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Case Report

HeartMate 3 Implantation via Only Left Thoracotomy: A Case Report

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Median sternotomy is a standard surgical technique used for left ventricular assist device (LVAD) implantation. However, if sternotomy has a prohibitive surgical risk, LVAD implantation can be performed through only left thoracotomy. We managed a patient with end-stage heart failure who had recently undergone coronary artery bypass grafting (CABG) elsewhere. The patient also had a deep sternal wound infection and bacteremia. Because of refractory cardiogenic shock, we performed extracorporeal membrane oxygenation (ECMO). After multiple mediastinal washouts and omental flap placement, ECMO was converted to extracorporeal LVAD (from the left ventricular apex to the descending aorta) through a left thoracotomy. The extracorporeal LVAD was maintained for 18 days and replaced by the HeartMate 3 LVAD. The patient was discharged in good condition 115 days after CABG.

Keywords: HeartMate 3, Left ventricular assist device, Thoracotomy, Sternal wound infection, Bacteremia, Case report

Case report

A 72-year-old man presented with dyspnea of New York Heart Association class IV severity. He had undergone percutaneous coronary intervention at the left anterior descending coronary artery 5 months earlier. He continued to have dyspnea, and his left ventricular ejection fraction was 25%. One month ago, he underwent coronary artery bypass grafting using the left internal thoracic artery and great saphenous vein targeting the left anterior descending coronary artery, the obtuse marginal branch of the left circumflex artery, and the posterolateral branch of the right coronary artery. However, his dyspnea did not improve after surgery, and he developed a high fever on postoperative day 21. His blood culture results showed methicillin-resistant *Staphylococcus aureus*, and he was administered vancomycin. At this time, his left ventricular ejection fraction was 22% with mild to moderate mitral regurgitation on echocardiography. He was transferred to Samsung Medical Center on postoperative day 22 for further management (Fig. 1).

After he arrived at our institution, his N-terminal probrain natriuretic peptide and lactic acid levels were 4,359.0 pg/mL and 10.22 mmol/L, respectively. Despite a high dose of inotropes and vasopressors, he was severely hypotensive. Thus, venoarterial extracorporeal membrane oxygenation (ECMO) insertion was performed via the right femoral vessels. The patient was also found to have a deep sternal wound infection (Fig. 2A). Emergent mediastinal washout, wound debridement, and vacuum-assisted closure were performed and repeated 4 times (Fig. 1). After negative chest wound culture was confirmed, omental flap placement was performed as a salvage operation. At the same time, the cannulation site was changed to the left femoral vessels, and thrombectomy was performed on the right superficial femoral artery due to distal limb ischemia. Computed tomography (CT) was followed up with a plan of durable left ventricular assist device (LVAD) implantation, and the results revealed healed mediastinal space with visible omental fat tissue (Fig. 2B, C).

Multiple attempts to wean the patient from ECMO failed. The patient was not dependent on a ventilator and

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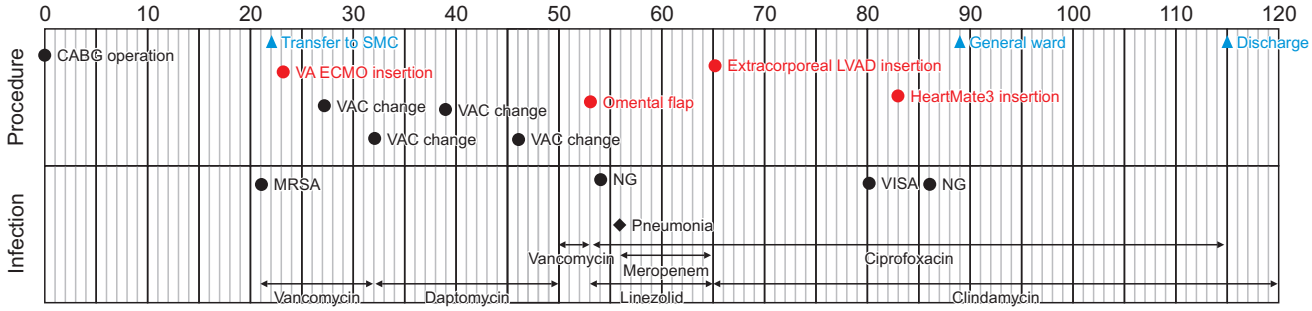

Fig. 1. Summary of key events in the course of the patient's care. CABG, coronary artery bypass grafting; MRSA, methicillin-resistant *Staphylococcus aureus*; SMC, Samsung Medical Center; VA, venoarterial; ECMO, extracorporeal membrane oxygenation; VAC, vacuum-assisted closure; NG, no growth; VISA, vancomycin-intermediate *Staphylococcus aureus*; LVAD, left ventricular assist device.

