CASE REPORT

A Survival Case of Cardiogenic Shock due to Left Main Coronary Artery Myocardial Infarction: Successful Cooperation with On-Site Percutaneous Coronary Intervention and Helicopter Emergency Medical Service

Yuichi Kimura¹, Keisuke Ohba¹, Hitoshi Sumida¹, Kenichi Tsujita¹, Toyoki Hirose², Hideki Maruyama³, Shiro Hirai³, Koichi Kaikita¹, Seiji Hokimoto¹, Seigo Sugiyama¹ and Hisao Ogawa¹

Abstract

A 54-year-old man was referred to a local hospital, located about 90 km from our hospital, with cardiogenic shock due to left main coronary artery infarction (LMCA-MI). Percutaneous coronary intervention (PCI) was performed under intra-aortic balloon pumping (IABP) support, but resulted in insufficient reperfusion and his condition worsened. The helicopter emergency medical service (HEMS) rapidly transported the patient to our hospital. After percutaneous cardio-pulmonary support system (PCPS) insertion, PCI could establish the coronary flow. A series of intensive therapies saved the patient. The cooperation of medical and emergency service system following revascularization and intensive care saved the patient with LMCA-MI accompanied by cardiogenic shock.

Key words: cardiogenic shock, acute myocardial infarction, percutaneous cardio-pulmonary support system, trans-radial percutaneous coronary intervention, helicopter emergency medical service

Case Report

A 54-year-old man was referred to the emergency department of Minamata City Hospital and Medical Center with severe chest pain lasting one hour, which had never been felt before. He had smoked 20 cigarettes a day for twenty years and was treated for hypertension and diabetes mellitus. His usual blood pressure was >150/90 mmHg using valsartan 80 mg daily, betaxolol hydrochloride 10 mg daily, long acting nifedipine 40 mg daily and his HbA1c was >7.5% using glimepiride 4 mg daily.

In the emergency department of Minamata City Hospital and Medical Center, he felt clammy and seemed anxious. His blood pressure was 110/60 mmHg, pulse rate was 92 beats per minute (bpm), and respiration was shallow and rapid at 36 per minute. Arterial oxygen saturation was 99% during oxygen breathing at 3 L/min through a nasal cannula. Electrocardiogram (ECG) showed a sinus rhythm, right bundle branch block, left axis deviation, and ST-segment elevation in leads I, aVL, aVR, V1 through V6, and ST-segment depression in leads II, III, aVF (Fig. 1). He was diagnosed as acute myocardial infarction with cardiogenic shock and emergency cardiac catheterization was performed.

A 6 Fr sheath was inserted through the right radial artery. The coronary angiogram showed total occlusion of the left main coronary artery (LMCA) without collateral supply and severe stenosis at the distal right coronary artery (Fig. 2). Intra-aortic balloon pumping (IABP) was inserted through the right femoral artery and trans-radial percutaneous coronary intervention (PCI) was carried out. First of all, two coronary soft guidewires were successfully passed into the...
left anterior descending artery (LAD) and the left circumflex artery (LCX). Then, it was disclosed that each antegrade coronary flow was narrow. After predilatation of LMCA, a LCX coronary guidewire was pulled out before stenting. A bare metal stent (3.5×18 mm) was implanted in LMCA to the proximal LAD with crossover to LCX. Two other bare metal stents (3.0×23 mm and 2.5×14 mm) were deployed to proximal to mid LAD with overlapping. With coronary stent implantation, coronary flow in LMCA was improved, but the ostium of LCX was totally occluded. Wiring through stent struts into a jailed LCX was not achieved and successful revascularization was finally not obtained. Symptom onset-to-balloon time was about 2 hours, but LAD flow was TIMI flow grade 1 and LCX remained totally occluded at the site of ostium. Ventricular tachycardia requiring cardioversion was developed in spite of the intubated and fully sedated condition.

Based on the need for more intensive treatment including a percutaneous cardio-pulmonary support (PCPS) system, the attending physician decided to transfer the patient to Kumamoto University Hospital in Kumamoto City. Minamata City is located about 90 km south of Kumamoto City. Transport by ambulance car is thought to take about 120-

![Figure 1](image1.jpg)

**Figure 1.** Electrocardiogram (ECG) obtained in the emergency room of Minamata City Hospital and Medical Center. Sinus rhythm, right-bundle-branch block and left axis deviation, and ST-segment elevation in leads I, aVL, aVR, V1 through V6, and ST-segment depression in leads II, III, aVF.

![Figure 2](image2.jpg)

**Figure 2.** Coronary angiography and percutaneous coronary intervention (PCI) at Minamata City Hospital and Medical Center. A: Left coronary angiography revealed complete obstruction at the left main coronary artery (LMCA). B: Right coronary angiography showed distal stenosis and no collateral supply to left coronary artery. C: A bare metal stent (3.5×18 mm) was implanted in LMCA to the proximal left anterior descending artery (LAD) with crossover to the left circumflex artery (LCX). D: After PCI to LMCA-LAD and LCX, both LAD and LCX flow were incomplete.
Figure 3. Electrocadiogram (ECG) record in the catheterization laboratory at Kumamoto University Hospital. Sinus rhythm, right-bundle-branch block and left axis deviation, and ST-segment elevation in leads I, aVL, aVR, V1 through V6, and ST-segment depression in leads II, III, aVF with prolonged QRS complex.

