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Case Report

On-pump beating CABG concomitant with bilateral living-donor lobar lung transplantation

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Introduction

Comorbidities in patients were previously considered to be a relative contraindication for lung transplantation.[1] Coronary artery disease (CAD), especially, was recognized a serious surgical risk.[2] Because the number of lung transplantations has been increasing, patients with many comobities including CAD, may be candidates for this treatment. Several reports described acceptable outcomes of preoperative or combined treatment for CAD in patients who are in need of lung transplantation.[3,4] These results suggest that patients with CAD need not be excluded as candidates for lung transplantation.

Case report

A 60-year-old male developed dyspnea on exertion over several years. The patient was diagnosed with idiopathic interstitial pneumonia via high resolution computed tomography (CT) findings. At the time, he smoked 3 packs a day for 43 years. At 62 years of age, home oxygen inhalation was started in addition to the antifibrosis agent, nintedanib. However, the patient's lung function was still deteriorating and symptoms of dyspnea rapidly worsened over following 2 months. Although this patient would not survive without undergoing lung transplantation, he could not be listed for a cadaveric lung transplant (CLT) because he was over 60 years of age, which was the age limit for CLT in Japan. He was referred to our hospital to undergo living-donor lobar lung transplantation (LDLLT). The concentration of preoperative serum Krebs von den Lungen-6 was high (756 U/mL). A pulmonary function test revealed a forced vital capacity of 1.66 L (43% of predicted) and a forced expiratory volume in 1 s of 1.62 L (43% of predicted). CT showed massive traction bronchiectasia and honeycombing, suggesting interstitial pneumonia in bilateral lungs (Fig. 1A, B).

Transthoracic echocardiography, as a preoperative screening examination, revealed impaired left ventricular wall motion, with mild hypokinesis of antero-septal and severe hypokinesis of inferior movements. His left ventricular ejection fraction was relatively preserved, with a level of 52%. Coronary angiogram showed two vessels with CAD: the right coronary artery (RCA) was completely occluded (Fig. 2A) and the circumflex artery (CX) showed 90% stenosis (Fig. 2B). Cardiologists and cardiac surgeons discussed the strategy to treat the diseased coronary artery. Coronary artery bypass grafting (CABG) was more favorable than percutaneous coronary intervention (PCI), because there is no requirement for dual antiplatelet therapy (DAPT) after re-vascularization. Our transplantation team, consisting of thoracic and cardiac surgeons, decided to perform CABG and LDLLT at the same time.

The surgical procedure is described below. Under general anesthesia, a clamshell incision was made and the hila were prepared for lung

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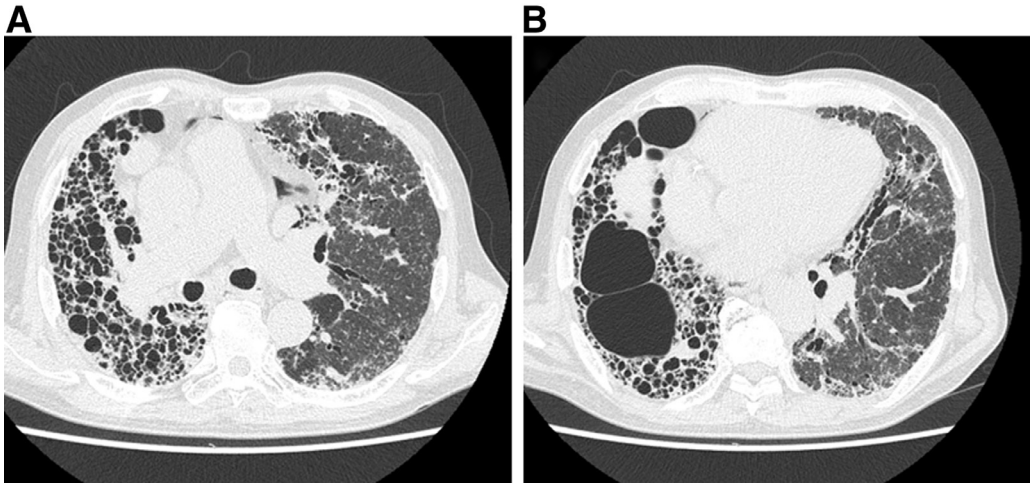