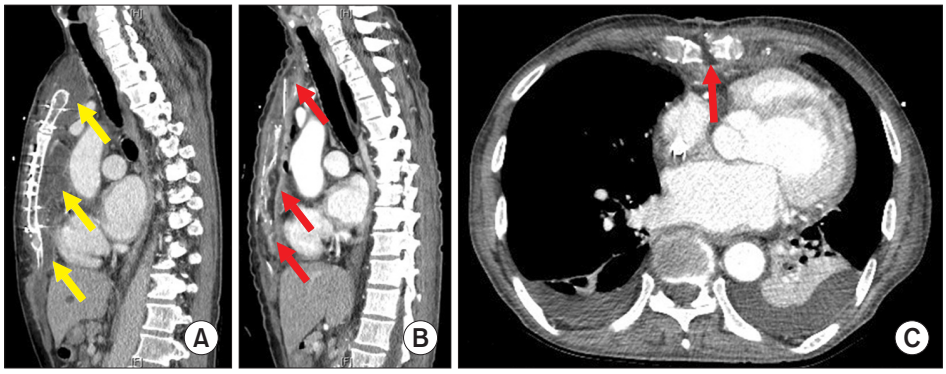

Fig. 2. Computed tomography findings before implantation of the HeartMate 3 left ventricular assist device. (A) Abscess in the whole retrosternal space and its extension toward the jugular notch (yellow arrows). (B, C) Healed mediastinal space with visible omental fat tissue (red arrows).

completely awake during chest wound management. Because we maintained active mobilization, bleeding from the femoral arterial cannulation site slowly increased. However, massive bleeding suddenly occurred at the ECMO insertion site, and the bleeding was not improved by compression and tamponade. Since there were no more peripheral vessels for ECMO, we performed emergent extracorporeal LVAD insertion 43 days after transfer to our hospital. After the induction of general anesthesia with a double-lumen endotracheal tube, left thoracotomy was performed at the sixth intercostal space. The pericardium was opened, and the bare area of the left ventricular apex was exposed. After heparinization, the mid-descending aorta was partially clamped, and a 12-mm Hemashield vascular graft (Boston Scientific, Natick, MA, USA) for the outflow tract was end-to-side anastomosed via 5-0 continuous monofilament polypropylene sutures. A 24F EOPA arterial cannula (Medtronic Inc., Minneapolis, MN, USA) was inserted into the left pleural space via tunneling the intercostal muscle and connected with the outflow graft. Under femoral ECMO support, a 32F straight venous cannula (Medtronic Inc.) was directly inserted into the left ventricular apex with double 3-0 pledgetted purse-string monofilament polypropylene sutures (Fig. 3A). Extracorporeal LVAD support was initiated, and previous ECMO support was removed in the operating room.

Despite the appropriate use of antibiotics and a well-healed chest wound, his blood cultures were not completely negative. Because the chest wound was completely healed and clean, we suspected that the ECMO circuits were infected. Thus, the implantation of the HeartMate 3 LVAD (HM3; Abbott Laboratories, Lake Forest, IL, USA) as destination therapy was decided.

Durable LVAD implantation via redo-left thoracotomy was performed 18 days after extracorporeal LVAD implantation. The left common femoral artery and vein were cannulated, and cardiopulmonary bypass (CPB) was initiated. The previous inflow cannula was removed, and the left ventriculotomy was extended. The left ventricular trabeculae that could interfere with inflow maintenance were removed as much as possible. The pump was inserted after HM3 standard cuff placement. The drive-line was brought out to 2 cm below the rib cage along the left anterior axillary line. The rifampicin-soaked outflow tract was connected with the previous 12-mm Hemashield vascular graft via end-to-end anastomosis using 6-0 continuous monofil-