150 minutes from Minamata City to Kumamoto City. Helicopter emergency medical service (HESM) was requested and a cardiologist from Kumamoto University Hospital was present for the emergency flight. During transportation by helicopter, IABP support was continued with the use of ECG trigger mode and IABP was fixed with a belt. He was ventilated manually under deep sedation but suddenly developed pulseless electrical activity for a short time and then recovered spontaneously. Seventy minutes of transportation time was necessary to arrival at Kumamoto University Hospital; in total four hours passed after onset.

On arrival at Kumamoto University Hospital, although he was supported by IABP and high-dose dopamine (20 μg/kg/min), his blood pressure was 70/50 mmHg, pulse rate was 110 bpm. ECG demonstrated ST-segment elevations in leads I, aVL, aVR, and V1 through V6 with a more prolonged QRS interval (Fig. 3). The creatine kinase (CK) measured 7,942 IU/L, CK-MB 400 IU/L, and analysis of arterial blood gases (ABG) under 10 L/min, manual ventilation showed progression of metabolic acidosis (Table 1). He was immediately transferred to catheterization laboratory, and

Figure 4. Coronary angiography after percutaneous coronary intervention (PCI) at Kumamoto University Hospital. A: Immediately after percutaneous cardio-pulmonary support (PCPS) insertion. B: After PCI to the left main coronary artery (LMCA) and left anterior descending artery (LAD) and left circumflex artery (LCX). Note the restoration of coronary blood flow of LCX. C: 83 days after admission.
Table 1. Laboratory Data at the Time of Arrival to Kumamoto University Hospital

(Hemogram)  
WBC 26.1 × 10^9 / μL, RBC 4.78 × 10^12 / μL, Hgb 15.5 g/dL, Hct 45.2 %, Plt 248 × 10^3 / μL.

(Biochemical examination)  
BUN 15.5 mg/dL, Crea 1.19 mg/dL, eGFR 51, TP 5.8 g/dL, Alb 3.1 g/dL, UA 6.6 mg/dL.  
Na 135 mEq/L, K 3.8 mEq/L, Cl 101 mEq/L, Ca 7.5 mg/dL, Mg 1.7 mg/dL, Mg 1.4 mg/dL.  
AST 656 IU/L, ALT 136 IU/L, LDH 1141 IU/L, Amy 60 IU/L, T-Bil 0.5 mg/dL, y-GTP 40 IU/L,  
CK 7942 IU/L, CK-MB 400 IU/L, CRP 0.06 mg/dL,  
LDL-C 127 mg/dL, HDL-C 37 mg/dL, TG 95 mg/dL, BS 231 mg/dL, HbA1C 8.0%.  
Insulin 49.7 μU/mL, TSH 0.8 μU/mL, FT3 2.25 pg/mL, FT4 1.33 ng/dL, BNP 27.9 pg/mL,  
hs-TnT 13.4900 ng/mL.

(Arterial Blood Gas Analysis: 10L/min, Manual ventilation)  
pH 7.139, PaO2 92.4 mmHg, PaCO2 46.3 mmHg, HCO3 14 mmHg, Base excess -15.7.

Figure 5. Electrocardiogram (ECG) obtained in the intensive care unit of Kumamoto University Hospital after percutaneous coronary intervention (PCI) supported with intra-aortic balloon pumping (IABP) and percutaneous cardiac-pulmonary support (PCPS). Sinus rhythm, right-bundle-branch block and left axis deviation, and ST-segment resolution was obtained and prolonged QRS complex became narrow.

PCPS was rapidly inserted through the left femoral artery and right femoral vein. Coronary angiography demonstrated no improvement of coronary flow. Intravascular ultrasound (IVUS) showed successful dilatation of the coronary stent without dissection and diffuse narrowing of LAD lumen distal to the stent. Sodium nitroprusside was injected selectively into LAD through a microcatheter, and coronary flow was improved to TIMI grade 2. ST-segment elevation in leads I, aVL remained, proximal LCX total occlusion was dilated with a 2.0 mm balloon. Following establishment of PCPS and successful dilatation of LCX (Fig. 4), ventricular arrhythmia disappeared, ST-segment resolution and shortened QRS complex were obtained (Fig. 5). The patient was moved to the intensive care unit.

In the intensive care unit, renal replacement therapy using continuous veno-venous hemodiafiltration was started on the 2nd hospital day because of acute kidney injury. CK peak was 14,022 IU/L and CK-MB peak was 764 IU/L 24 hours after onset. Based on blood pressure, pulse rate, ABG, cardiac output (CCO), venous oxygen saturation (SvO2) measurements, PCPS and IABP were successfully removed after 3rd and 7th hospital days, respectively. He was extubated on the 13th hospital day followed by noninvasive positive pressure ventilation. Unfortunately, recovery of the renal function was not obtained and he needed maintenance hemodialysis support. He was discharged on the 83rd hospital day without further event (Fig. 6).