Fig. 1. High resolution computed tomography showed massive traction bronchiectasia and honeycombing in bilateral lungs (A) (B).

transplantation. The greater saphenous vein was harvested from the bilateral lower legs for use in coronary artery bypass. Extracorporeal membrane oxygenation (ECMO) was established, with a 20 French arterial cannula placed in the ascending aorta and a 25 French venous cannula placed into the right atrium via the right femoral vein. Under on-pump beating-heart, two proximal sites of the saphenous vein graft (SVG) were anastomosed to the ascending aorta using an Enclose II device (Novare Surgical Systems, Cupertino, CA). Distal anastomoses of the SVG were achieved to the circumflex and right coronary artery using a Starfish Heart positioner and Octopus Tissue Stabilizer (Medtronic Inc. Minneapolis, MN). The patency of the SVG was confirmed using a flowmeter. After coronary revascularization, another 28 French venous cannula was inserted into superior vena cava to prevent deterioration of pump flow during the subsequent LDLLT. Donors were the patient's son and younger brother. The son's right lower lobe and the brother's left lower lobe were procured sequentially by the separate teams. Each side of lobe implantation started with bronchial anastomosis, followed by pulmonary venous anastomosis with a side-biting clamp on the pulmonary veins, and ended with pulmonary artery anastomosis. ECMO was discontinued and the patient was de-cannulated. After the completion of CABG and LDLLT, SVGs were placed on the surface of heart using fibrin glue, to prevent it from becoming kinked (Fig. 3A). The heart was covered almost completely with an expanded polytetrafluoroethylene patch except for a hole for the pericardial drainage tube. The total ECMO time was 5 h 21 min, total operation time was 9 h 49 min, and total anesthesia time was 11 h 35 min.

There was no postoperative primary lung graft dysfunction or acute cellular rejection. Prednisone was used in combination with tacrolimus and mycophenolate for maintenance immunosuppression. On postoperative day (POD) 2, a tracheostomy was performed as scheduled. On POD 5, the patient could walk for 30 m in the intensive care unit. The patient was completely weaned off mechanical ventilation on POD 17. He was transferred to the general ward on POD 19 and the tracheostomy tube was removed on POD 20. Post-operative coronary CT angiography revealed good patency of the vein grafts (Fig. 3B, C). A lengthy hospital stay was needed because the patient had back pain resulting from a steroid-induced thoracic bone fracture. The patient was discharged on POD 117 without any cardiac event.

Discussion

Lung transplantation is a valuable treatment option for patients with various end-stage lung diseases. Because lung transplantation has been performed in many patients worldwide, the population of transplant recipients is currently aging, and accordingly, CAD is more

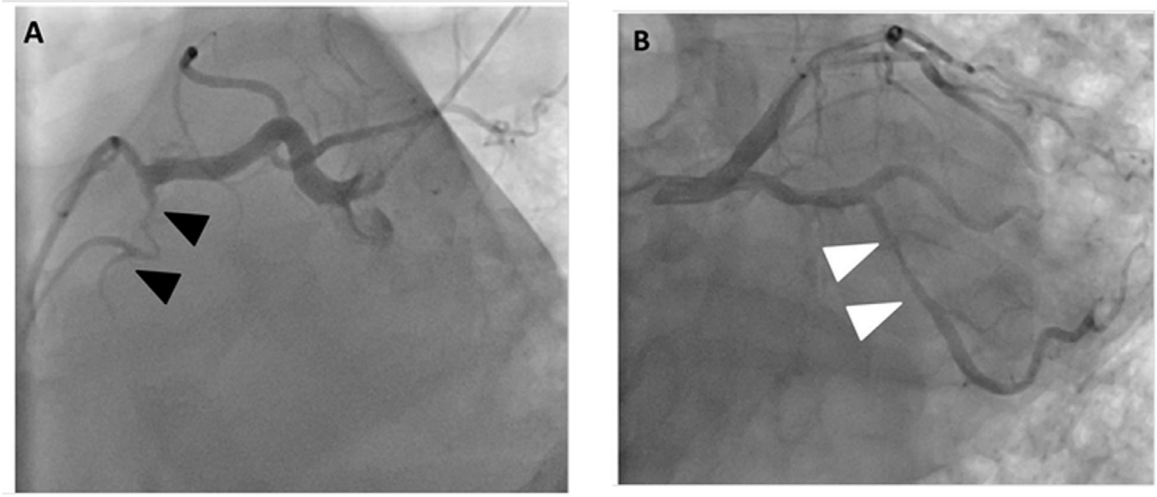

Fig. 2. Coronary angiography revealed that the right coronary artery was totally occluded (A, black arrows) and there was a severe stenotic lesion in the obtuse marginal branch (B, white arrows).

