

## Percutaneous Cardiopulmonary Support after Acute Myocardial Infarction at the Left Main Trunk

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**Background:** Percutaneous cardiopulmonary support (PCPS) has recently become an accepted modality for the treatment of cardiogenic shock after acute myocardial infarction (AMI). However, the clinical outcomes of patients with AMI at the left main trunk (LMT) undergoing PCPS remain unclear.

**Patients and Methods:** From January 2000 to September 2007, we experienced 16 cases of AMI at the LMT requiring emergent PCPS. The average age ranged from 56 to 74 (mean 68.8), and 13 were male. All cases underwent percutaneous coronary intervention (PCI). The maximum creatine kinase leakage ranged from 6,069 to 22,580 IU/l (mean; 12,880 IU/l). The time to revascularization ranged from 30 min to 1,138 min (mean 229 min). An intra-aortic balloon pumping (IABP) was inserted in all patients.

**Results:** Among our 16 patients, 10 (62.5%) could be successfully weaned off PCPS, and 6 (37.5%) could be weaned off both PCPS and IABP and discharged. Three patients underwent left ventricular assist system (LVAS) implantation. Two of them, without preoperative severe systemic complications, survived more than 100 days after implantation, whereas the third died perioperatively because of a systemic complication from the preoperative period. Eight patients died of low output syndrome or brain death. Cardiac function did not recover in patients in whom the time to revascularization was more than 4 hours and PCPS support duration more than 3 days.

**Conclusions:** The clinical outcomes of patients with LMT disease requiring PCPS is not satisfactory. In order to improve clinical outcomes of these patients, a strategy involving a timely insertion of LVAS before the onset of complications might be necessary. (*Ann Thorac Cardiovasc Surg* 2009; 15: 93–97)

**Key words:** acute myocardial infarction, percutaneous cardiopulmonary support, left main trunk

### Introduction

The efficacy of percutaneous cardiopulmonary support

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(PCPS) as a bridge to revascularization in acute myocardial infarction (AMI) patients with the complication of cardiogenic shock has been supported by several investigations.<sup>1–3)</sup> However, the treatment of AMI at the left main trunk, which is particularly complicated by cardiogenic shock, is still challenging, because the clinical outcomes of patients with broad myocardial infarction at the left main trunk (LMT) transiently supported by PCPS does not seem to reach satisfactory long-term survival because of heavily damaged cardiac function.<sup>4)</sup> In the past decade, the treatment strategy for end-stage heart failure has changed. Recently, the U.S. Food and

**Table 1. Profiles of the 3 AMI patients at the LMT who received LVAS implantation**

No.	Age (gender)	Max CK leakage (IU/l)	Time to Revascularization	PCPS support duration	IABP support duration	Time from MI to LVAD	Preoperative complication	Operation	Postoperative complication	Prognosis (POD)
1	74 (male)	16,506	137 min	3 days ↓ Weaned	18 days	18 days	ARDS RF	LVAS RVAS	ARDS	Death 26 days
2	65 (male)	16,488	327 min	3 days ↓ Not weaned	3 days	3 days	None	LVAS	CI	On going 205 days
3	66 (male)	9,384	1,200 min	2 days ↓ Weaned	20 days	20 days	None	LVAS	Pneumonia CABG	On going 119 days

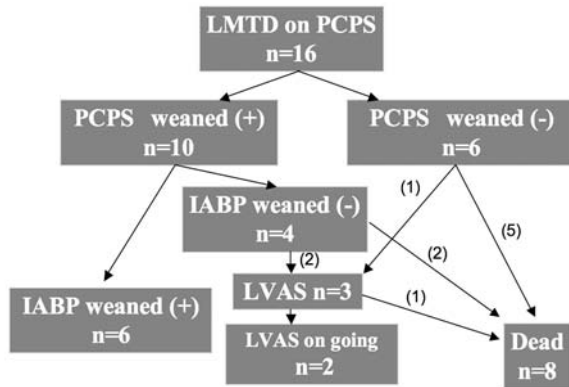
CK, creatine kinase; PCPS, percutaneous cardiopulmonary support; IABP, intra-aortic balloon pumping; MI, myocardial infarction; LVAD, left ventricular assist device; POD, postoperative day; ARDS, acute respiratory distress syndrome; RF, renal failure; LVAS, left ventricular assist system; RVAS, right ventricular assist system; CABG, coronary artery bypass graft; CI, cerebral

Drug Administration approved implantable left ventricular assist devices (LVADs) as a destination therapy for end-stage heart failure patients who are ineligible for cardiac transplantation. Furthermore, regeneration therapy might contribute to an increasing rate of “bridge to recovery” in AMI patients<sup>5,6)</sup> and thereby increase the significance of a left ventricular assist system (LVAS) implantation in elderly AMI patients. In such cases, it is important to make a timely decision regarding LVAS implantation because prolonged PCPS can lead to severe complications, and the clinical outcomes of patients undergoing LVAS implantation is discouraging. However, few reports have focused on the clinical outcomes of patients with AMI at the LMT undergoing PCPS, or on the timing of the switch from PCPS to LVAS after AMI at the LMT. Therefore the present study investigated (1) the clinical outcomes of 16 patients with AMI at the LMT complicated by cardiogenic shock supported by PCPS, and (2) the factors contributing to myocardial recovery to improve the clinical outcomes of patients with AMI at the LMT complicated by cardiogenic shock.

