Extracorporeal Life Support in Resuscitation for Acute Myocardial Infarction with Cardiogenic Shock

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In this investigation we report our experience of using extracorporeal life support (ECLS) to resuscitate a 69-year-old woman with critical left main coronary artery disease complicated by acute myocardial infarction and cardiogenic shock. Intra-aortic balloon pump and ECLS were deployed within 45 minutes after the insult to restore the circulatory support while emergent revascularization surgery was performed within 3 hours of the insult. The patient was weaned from ECLS successfully after 52 hours of support and discharged with fully recovered left ventricular function. ECLS is effective in resuscitation of patients with cardiogenic shock. ECLS restored the systemic perfusion rapidly and avoided further injury to the organs, thus, improving the results of the subsequent coronary bypass surgery. *(Chang Gung Med J 2006;29:207-11)*

Key words: extracorporeal life support, acute myocardial infarction, resuscitation.

Extracorporeal life support (ECLS) of cardiogenic shock has been conducted since the early 1970s and has been proven to improve the survival rate of such patients.[1-5] ECLS rapidly restores systemic perfusion and prevents further injury to organs, serving as a short-term cardiopulmonary support.[2,4,5] We report our first successful experience of the use of ECLS in supporting a 69-year-old woman with cardiogenic shock due to acute myocardial infarction (AMI).

CASE REPORT

A 69-year-old woman with history of hypertension and hyperlipidemia was admitted to our cardiovascular ward because of unstable angina for 1 month. Coronary angiography revealed critical stenosis of the left main coronary artery and significant involvement of the left anterior descending artery. The wall motion and the contractility of the left ventricle remained adequate. Coronary artery bypass grafting surgery was suggested and urgent revascularization was scheduled for the left main lesion.

Unfortunately, the patient suffered from an attack of severe chest pains associated with loss of vital signs in the afternoon on the day before the scheduled operation. Cardiopulmonary resuscitation was performed immediately and initial electrocardiography showed idiopathic ventricular rhythm (40 beats/min). The patient's blood pressure was transiently restored to 90/50 mmHg after intra-aortic balloon pump (IABP) support and a high dosage of dopamine (>10 mcg/kg/min) was administered. Emergent surgical revascularization was arranged immediately. However, her blood pressure dropped to 60/40 mmHg with sinus bradycardia before she was transported to the operation room. In such critical condition, the ECLS system (catalog no. CB2505, Medtronic Inc, Anaheim, CA) incorporated

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a centrifugal pump for circulatory support and a hollow fiber microporous membrane oxygenator for oxygenation was deployed immediately for extra support. Via percutaneous cannulation of the femoral artery and vein, the ECLS worked smoothly and restored the hemodynamics within 45 minutes after she went into shock.

The emergent coronary bypass grafting was performed 3 hours after she went into shock. Under ECLS support, a beating heart coronary bypass surgery without aortic crossclamp was performed through a median sternotomy and a myocardial coronary stabilizer system (Octopus, Medtronic, Minneapolis, Minn, USA) was also applied. The left anterior descending artery and the second obtuse marginal branch of left circumflex artery were bypassed with saphenous vein graft sequentially. The anastomoses time was 45 minutes and the blood pressure and the cardiac output remained stable throughout the operation. After the bypass surgery, myocardial stunning was identified using intraoperative transesophageal echocardiography and the patient was kept with ECLS support for postoperative cardiac assistance. The patient regained consciousness 4 hours after surgery and was weaned from ECLS successfully after 52 hours of support. The IABP support was also weaned successfully after 112 hours. Serial cardiac echocardiography revealed a steady improvement in the left ventricular contractility. The ventilator was not weaned until the 16th postoperative day due to her weakness and oxacillin-resistant Staphylococcus aureus (ORSA) pneumonia.

