



## Successful Single-Lung Transplant for the Dominant Side: A Case Report

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### ABSTRACT

Although single-lung transplant on the side with better lung function is challenging in patients with significantly asymmetrical lung function between the right and left sides, it sometimes can be a realistic option because of the recipient's condition and from the viewpoint of organ sharing. We report our experience with a successful case of single-lung transplant on the side with a pulmonary perfusion ratio of 89%. The transplant was performed with the patient under central venoarterial extracorporeal membrane oxygenation through a clamshell incision, and the patient had an acceptable short- and long-term outcome with a remarkable improvement of lung function.

**A**LTHOUGH bilateral lung transplant (BLT) has become a major procedure in the International Thoracic Organ Transplant Registry on the basis of its greater rate of survival [1], single-lung transplant (SLT) is a procedure of choice with a priority in Japan, which is facing an extremely severe donor organ shortage [2].

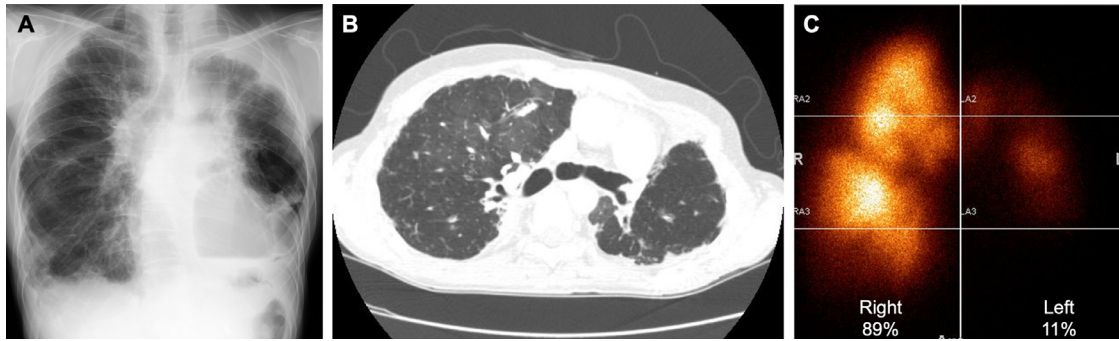
In patients with significantly asymmetrical lung function between the right and left sides, SLT in the side with lower function is usually preferred in consideration of the infrequent need for extracorporeal membrane oxygenation (ECMO) and the probable advantage in postoperative lung function [3]. However, the size of the thoracic cavity in the side with lower lung function is sometimes too small for the implanted lung to expand sufficiently so that the lung can fully exert its functional potential. Although SLT in the side with better lung function in patients with significantly asymmetrical pulmonary perfusion ratio is challenging and little is known about the short- and long-term outcomes of such a procedure, it sometimes can be a realistic option because of the recipient's condition and from the viewpoint of organ sharing. We report our experience with a successful case of SLT on the side with a pulmonary perfusion ratio of 89%.

transplant (HSCT) 16 years before the referral and had received a left upper lobectomy for pulmonary aspergillosis 2 months after the HSCT. When referred this time, she was experiencing severe shortness of breath with grade 3 on the modified Medical Research Council dyspnea scale, and her 6-minute-walk distance (6MWD) was 262 m. Her partial pressure of oxygen (PaO<sub>2</sub>) was 65.2 mm Hg on room air. She showed mixed ventilatory impairment with a forced vital capacity (FVC) of 1.16 L (33.6% of predicted) and a forced expiratory volume in 1 second (FEV1) of 0.46 L (15.9% of predicted). Chest radiography showed a small left hemithorax and large bulla in the left lower lung field (Fig 1A). Chest computed tomography showed patchy ground-glass lesions in the bilateral lung fields consistent with bronchiolitis obliterans (BO) after HSCT (Fig 1B). Lung perfusion scintigraphy with technetium-99m–labeled macroaggregated albumin showed a dominant perfusion ratio in the right lung of 89% (Fig 1C). Echocardiographic study showed normal cardiac function with a left ventricular ejection fraction of 73%. In consideration of the too small left thoracic cavity, we planned right SLT, and she was wait listed. During the waiting period, her respiratory failure progressed, and non-invasive positive pressure ventilation was intermittently

### CASE

A 37-year-old woman was referred to us for evaluation for lung transplant (LTx). She had undergone hematopoietic stem cell

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**Fig 1.** (A) Chest radiograph showing a small left thorax and large bulla in the left lower lung field. (B) Chest computed tomography before lung transplant showing patchy ground-glass lesions in the bilateral lung fields consistent with bronchiolitis obliterans after hematopoietic stem cell transplant. (C) Lung perfusion scintigraphy with technetium-99m–labeled macroaggregated albumin showing a perfusion ratio in the right lung of 89%.

applied. She eventually underwent right SLT after a waiting period of 73 months. The arterial blood gas analysis just before the LTx revealed a PaO<sub>2</sub> of 63.2 mm Hg and partial pressure of carbon dioxide of 76.7 mm Hg with 2 L/min oxygen inhalation.

