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Bridge to Transplantation with a Left Ventricular Assist Device

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A 61-year-old female patient was diagnosed with dilated cardiomyopathy with severe left ventricle dysfunction. Two days after admission, continuous renal replacement therapy was performed due to oliguria and lactic acidosis. On the fifth day, an intra-aortic balloon pump was inserted due to low cardiac output syndrome. Beginning 4 days after admission, she was supported for 15 days thereafter with an extracorporeal left ventricular assist device (LVAD) because of heart failure with multi-organ failure. A heart transplant was performed while the patient was stabilized with the LVAD. She developed several complications after the surgery, such as cytomegalovirus pneumonia, pulmonary tuberculosis, wound dehiscence, and H1N1 infection. On postoperative day 19, she was discharged from the hospital with close follow-up and treatment for infection. She received follow-up care for 10 months without any immune rejection reaction.

Key words: 1. Left ventricular assist device
2. Heart failure
3. Heart transplantation
4. Extracorporeal membrane oxygenation

CASE REPORT

A 61-year-old woman presented to the hospital with orthopnea as her chief complaint. Symptoms were first noticed three months prior to the hospital visit. Seven weeks prior to the visit, she went to a nearby hospital complaining of even more severe orthopnea. An echocardiogram showed that her left ventricular ejection fraction (LVEF) was 10%; she was then admitted to our hospital for a more detailed diagnosis and heart transplantation.

In 2004, although she was diagnosed with atrial fibrillation and warfarin was prescribed, she did not take warfarin. After diagnosis, she was closely observed, and an echocardiography was performed in 2009. Because her LVEF was measured at 20%, an implantable cardioverter-defibrillator was inserted to prevent sudden cardiac arrest.

An examination of her family history revealed that her father had died when he was approximately 40 years of age, and her younger brother had also died suddenly for unknown reasons.

On admission, transthoracic echocardiography showed dilated cardiomyopathy with left ventricle systolic dysfunction. This was combined with right ventricle dilation with systolic dysfunction. The LVEF was measured at only 10%. Severe cardiomegaly was found on the chest X-ray (Fig. 1). B-type natriuretic peptide was elevated to 35,000 pg/mL.

During the second day of hospitalization, continuous renal replacement therapy was performed because of oliguria and

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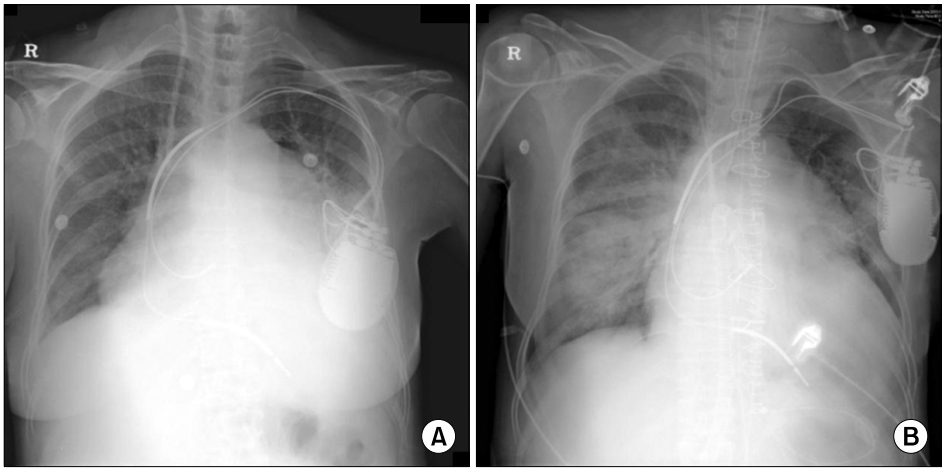

Fig. 1. (A) Preoperative chest X-ray of the patient. The chest X-ray shows severe cardiomegaly and an implantable cardioverter-defibrillator. (B) Left ventricular assist device support state.

Fig. 2. Intraoperative view. A 22 Fr straight cannula was inserted into the aorta, and a 30 Fr angled cannula was inserted into the left atrium.

lactic acidosis. On the fifth day of hospitalization, the total bilirubin, aspartate aminotransferase (AST), and alanine aminotransferase (ALT) were 5.6, 1,032, and 534 U/L, respectively. Those findings were thought to be the results of liver congestion caused by heart failure. An intra-aortic balloon pump was inserted to improve low cardiac output. During the ninth day of hospitalization, respiratory acidosis occurred as a result of respiratory difficulty. Subsequently, the patient's heart rate slowed down, finally resulting in cardiac arrest. The patient was revived after 11 minutes of cardiopulmonary cerebral resuscitation.

We concluded that heart transplantation was the only viable treatment and decided to insert a left ventricular assist device (LVAD) as a bridge to heart transplantation.