The postoperative course was complicated initially by pancreatitis and subsequently by poststernotomy mediastinitis. Amylase, but not lipase, was significantly elevated since the second postoperative day and followed by leukocytosis. Abdominal computed tomography was conducted to rule out bowel ischemia, acute pancreatitis, and cholecystitis. It revealed distended bowel loops only. Acute pancreatitis was favored later because of the persistent elevation of serum lipase and the regression of amylase. Nil per os (NPO), gastric decompression, and parenteral nutrition support improved her condition and enteral feeding was begun on the 12th postoperative day. A sternal wound abscess was observed on the 25th postoperative day. Incision and drainage of the abscess was tried initially but non-healing of the sternum was noted. After extensive debridement, an island pedicled rectus abdominalis myocutaneous flap was used to cover the defect by a plastic surgeon. The patient recovered well and was discharged 72 days after the operation. During the 6 months of follow up, the patient remained in the functional class I status as classified by the New York Heart Association. Summary of the findings of serial echocardiography and the changes of the pancreatic enzymes are showed in Table 1 and Figure 1.

Table 1. Summary of the Findings of Serial 2-Dimentional Echocardiography

Time	Abnormal wall motion	LVEF
Before shock	No	71.3%
Shock	Hypokinesia of anteroseptal, septal, inferior segment	30%
Postoperative day 1	Hypokinesia of anteroseptal, and septal segment	32%
Postoperative day 2	Hypokinesia of anteroseptal, and septal segment	32%
Postoperative day 3 (Remove ECMO)	Hypokinesia of anteroseptal, and septal segment	32%
Postoperative day 11	No	69%

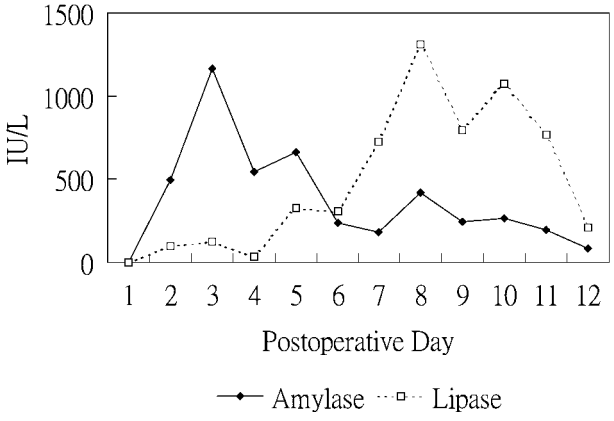

Fig. 1 Postoperative changes of pancreatic enzymes.

DISCUSSION

Cardiogenic shock is the leading cause of death in patients with AMI.[6,7-10] In patients with cardiogenic shock, the heart fails to pump effectively to maintain a sufficient perfusion pressure. Despite continuous cardiopulmonary resuscitation (CPR), the

ischemic injury of all organs, including the heart, will progress and become irreversible if effective circulation is not established within 30 to 45 minutes.[3,7]

Early revascularization with percutaneous transluminal angioplasty (PTCA) or coronary bypass grafting (CABG) has been shown to increase the survival of these patients.[6,8-10] Hochman et al. reported that the 1-year survival rates between an early revascularization group and an isolated medical stabilization group of patients with AMI with cardiogenic shock were 51.6% and 33.3%, respectively.[10] Emergent CABG carries a high in-hospital mortality rate of approximately 12% to 56%.[8,9]

Some patients died of multi-organ failure or neurological injuries secondary to prolonged cardiac resuscitation despite satisfactory revascularization. Unstable hemodynamics before operation is one of the most important predictors of postoperative death.[6-9]

The history of cardiopulmonary bypass in emergent resuscitation can be traced to 1937 when John Gibbon applied the technique to treat a patient with severe pulmonary embolism.[2] Initially, the extracorporeal membrane oxygenator (ECMO) was thought to be ineffective in the management of severe myocardial failure in adults because of the necessity of anticoagulation and the incompleteness of left ventricular decompression.[1,5] However, the technique has been revolutionized, especially in the design of the oxygenator and the blood-contact surface. ECMO is now the first choice for temporary or short-term cardiopulmonary support in various situations because of its simplicity and mobility.[1-3] Due to the special design of the oxygenator and the heparin-coated surfaces, ECMO needs less anticoagulant medication and works longer than conventional cardiopulmonary bypass machines.[2,4] It can provide circulatory support from the critical preoperative stage throughout the operative period of the beating heart CABG to the postoperative stage in the intensive care unit. Data published by the Extracorporeal Life Support Organization (ELSO) in 1997 revealed that the survival rate of patients that received ECMO in cardiac support was 41% and the postcardiectomy support group accounts for the majority of the cases.[2]