## Patients and Methods

From January 2000 to September 2007, we experienced 16 patients with AMI at the LMT who required PCPS in our institute. In patients with LMT disease whose hemodynamic state is stable with or without an intra-aortic balloon pumping (IABP), we usually perform surgical revascularization. However, for patients in cardiogenic shock and requiring PCPS, in which early revasculariza-

tion is necessary, percutaneous coronary intervention is performed. They all underwent percutaneous coronary intervention (PCI). The timing of the insertion of PCPS was before PCI in 12 cases because of rapidly deteriorating hemodynamics. In the other 4 cases, PCPS was employed during or after PCI because of complications from cardiogenic shock (systolic blood pressure lower than 80 mmHg) or refractory ventricular tachycardia. IABP was employed in all patients. The age of these patients ranged from 56 to 74 (mean 68.3), and 13, were male. The time to revascularization ranged from 30 to 900 (mean 229 min; n = 14; the exact times in 2 cases are unknown). The maximum CK leakage ranged from 6,069 to 22,580 IU/l (mean 12,880 IU/l). In the present series, 3 patients underwent LVAS implantation (Table 1). Two of them could be weaned from PCPS, but none could be weaned from IABP. The criteria for insertion of the LVAS were as follows: (1) systolic pressure less than 80 mmHg or a need for intravenous vasopressors to maintain a blood pressure of 80 mmHg or greater; (2) evidence of end-organ hypoperfusion, such as diminished urine output or elevation of liver-function related enzymes; (3) a cardiac index of less than 2.2 L/min/m<sup>2</sup> and pulmonary capillary wedge pressure of 15 mmHg or greater. After LVAS implantation, the infection control is one of the most important problems for patients surviving the acute postoperative period. When a high fever was observed, arterial blood culture, chest Xp, echocardiography, and general blood examination were performed to find the infected focus, and strong antibiotics having a broad spectrum are started. In some cases of



**Fig. 1.** Cohort summary of patients with LMTD on PCPS. LMTD, left main trunk disease; PCPS, percutaneous cardiopulmonary support; IABP, intra-aortic balloon pumping; LVAS, left ventricular assist system.

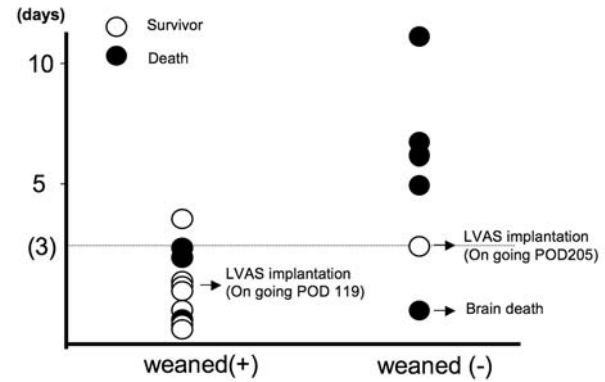
suspected LVAS infection, a pump exchange is performed. The clinical course, the duration of PCPS support, and the time to revascularization in these 16 patients were analyzed.

**Results**

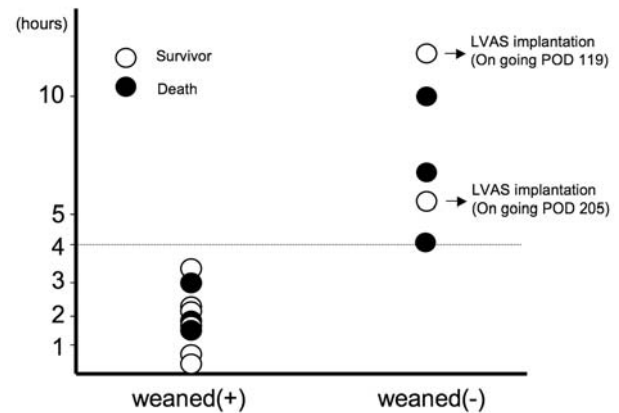
Among the 16 patients, 10 (62.5%) could be successfully weaned off of PCPS and 6 (37.5%) from both PCPS and IABP, all of whom could be discharged and who later achieved long-term survival. Three patients underwent LVAS implantation. Two of them, who had been implanted with no systemic complications, survived more than 100 days after implantation, whereas the other died perioperatively because of acute respiratory dysfunction syndrome from the preoperative period (Table 1). The patients not weaned from PCPS all died because of a lack of cardiac functional recovery (n = 5) or brain death (n = 1) (Fig. 1).