In the operating room, a median sternotomy was performed. A 22 Fr straight cannula (Edwards Life Sciences Research Medical RMI cannula, Irvine, CA, USA) was inserted into the aorta, and a 30 Fr angled cannula (Edwards Lifesciences Research Medical RMI cannula) was inserted into the left atrium, and a pulmonary artery cannula was inserted into the main pulmonary artery to monitor pulmonary arterial pressure (Fig. 2). A Jostra pump (Maquet Cardiopulmonary; AG, Hirrlingen, Germany) was also used. The cannula exited through the anterior chest wall. The sternum was closed and the skin was closed layer by layer. The pump's speed was between 2,800 and 3,200 revolutions per minute, and its flow was 2.6 to 3.2 L/min. Anticoagulation therapy was performed using heparin to maintain an activated clotting time around 180 to 220 seconds, and after LVAD insertion, the patient's vital signs stabilized. By continuously infusing diuretics, the urine output was also stabilized between 100 to 300 mL/hr.

Also, inhaled nitric oxide (NO) was started in the intensive care unit for right ventricular dysfunction. The maximal dose of inhaled NO was 20 ppm.

The AST, ALT, and creatinine levels, which indicate end-organ function, started to decrease 5 days after the LVAD insertion. The appropriate amount of urine output was also maintained without diuretics 5 days after the LVAD insertion.

On the twentieth day of hospitalization, the total bilirubin AST, and ALT were measured at 5.5, 47, and 19 U/L, respectively. On the twenty-fourth day of hospitalization, the

heart transplantation was performed while stabilizing the patient with LVAD. Redo-sternotomy was performed. There was a hematoma around the pericardium. Cannulation was performed at the distal aorta, inferior vena cava, and superior vena cava for cardiopulmonary bypass (CPB). After starting the CPB, we decreased the LVAD flow gradually and finally removed the LVAD with its cannulae. A thrombus was found at the point where the pulmonary artery catheter was located for the LVAD. The remaining cannulae did not reveal any unusual findings. The heart size was 16×10×9 cm.

All four chambers were dilated, and the septum and the myocardial wall were thin. Before surgery, basiliximab was used as an immunosuppressant, and vancomycin and meropenem were used as antibiotics. After surgery, methyl-prednisolone (Solu-Medrol; Pharmacia Upjohn, Peapack, NJ, USA), tacrolimus, and basiliximab were used. She developed several complications after the surgery, including cytomegalovirus pneumonia, pulmonary tuberculosis, wound dehiscence, and H1N1 infection.

On the ninetieth postoperative day, she was discharged from the hospital with close follow-up and treatment for infection. Currently, she frequently visits the hospital for outpatient treatment.

DISCUSSION

A heart transplantation is the only available treatment when advanced ischemic heart failure occurs and dilated cardiomyopathy is unresponsive to medical treatment. However, the number of donor hearts available for transplantation for these patients is insufficient [1]. Some patients can die of multi-organ failure while they are waiting for heart donors. LVAD is known to be a good alternative as a bridge for heart transplantation.

Since the beginning of the artificial heart program at the National Institute of Health in 1964, diverse circulatory-support devices have been developed for short-term use in patients with advanced heart failure [2]. A ventricular assist device (VAD) was successfully applied in 1971 by DeBakey [3]; it then began to be used as a bridge to transplantation, bridge to recovery, and bridge to destination therapy. The advantages of VAD are increasing the functional status and quality of life, but possible complications may develop, such as thromboembolism, hemorrhage, right heart failure, and stroke. If early insertion is performed before multi-organ failure, it may decrease the risk of complications and increase the survival rate [1].

In our case, the patient experienced advanced heart failure, and her level of LVEF was at 10% as a result of dilated cardiomyopathy. Acute kidney injury occurred before the VAD insertion, in addition to liver injury due to heart failure. Subsequently, cardiac arrest occurred and multi-organ failure commenced due to pulmonary edema and respiratory acidosis. We were worried about the application of extracorporeal membrane oxygenation (ECMO) or VAD as a bridge to heart transplantation. From past experience, ECMO had not improved measures of end-organ function, such as AST, ALT, and creatinine levels, which are indicators of liver and kidney function. However, a VAD improved end-organ function. A VAD can also supply effective hemodynamic support for patients awaiting heart transplantation with improved functional status and quality of life [4]. We subsequently decided to insert an LVAD as a bridge treatment for left ventricle function.

Since we used the extracorporeal type of VAD for this patient, she experienced some discomfort due to limited mobility. However, the patient continued receiving LVAD support for 15 days, which allowed her organ function to improve. A heart transplantation was performed after stabilizing her body condition. However, after the heart transplantation, wound dehiscence occurred. Moreover, due to the development of pneumonia, the patient needed long-term hospital care.

Currently, many patients with advanced heart failure who do not respond to medical treatment are waiting for heart transplantation; however, donor hearts are limited in quantity. Moreover, some patients can die of multi-organ failure while they are waiting for heart donors. In this case, VAD application was useful as a bridging treatment before heart transplantation.

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