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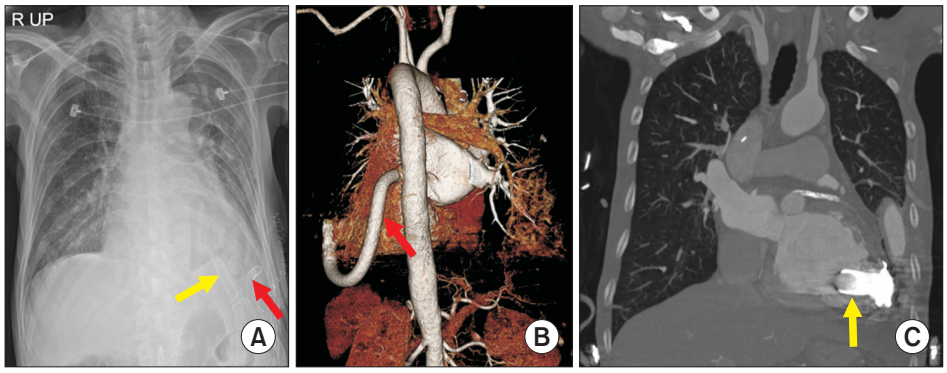

Fig. 3. (A) Chest X-ray after insertion of the extracorporeal left ventricular assist device. The inflow cannula (yellow arrow) is into the left ventricular apex. The outflow cannula (red arrow) is connected to the 14-mm Dacron graft, which is anastomosed to the mid-descending aorta. (B) Three-dimensional computed tomography angiogram after implantation of the HeartMate 3 left ventricular assist device. The outflow graft is indicated by a red arrow. (C) The inflow cannula (yellow arrow) is well placed in the left ventricle.

ament polypropylene sutures. Durable LVAD support was initiated, and CPB was weaned without difficulty.

The patient maintained stable hemodynamics in the intensive care unit. He was transferred to the general ward 6 days after HM3 LVAD implantation Three-dimensional CT angiography, showed that his inflow cannula and outflow tract of the HM3 LVAD were well positioned (Fig. 3B, C). In postoperative echocardiography, the left ventricular ejection fraction was 15%–20% with intermittent opening of the aortic valve. No signs of active infection were observed during his recovery. The patient was discharged 32 days after HM3 LVAD implantation and 93 days after transfer to our institution. More than 100 days after HM3 LVAD implantation, the patient never had any rehospitalizations or complications, including fever. The need for informed consent was waived by the Institutional Review Board (IRB approval no., 2022-10-001-001).

Discussion

Median sternotomy is a standard approach for most LVADs. However, patients with multiple sternotomies might have increased surgical risk [1]. According to Potapov et al. [2], a left thoracotomy approach could be considered in patients who had previous cardiac surgery. Several reports have demonstrated that a sternal-sparing approach is an effective and safe surgical technique for HM3 LVAD implantation in well-selected patients [3-5]. This minimally invasive procedure could be used as an alternative technique for patients at high risk of mediastinal re-entry. However, most studies that used LVAD via left thoracotomy still utilized the ascending aorta for outflow graft attachment. Therefore, these cases required upper mini-sternotomy or right anterior thoracotomy. Cho (Y.H.C., the surgeon in this case) et al. [6] reported a case of durable LVAD implantation via left thoracotomy only (i.e., the outflow graft was anastomosed to the mid-descending aorta). We applied the same technique to this patient. Unlike previous studies that used bilateral thoracotomy [3-5], we chose left thoracotomy only to avoid recurrent mediastinal infection and wound dehiscence.

Active systemic infection is a contraindication to durable LVAD implantation [2,7]. Therefore, we tried to avoid LVAD implantation. Whenever we decreased the ECMO flow, the patient had severe pulmonary edema, dyspnea, and hypotension. We changed the ECMO circuits and cannulas to control bacteremia, but the patient only showed a partial response. The patient was completely awake, except for several days when he was under general anesthesia. It was extremely hard to maintain his fitness through exercise in the intensive care unit. The drainage cultures from the mediastinal wound became negative. After extracorporeal LVAD implantation, only 1 blood culture was positive. We thought that removing extracorporeal circulation was the only way to completely control his infection. Thus, we performed HM3 LVAD implantation while administering antibiotics under the guidance of the Department of Infectious Diseases. Despite our successful experience, the procedure cannot be generally practiced. Alternative incision sites and durable LVAD implantation while bacteremia is not completely controlled should only be considered in highly selected patients with a multidisciplinary discussion. In our case, periodic and in-depth consultations with an infectious disease specialist were conducted regarding the dosage, regimen, and change of antibiotics. Currently, the prescription of oral antibiotics (clindamycin) is main-

tained in an outpatient clinic under the judgment of the infectious disease specialist.

In conclusion, HM3 LVAD implantation through only left thoracotomy can be an option for selective indications. This approach may be useful for patients at a prohibitive risk of median sternotomy. Although active bloodstream infection is still an absolute contraindication for durable LVAD implantation, aggressive removal of the source of infection may lead to acceptable clinical outcomes.

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Conflict of interest

No potential conflict of interest relevant to this article was reported.

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