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Preoperative Extracorporeal Membrane Oxygenation for Severe Ischemic Mitral Regurgitation

— 2 case reports —

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Indication for extracorporeal membrane oxygenation (ECMO) has been extended as the experience of ECMO in various clinical settings accumulates and the outcome after ECMO installation improves. We report two cases of successful mitral valve surgery for severe ischemic mitral regurgitation in patients on ECMO support for cardiogenic shock which developed upon coronary angiography.

Key words: 1. Mitral valve
2. Coronary artery disease
3. Extracorporeal membrane oxygenation

CASE REPORT

1) Case 1

A 65-year-old woman visited our emergency room with severe dyspnea. Four months before, the patient had developed cardiogenic shock while attempting stent insertion (Endeavor 3.0～18®) into the obstructed left main coronary artery (80%), which necessitated urgent institution of extracorporeal membrane oxygenation (ECMO) and intra-aortic balloon pump. After coming off extracorporeal life support systems, she underwent stenting (Taxus 2.75～38®) of the obstructive left anterior descending coronary artery (LAD), which resulted in second attack of cardiogenic shock and ECMO support, which was successfully weaned off. She had been discharged home after these events, and had been followed up in the outpatient department. On arrival at ER, her consciousness was clear, and chest x-ray showed pulmonary congestion. Electrocardiogram showed acute exacerbation of chronic myocardial infarction. On echocardiography, severe mitral regurgitation due to restricted valve motion was noted, and left ventricular ejection fraction was 28%. She developed the third attack of cardiogenic shock during emergency coronary angiogram, and was put on ECMO again (Fig. 1). Coronary angiogram on ECMO support showed restenosis of the previous LAD stent (80%) and complete obstruction of the left circumflex and right coronary arteries. We elected to perform emergency coronary artery bypass grafting and mitral valve replacement. After ECMO circuit was converted to conventional cardiopulmonary bypass using the same femoral artery-vein cannulae, a great saphenous vein graft was anastomosed to the LAD and an additional saphenous vein graft was placed from the LAD graft to the posterior descending

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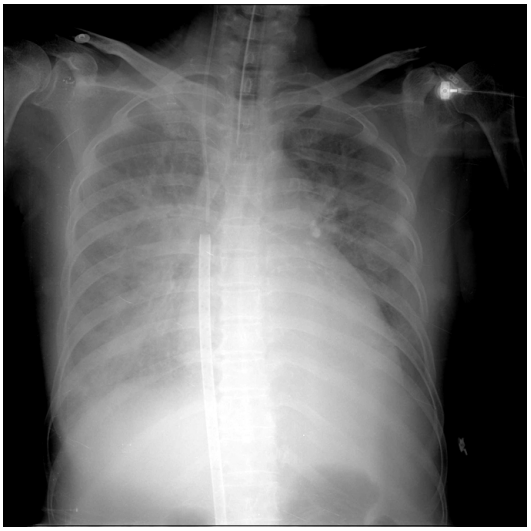

Fig. 1. Preoperative chest X-ray (case 1) showing ECMO catheter and pulmonary venous congestion. ECMO=Extracorporeal membrane oxygenation.

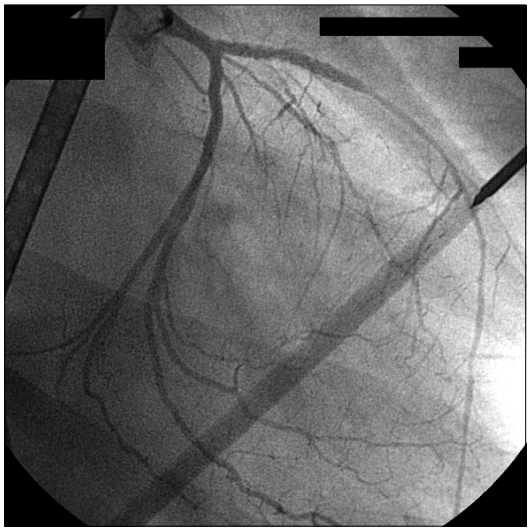

Fig. 2. Preoperative coronary angiogram under ECMO support in case 2 showing patent LAD stent which had been placed 4 months before. ECMO=Extracorporeal membrane oxygenation; LAD=Left andterior descending coronary artery.

coronary artery in an inverted-Y fashion. Operative findings of the mitral valve consisted of severe fibrotic change of the anterior leaflet, dilatation of the mitral valve annulus, and central non-coaptation. A bioprosthetic valve was placed while the native mitral valve leaflets were preserved. The patient was able to come off bypass without any event. Cardiopulmonary bypass time and aortic cross-clamping time were 168 minutes and 85 minutes, respectively. In provision for the later postoperative use, we decided to leave the femoral arterial and venous cannulae in situ, which were removed on postoperative day 1. She was extubated on postoperative day 4, but developed superficial wound infection with dehiscence which was repair on postoperative day 36. She was finally discharged home on postoperative day 91. She was readmitted in 2 months after discharge due to general weakness, fever, and septicemia. Echocardiography showed 7×3 mm sized vegetation at the prosthetic mitral valve, and bacteriologic examination identified methicillin-resistant Staphylococcus aureus as a causative microorganism. Surgical intervention was recommended, but the patient refused to receive further treatment and died of sepsis.

