18 patients). The mortality was 23.1% (3 of 13 patients) in patients with successful primary angioplasty, and the mortality rate was 100% (5 of 5 patients) in patients with unsuccessful primary angioplasty. A 6-month angiographic follow-up was obtained in the remaining seven patients who refused CABG after successful angioplasty (Fig 1), and two patients (28.6%; patient 9 and patient 11) had restenosis of the LMCA. These two patients received LMCA stent deployment again (Fig 1). Therefore, 10 patients (55.6%) survived at a mean follow-up period of 44 ± 14 months.

**Prognostic Determinants**

We found that the incidence of intercoronary collaterals (83.3% vs 33.3%, \( p = 0.068 \)), dominant RCA (100.0% vs 60.0%, \( p = 0.074 \)) and incompletely occluded LMCA (75.0% vs 20.0%, \( p = 0.060 \)) was higher in the survival group than in the mortality group, although it did not reach statistical significance. However, the combined coexisting incidence intercoronary collaterals, dominant RCAs, and incompletely occluded LMCA were signifi-

<table>
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<th>Preinfarction Angina/Collateral Low</th>
<th>Obstructive Level/Severity of Stenosis, %</th>
<th>TIMI Flow, Initial/Final</th>
<th>Reperfusion Method</th>
<th>Procedural Success</th>
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* = D = distal; P = proximal; M = mid; O = ostial; LM = left main coronary artery; + = angina occurred within 48 h before infarction; ++ = angina occurred ≥ 5 d before infarction.
cantly higher in the survival group than in the mortality group (100% vs 0.0%, p = 0.0006).

**DISCUSSION**

*Incidence of LMCA Occlusion*

Previous studies\(^1\),\(^2\),\(^9\),\(^14\) have reported that the incidence of LMCA occlusion is 0.03 to 0.04% in patients undergoing elective coronary angiography and 0.37 to 2.96% in patients with AMI undergoing emergent cardiac catheterization. However, the true incidence of acute LMCA occlusion remains uncertain. The lower incidence of acute LMCA occlusion (0.37%) in those studies\(^1\),\(^2\) may be underestimated, because most of the patients in this clinical setting may die before coronary angiography can be performed. In contrast, the higher incidence of acute LMCA occlusion in those studies\(^9\),\(^14\) may be due to biased case selection. In our study, the incidence of acute LMCA occlusion was 2.4%. The higher incidence of acute LMCA occlusion in our study can be explained by the following reasons. First, there may have been different populations in the studies. Second, it may be due to the willingness of physicians to refer predominantly high-risk patients for primary angioplasty to our hospital because it has a primary angioplasty program since 1993 and serves as a regional referral center for community hospitals. Therefore, “pretreatment selection of sicker patients” may explain a higher incidence in our experience. Third, our intervention team stands by 24 h and can arrive in the cardiac catheterization laboratory within 10 min. Coronary angiography can be performed as soon as written informed consent is obtained. Finally, in patients with AMI complicated by cardiogenic shock, coronary angiography was performed in patients even during cardiopulmonary cerebral resuscitation in our hospital.

*Clinical Presentations of Acute LMCA Occlusion*

Clinical presentations of acute LMCA occlusion are usually catastrophic,\(^2\),\(^9\),\(^10\) and include cardiogenic shock with severe left ventricular dysfunction, malignant arrhythmia, pulmonary edema, and acute respiratory failure requiring mechanical ventilatory support. In the present study, AMI caused by severely obstructive or a totally occluded LMCA was accompanied by cardiogenic shock in 77.8%, acute...
From an anatomic point of view, the left ventricular myocardium is mainly supplied by the left coronary artery, and, theoretically, acute LMCA occlusion usually results in severe left ventricular dysfunction and clinical deterioration occurred within minutes, leaving no chance to take the patient to the cardiac catheterization laboratory. However, LMCA occlusion does not always lead to a fatal outcome, and, actually, there are always some patients managed with conventional therapy who can survive several years. Thus, it is not surprising that the clinical outcomes of the patients with acute LMCA occlusion must depend on some distinguishing features that will substantially alter an otherwise unfavorable prognosis in this clinical setting. Previous studies have suggested that the presence of collateralization is crucial for the prognosis, and only patients with a dominant RCA will survive to receive a diagnosis and invasive treatment. However, this observation may not convince everyone, because a statistical method has never been performed to support this observation.