In patients with AMI with cardiogenic shock who are unresponsive to high dose inotropic agents and IABP, ECLS in time quickly restores systemic circulation, assures diastolic perfusion of the myocardium, reduces cardiac workload, and prevents further injury of organs. Successful initiation of ECLS in these patients eliminates the need to administer a large dose of inotropic agents that might increase myocardial oxygen consumption and worsen myocardial ischemia.[2,4,5,7] Revascularization with PTCA or CABG should be performed as soon as possible following ECLS for myocardial salvage.[3,4,6,7] Jaski et al. reported that the long-term survival rate in patients with AMI and cardiogenic shock rescued using ECLS and following revascularization was 40%.[6] Patients treated using ECLS only without subsequent revascularization procedures died.[3,4,6,7]

The incidence of major gastrointestinal complications following cardiac operations is between 0.5 and 3%.[11-13] Decreased visceral blood flow during episodes of hypotension contributes to such complications. Risk factors associated with these complications include advanced age, perioperative hypoperfusion, emergency operation, long bypass times, the need of high-dose vasopressors and intraaortic balloons, and valve operations.[11,12] More than 800 mg of calcium chloride per square meter of body surface area is an independent risk factor for pancreatitis.[12] There were 25-52% of postoperative cardiac patients that developed asymptomatic hyperamylasemia, often from saliva. Only 1~2% developed symptomatic pancreatitis and 0.13-0.6% had necrotizing pancreatitis.[11,12] Pancreatitis usually occurs within a few days after the operation with symptoms of fever, nausea, epigastric pain, leukocytosis, and elevated serum amylase of pancreatic origin and lipase. Patients with hyperamylasemia are monitored to ensure that their enzyme levels trend lower and there are no symptoms indicating necrotizing pancreatitis. Intravenous fluids, nasogastric drainage, and bowel rest until serum amylase levels return to baseline are enough for patients with mild pancreatitis.[11] Preoperative shock, rather than long-term ECLS, was probably the major cause of pancreatic cellular injury in the patient reported herein. A higher incidence of splanchnic hypoperfusion is associated with cardiopulmonary bypass with nonpulsatile flow; this condition is worsened by hypothermia.[13] Pulsatile flow without hypothermia provides better splanchnic perfusion and blood flow redistribution than nonpulsatile flow because it reduces the systemic vascular

resistance.[13] Although ECMO provides nonpulsatile flow, the pulsatile flow generated by IABP and the native heart and normothermic coronary bypass surgery under sufficient perfusion pressure reduce the risk of the correlated gastrointestinal ischemia.

This favorable experience demonstrated that ECLS may improve the survival of emergent CABG in patients with AMI and cardiogenic shock. ECLS in time can preserve the left ventricular function in selected patients with early revascularization. Postoperative complications may be avoided with more experience and initiation of ECLS earlier to shorten the duration of shock as well as more delicate tissue management and hemostasis.

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體外維生系統用於急性心肌梗塞所引發的心因性休克之急救

武孟餘 蔡峰鈞

本篇主要是報告本院以體外維生系統來搶救一位已知有嚴重的左主幹冠狀動脈狹窄，突發急性心肌梗塞合併心因性休克的 69 歲女性。在施以傳統的體外心肺復甦術搶救無效後，緊急放置體外維生系統 (葉克膜) 及主動脈氣球幫浦。使病人於休克後 45 分鐘內恢復穩定的血壓，並且於休克後 3 小時內施行緊急冠狀動脈繞道手術。病人於 52 小時後順利脫離體外維生系統，出院後追蹤發現左心室機能已恢復正常。以體外維生系統來搶救急性心肌梗塞所引發的心因性休克是有效的，因其可迅速恢復系統灌流以減低各器官因缺血而來的傷害。如此便可增加其後之緊急冠狀動脈繞道手術的成功率。(長庚醫誌 2006;29:207-11)

關鍵字：體外維生系統，急性心肌梗塞，急救。

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