The 10 patients weaned from PCPS had been on support from 1 to 4 days. Within 3 days, 9 of the 10 (90%) had recovered their cardiac function and could be weaned. No patients on PCPS support for more than 5 days recovered their cardiac function (Fig. 2).

The time to revascularization was compared between patients weaned from PCPS and those that were not. The actual time was not clear in one patient in each group. In the weaned group, the average time to revascularization was 135 min (range 30–219 min), but in the unweaned group it was 700 min (327–1,138 min) (Fig. 3). No patients



**Fig. 2.** PCPS duration in patients with LMTD. LVAS, left ventricular assist system; POD, postoperative day.



**Fig. 3.** Time to revascularization and PCPS weaning. LVAS, left ventricular assist system; POD, postoperative day.

who took more than 4 hours to achieve revascularization by PCI could be weaned from PCPS.

**Discussion**

PCPS successfully stabilized patients hemodynamically, allowing for revascularization in patients with AMI complicated by cardiogenic shock. Reported survival rates for patients treated with emergency PCPS were varied, ranging from 33 to 87%.<sup>1,2)</sup> However, these reports consisted of cases with various infarction areas. Obo et al. reported the clinical outcomes of patients with AMI requiring emergent PCPS, classified by the number of responsible vessels.<sup>4)</sup> In their series, consisting of 7 noniatrogenic AMI patients with two-vessel territory disease (6 had

AMI in the left main or left main equivalent coronary artery, and one had AMI in the left anterior descending and right coronary arteries), 3 (42.9%) patients survived, which is similar to the survival rate in the present series (37.5%). Although there are few reports of AMI patients requiring PCPS that have focused on the left main trunk, PCPS frequently does not achieve a satisfactory result by itself because of large myocardial infarction size and poor recovery. Further treatment, such as heart transplantation or implantation of an LVAD, should be considered to improve the clinical outcomes of patients with AMI requiring PCPS. However, because of the chronic shortage of donor hearts, the implantation of LVADs seems more practical. Therefore an early decision to implant an LVAS becomes more important.

The timing of LVAS implantation is still controversial, and few studies have focused on when to implant it in AMI patients with cardiogenic shock. This clinical experience suggests that patients may have comparable outcomes whether implanted early (within 2 weeks of acute MI) or late (more than 2 weeks after acute myocardial infarction [MI]).<sup>7</sup> Dang et al. reported that survival is adversely affected by performing coronary artery bypass grafting before the insertion of an LVAS for the treatment of MI with cardiogenic shock.<sup>8</sup> From the outcomes of early operations in this setting, experienced centers have sometimes implanted an LVAS after hemodynamic and end-organ stabilization. For these potential assist device recipients, however, the associated risks of infarction extension and malignant arrhythmia must be more critical than those of the operation itself. Although in the early years of device support these risks were comparable, the recent improvements in survival rates after LVAS implantation have made the risks of the operation much smaller. To achieve the optimal timing of implantation, it will be important to judge whether cardiac function can recover with only conservative medical support, including IABP and PCPS, as soon as possible. Most AMI patients who need LVAS implantation have LMT disease or an LMT-equivalent disease and have received PCPS because of cardiogenic shock. Longer PCPS results in various complications, such as infection, bleeding, respiratory dysfunction, and other organ failure, leading to a worsening of the clinical course after LVAS implantation. If the clinical outcomes of LVAS implantation are to be improved, it is very important for PCPS to be converted to LVAD as early as possible in cases with little possibility of improvement in cardiac function, before the onset of complications associated with a longer

duration of PCPS support. The present study revealed that the cases in which time to revascularization was longer than 4 hrs, or those in which the PCPS support time was longer than 3 days, patients have less likelihood of improvement in their cardiac function. Because of recent studies reporting both the beneficial influence of ventricular assistance on end-organ functions and the possibility of ventricular decompression allowing for full or partial myocardial recovery, the notion of early LVAS insertion for acute MI has received wide attention.<sup>9</sup> Ventricular decompression and the restoration of blood flow to the myocardium have been proven to limit infarct size and expansion, a finding that supports early LVAS insertion, not only as a bridge to transplantation, but also as a bridge to recovery.<sup>10,11</sup>

The limitations of the present study are that it is a retrospective study and the number of cases in both studies is relatively few. Moreover, the clinical outcomes of patients with ischemic cardiomyopathy undergoing LVAS implantation are not encouraging as treatment of aiming “bridge to recover”.

## Conclusion

To improve the clinical outcomes of AMI patients at LMT undergoing PCPS, strategies such as a timely LVAS implantation before the onset of complications might be necessary. The time to revascularization (longer than 4 hrs) and PCPS support time (longer than 3 days) might be key points in deciding the optimal implantation time.

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