In our study, we found that the presence of intercoronary collaterals, a dominant RCA, or an incompletely occluded LMCA was higher in the survival group than in the mortality group. Moreover, we also found that the combined coexisting incidence of intercoronary collaterals, a dominant RCA, and an incompletely occluded LMCA was significantly higher in the survival group than in the mortality group. Therefore, we suggested that these distinguishing coronary angiographic features were the significant predictors of survival in patients with acute LMCA occlusion. Our results further confirmed previous observations.

**Management of AMI Caused by Left Main Disease**

Management of acute LMCA occlusion included thrombolytic therapy, emergency CABG, and primary angioplasty. Because the low incidence of acute LMCA occlusion, a large randomized trial is unlikely to be carried out to evaluate which reperfusion method is most feasible and effective for its management.

Two retrospective studies from Quigley et al and Chauhan et al demonstrated that the in-hospital mortality rate was very high, ranging from 83.3% to 94.0%, for patients with acute LMCA occlusion regardless of the method of management. However, most the patients in the study of Quigley et al had been admitted to the hospital for > 12 h after AMI, and most of the patients in the study of Chauhan et al had an occluded RCA. Therefore, the high mortality rates in their studies could be attributed to late revascularization or absence of intercoronary collaterals.

Although the role of thrombolytic therapy in patients with AMI is well established, it can only achieve normal coronary flow in 54.0% of patients at 90 min. Furthermore, thrombolytic therapy for AMI caused by acute LMCA occlusion has been only reported sporadically, and no reliable data exist to support its role in this clinical entity. Severe left main disease is an indication for CABG. However, when acute LMCA occlusion happens, hemodynamic deterioration usually follows quickly and sudden death may occur. It is also impossible for us to identify an acute LMCA occlusion until the patients are in the catheterization laboratory undergoing coronary angiography. Therefore, there may not be enough time for emergency CABG in this setting. Primary coronary angioplasty can offer immediate restoration of coronary flow when acute left main occlusion is identified by coronary angiography.

The efficacy and feasibility of primary angioplasty in AMI complicated by cardiogenic shock had been emphasized by Moscucci and Bates. In their pooled data on 646 patients, mortality for cardiogenic shock was 45%. However, if primary angioplasty was successful, mortality was 33%; if primary angioplasty was unsuccessful, mortality was 81%. Our results were similar with the results from Moscucci and Bates and best reflected the published data on primary angioplasty in AMI complicated by cardiogenic shock. Long-term results of angioplasty or stenting in unprotected LCMA have been reported by previous studies. Although the procedure is technically feasible, the long-term mortality rate and the incidence of repeat coronary angioplasty or CABG are still high. Therefore, it is unlikely that percutaneous coronary angioplasty will replace CABG in the treatment of unprotected LMCA disease. The restenosis rate of either elective or primary LMCA stenting may remain high, and the clinical impact of restenosis after LMCA stenting may present more serious complications, such as acute pulmonary edema, malignant arrhythm-
mia, or sudden death (as in patient 3 and patient 13), in this subgroup of patients. Therefore, in our patients, CABG was suggested after survival from the acute phase. However, when considering the high operative mortality rate due to several other coexisting medical problems, including diabetes mellitus, chronic renal insufficiency, old age, or fear of potential risk of surgical intervention, all of our patients and families refused our recommendations. To these patients, we suggest that regular clinical, noninvasive, and scheduled angiographic follow-up is advisable.

Our study has three limitations. First, the number of patients in this study was small. Thus, our conclusions should be viewed as preliminary and await confirmation by larger series or controlled clinical trials. However, our result was promising. Second, the difference in restenosis rates between primary balloon angioplasty and stenting could not be obtained, as this was not a randomized study. However, a randomized trial of primary balloon angioplasty and stenting in the treatment of acute left main occlusion has never been conducted, as its incidence is low. Finally, inhibition of platelet glycoprotein IIb/IIIa receptor by antagonists has been shown to improve clinical outcomes of primary percutaneous transluminal coronary angioplasty. However, the platelet glycoprotein IIb/IIIa-receptor antagonists are still not available in our country. Moreover, whether adjunctive therapy with platelet glycoprotein IIb/IIIa-receptor antagonists could improve the in-hospital outcome of patients in this clinical setting remains to be determined.

In conclusion, patients with acute LMCA occlusion usually presented as cardiogenic shock, acute pulmonary edema, or sudden death. Those patients who survived to be discharged had significantly higher combined coexisting incidence of intercoronary collaterals, a dominant RCA, and an incompletely occluded LMCA. Our experience suggests that primary LMCA angioplasty is a feasible and effective procedure, and it may save lives in this clinical setting.

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