Discussion
LMCA-MI usually involves such conditions as cardiogenic shock, fatal arrhythmia, and pulmonary edema, and carries a very high mortality. In particular, cardiogenic shock due to LMCA occlusion is one of the most severe clinical cardiology presentations. The shock state in patients appears to be the result of a vicious cycle of reduced cardiac output, low blood pressure, coronary insufficiency, and further reduction in contractility and cardiac output (1). Optimal treatment demands early reperfusion as well as hemodynamic support to prevent end-organ failure and death. Complete revascularization with PCI has been recommended (2), however it involves the extension of technical difficulties. Trifurcating coronary artery disease is a complex atherosclerotic process involving the origin of one or more of three side branches arising from a left main coronary vessel or trunk, with or without the involvement of LMCA itself (3).

In the present case, complete revascularization could not be achieved and the patient continued to worsen and cardiac function could not maintain adequate circulation to prevent end-organ failure with only IABP support, and thus PCPS implantation at a tertiary center was considered (4). The co-
operation with medical and helicopter emergency medical service system was successfully implemented to transfer the patient with IABP and functional recovery once revascularization and hemodynamic stability was obtained.

On arrival at the Kumamoto University Hospital, shock status was more deteriorated and ECG demonstrated ST-segment elevations in leads I, aVL, aVR, and V1 through V6 with more prolonged QRS interval. Prolonged QRS duration indicates global ventricular ischemia and is reported to be the most sensitive predictor of left main and/or triple vessel disease (5). After introducing PCPS, coronary angiogram revealed there was no peri-vessel disease. Myocardial perfusion was not improved adequately in spite of restoration of occluded infarct-related lesion. In the former hospital, proximal LAD obstruction due to stent-related dissection by IVUS and performed diagnostic therapy of the microvascular damage by selective intracoronary injection of nitroprusside.

Early procedure outcome after PCI is correlated with clinical factors, including age, unstable angina, congestive heart failure, cardiogenic shock, renal insufficiency, and pre-procedural instability requiring IABP, multivessel disease, and bifurcation lesion, among other factors (8, 9). In the present case, LCX flow was insufficient and LCX could not be opened via only IABP in the former hospital. We believe that PCPS support could break the vicious cycle and achieve sufficient blood pressure to maintain the coronary flow after balloon angioplasty.

Recently, radial access intervention was reported to be superior to femoral access in patients with acute coronary syndromes who were undergoing coronary intervention, because of the lower rate of local vascular complications and bleeding (10). In fact, LMCA-MI usually rapidly results in severe left ventricular dysfunction, it is certainly important for securing femoral access for the use of assisted circulation apparatus. In this setting, bilateral femoral arteries are occupied by intra-aortic balloon counterpulsation and PCPS. We believe that the radial artery is the best access site even in cases of cardiogenic shock if cannulation is available.

Some studies have shown improved outcomes with helicopter emergency medical service system (HEMS). The present patient was transported for more intensive treatments

**Figure 6.** Clinical course in the intensive care unit. The renal replacement therapy using continuous veno-venous hemodiafiltration was started on the 2nd hospital day. Percutaneous cardio-pulmonary support (PCPS) and intra-aortic balloon pumping (IABP) were removed after the 3rd and 7th hospital days, respectively. He was extubated on the 13th hospital day followed by non-intubated positive pressure ventilation (NPPV). IABP: intra-aortic balloon pumping, sBP: systolic blood pressure, CI: cardiac index, DOA: dopamine, DOB: dobutamine, HR: heart rate, NA: noradrenaline, PCPS: percutaneous cardio-pulmonary support.
with the use of a rescue helicopter. A primary benefit of HEMS has been thought to be a shorter time periods to treatment. Sullivent et al. suggested further benefits by HEMS. A higher level of care provided by air medical crews than ground ambulance in terms of both equipment and medical expertise, the place is accessed only by helicopter, coverage of longer distances in a short time period (11).

Mehran et al. reported eight independent risk factors (hypotension, IABP, congestive heart failure, chronic kidney disease, diabetes, age>75 years, anemia, and volume of contrast) of contrast-induced nephropathy and post-coronary procedural hemodialysis (12). In the present case, a total of 200 mL contrast sodium with PCI was used daily. According to the risk score, the present patient’s contrast-induced nephropathy and hemodialysis risk was over 50% and 10%, respectively. The timing of renal replacement therapy are controversial (13), we started renal-replacement therapy early to provide adequate nutrition and avoid the dangerous metabolic, fluid, and electrolyte derangements of uremia, but there were the risks of hemorrhage during vascular access, hypotension and arrhythmia during dialysis, and possible dalysis induced recurrent renal injury or delayed renal recovery (14). We could save this patient’s life, but could not save his kidney. We are not able to discuss and conclude the appropriate timing of renal replacement therapy from this case.

In conclusion, we report the survival case of cardiogenic shock due to LMCA infarction that occurred in a small city. The cooperation of medical and helicopter emergency medical service system following revascularization and intensive care saved the patient with LMCA-MI accompanied by cardiogenic shock.

The authors state that they have no Conflict of Interest (COI).

References