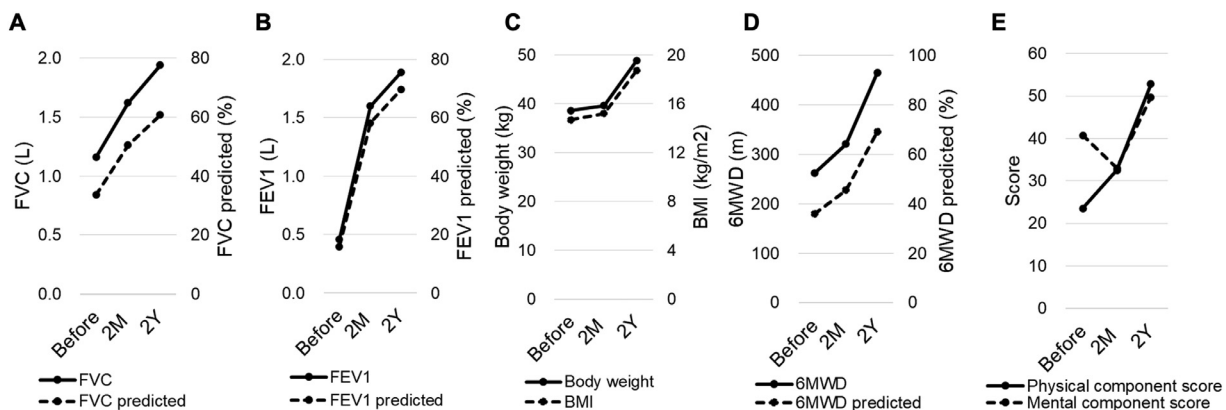
Her chest was opened through a clamshell incision, and the right SLT was uneventfully performed with the patient under central venoarterial (VA; right femoral vein to ascending aorta) ECMO. After the transplant, a catheter was inserted into the left femoral vein, and the supporting system was converted to peripheral venovenous (VV) ECMO. The patient was weaned from the ECMO on postoperative day 1, and the severity of primary graft dysfunction was grade 0 at 72 hours. She was weaned from mechanical ventilation on day 20, stepped down from the intensive care unit (ICU) on day 36, and discharged from the hospital on day 93 after transplant.

Her pulmonary function test result showed a remarkable improvement after the surgery (Fig 2A and B). Similarly, a significant recovery was seen in her physical and exercise strength (Fig 2C and D) and in her scores for health-related quality of

life (QOL) evaluated with the 12-item Short Form Health Survey (Fig 2E) [4]. The perfusion ratio of the transplanted right lung was 98% at 2 years after SLT.

## DISCUSSION

SLT on the side of better lung function with a perfusion ratio of 89% was successfully performed in a patient with severe respiratory failure due to BO after HSCT. The possibly more appropriate procedure for this patient with a small left hemithorax may be BLT with volume reduction of the implanted left lung from the viewpoint of long-term lung function. However, we selected SLT in the right side because of anxiety about severe intrathoracic adhesions in the left side due to previous surgery, to provide the opportunity for LTx in case only a donor right lung was available for transplant, and to account for the fact that Japan faces an extremely severe donor organ shortage. Indeed, the left lung of the same donor was transplanted into another patient in our institute. Despite the lack of robust



**Fig 2.** (A) Changes in the forced vital capacity (FVC), (B) forced expiratory volume in 1 second (FEV1), (C) body weight and body mass index (BMI), (D) 6-minute-walk distance (6MWD), and (E) physical and mental component scores evaluated with the 12-item Short Form Health Survey before and 2 months (2M) and 2 years (2Y) after lung transplant.

evidence that SLT for the side with significantly dominant lung function can provide a favorable short- and long-term clinical outcome, our patient demonstrated a remarkable improvement in pulmonary function, physical strength, and health-related QOL at 2 years after LTx.

One of the most important issues in the management of SLT for the side with significantly dominant pulmonary perfusion may be the way ECMO is applied. Our basic strategy of ECMO use in SLT is applying peripheral VA ECMO in cases with pulmonary hypertension and peripheral VV ECMO for the others, both of which have the advantage of continuous use of ECMO in the ICU without a route exchange. In the present case, however, we chose central VA ECMO through a clamshell incision in anticipation of differential hypoxia with peripheral VA ECMO [5]; that is, poorly oxygenated blood ejected into the ascending aorta from the left ventricle could compete with the retrograde flow from the ECMO circuit, which could potentially cause myocardial and cerebral ischemia.

In summary, we successfully performed SLT for the lung with significantly dominant function. Our experience with the present case merits further observational studies to examine the

clinical outcomes of SLT for the dominantly perfused side, especially in societies facing severe donor organ shortages.

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