2) Case 2

A 48-year-old man visited our emergency room with severe dyspnea. He had a smoking history of 10 pack-years, and had been followed up in the out-patient clinic for systemic hypertension, myocardial infarction and moderate mitral regurgitation. Four months before, he had undergone coronary artery stenting (Cypher 3.0～33®) to relieve complete obstruction of LAD, which resulted in the deterioration of mitral regurgitation. Surgical treatment for the mitral valve was suggested, but he declined. Echocardiography at this admission revealed severe mitral regurgitation due to restricted valve motion, and left ventricular ejection fraction was 30%. Upon coronary angiography, he developed cardiogenic shock, and ECMO was installed. Previous LAD stent turned out to be patent on the coronary angiography (Fig. 2). Given severe pulmonary edema on chest X ray and moderate left ventricular dysfunction, we elected to put the patient on ECMO temporarily to ameliorte cardiopulmonary function. After 2 days of ECMO support, the patient was brought to the operating room and cardiopulmonary bypass was instituted using the same femoral arterial and venous cannulae. An additional venous cannula was inserted into the superior caval vein after sternotomy due to insufficient venous drainage from the single femoral venous cannula. Operative findings of the mitral valve were annular dilatation and restrictive motion of the

posterior leaflet. Ring annuloplasty using commercialized mitral ring (Carpentier-Edwards Physio ring 28 mm, Edwards) was performed. The patient came off cardiopulmonary bypass without any event, and, differing from the 1st case, the femoral arterial and venous cannulae were removed after the completion of the procedures. Intra-operative trans-esophageal echocardiography showed mild residual mitral regurgitation. Cardiopulmonary bypass time and aortic cross-clamping time were 103 minutes and 53 minutes, respectively. The patient was extubated on postoperative day 1, and echocardiography on postoperative day 19 showed mild to moderate residual mitral regurgitation. He was discharged home on postoperative day 29, and has been followed up for 14 months in a good clinical condition.

DISCUSSION

Coronary artery disease is frequently associated with mitral regurgitation. As benefits are substantiated by the meta-analysis of the reports pertaining to the outcome of surgical intervention on ischemic mitral regurgitation, concomitant mitral valve surgery upon coronary artery bypass grafting is recommended by the major academic bodies in north America (i.e. American College of Cardiology, American Heart Association) and in Europe (i.e. European Society of Cardiology). Elimination of the left ventricular volume overloading by mitral valve surgery is believed to be beneficial for the recovery of left ventricular function after coronary artery revascularization [1].

With respect to the types of mitral valve surgery, either mitral valve replacement or mitral annuloplasty could be performed according to the disposition of valve pathology and patient characteristics. For instance, valve replacement is recommended in case of papillary muscle rupture or leaflet motion restriction caused by papillary muscle displacement [2]. There are a number of reports asserting the superiority of the mitral valve repair over replacement [3], but selection from the two surgical options should be undertaken based on the exact valve regurgitation mechanism of individual patients. In this report, the first patient underwent valve replacement due to the severe fibrotic change of the anterior leaflet, while ring annuloplasty alone was deemed appropriate to alleviate severe mitral regurgitation in the second case.

As for the selection of the life support system, intra-aortic balloon pump (IABP) has been widely used as a rescue measure for circulatory collapse. IABP is believed to improve left ventricular function by reducing left ventricular afterload and augmenting coronary perfusion while maintaining pulsatility of the systemic circulation. However, Barlett et al. [4] claimed that ECMO is more beneficial for cardiogenic shock, given that patients in this setting may need both circulatory and pulmonary support. In between these two assertions, Wang et al. [5] proposed that IABP is indicated for patients with coronary artery disease while ECMO is preferred in patients with valvular heart diseases. In our first case, ECMO was used because coronary arteries were severely obstructed and IABP alone might have not been effective. In the second case, ECMO was indicated to alleviate pulmonary edema caused by severe mitral regurgitation. Indications for ECMO or other percutaneous circulatory support systems are diverse, such as cardiac arrest, cardiogenic shock, high-risk cardiovascular intervention, bridge to emergency cardiac operation or cardiac transplantation, and pulmonary thromboembolism [6-10]. Nichol et al. [11] conducted a meta-analysis of 85 publications between 1966 and 2005 regarding percutaneous cardiopulmonary bypass, and concluded that this measure is mostly effective for rescuing critically ill patients, providing the median survival of 47% in 1,495 patients enrolled in this analysis. In the literature, however, survival rate after instituting mechanical circulatory support widely varies between 15% and 60%, which may well be attributed to small number of patients in most of the reports, diversity of the underlying diseases, and differences in experience and quality of care from one institution to another. It has been reported that selection of candidates, timing of life support system installation and technical aspects mainly determine the survival [7,12].

Mechanical circulatory support may be mandatory upon coronary angiography or catheter intervention in high-risk patients with cardiogenic shock or uncontrolled arrhythmia [13,14]. Shiraishi et al. [15] reported that mechanical circulatory support was necessary in 275 (15.4%) among 1,785 patients who underwent cardiovascular intervention for acute myocardial infarction. With respect to the institution of life

support system as a bridge to a definitive cardiac operation, there are reports of successful cardiac operation after an urgent installation of mechanical circulatory support for cardiogenic shock which developed during coronary angiography. Grambow et al. [16] reported 20% survival in patients with circulator assist device instituted for circulatory collapse in the catheterization laboratory.

For the percutaneous circulatory support, we are using CAPIOX emergency bypass system (EBS; Terumo Inc, Tokyo, Japan), which consists of centrifugal pump, membrane oxygenator (polypropylene hollow fiber) and heparin-coated circuit. This system is characterized by lower heparin administration, longer durability of the oxygenator, fast and easy auto-priming, and small-sized equipment with excellent adaptability to a small space. It can also be easily manipulated by un-experienced medical personnel. Thus, we have an institutional strategy to institute EBS system as soon as possible in case of cardiogenic shock after coronary artery angiography or intervention, and this might have lead to rescue the two patients with cardiogenic shock in the catheterization laboratory.

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