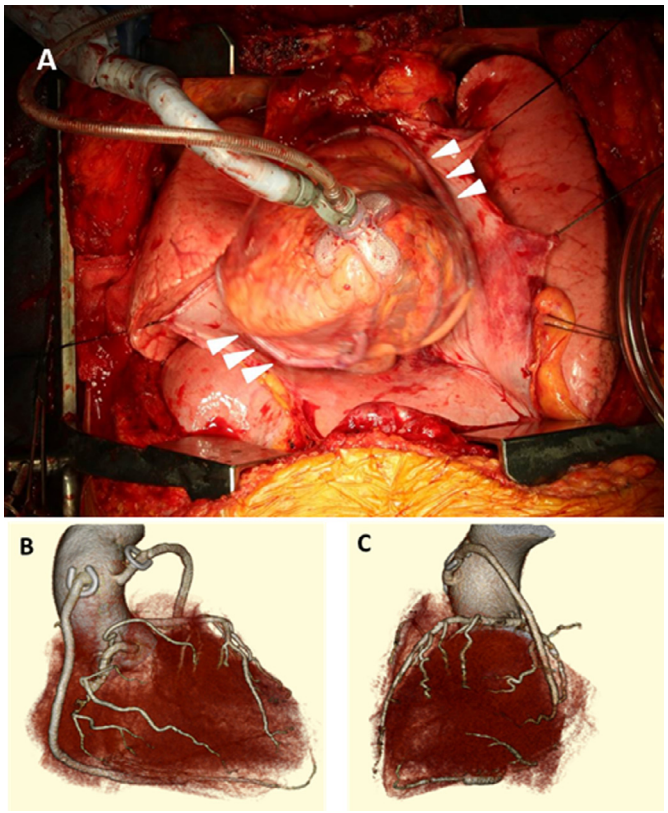

Fig. 3. The apex of the heart was lifted using a heart positioner fixed to a rib retractor. White arrows indicate that the saphenous vein graft was bypassed to the circumflex artery and right coronary artery. Bilateral lung transplantation was completed (A). Post-operative coronary CT angiography indicated good venous graft patency with the right coronary artery (B) and circumflex artery (C).

likely to be encountered in the recipient population. It is estimated that over half of the patients with advanced lung disease have occult CAD.[5] Historically, CAD has been a relative contraindication to lung transplantation. However, previous investigators have demonstrated that some degree of CAD that is amenable to coronary revascularization does not impair short-term or long-term patient or graft survival after lung transplantation.[3,4] Additionally, some thoracic surgeons suggest that CABG should not be a contraindication for lung transplantation in well-selected patients.

In Japan, living-donor lobar lung transplantation (LDLLT) plays an important role in the field of lung transplantation, because of a shortage of cadaveric lung donors. The average wait time for a cadaveric lung is exceeding 800 days. Additionally, there is an age limit for the recipient of CLT. In this case, the patient was over 60 years of age when he was referred to thoracic surgeons at our hospital for the possibility of a lung transplant. For the past several years, most of the reports on LDLLT have been from Japan.[6] It has been reported that bilateral LDLLT provides equal or better survival than conventional CLT by the Kyoto University team.[7]

In the treatment of CAD, it is unclear whether PCI should be performed before transplant or CABG be concomitant with the lung transplant. The PCI procedure is less invasive than CABG, but insertion of a drug-eluting stent requires DAPT for a period of time. This therapy induces bleeding complications and surgery with a high risk of bleeding, such as lung transplantation, is a contraindication for DAPT.

In this case of bilateral lung transplantation, CABG was performed on the beating-heart supported by ECMO. Without sternotomy, there were no difficulties in positioning the heart and stabilizing the target coronary arteries, because the tissue stabilizer and heart positioner were easily fixed to the rib retractor. We obtained an excellent surgical field. SVG was used to re-vascularize the RCA and CX territory. Although the internal thoracic artery (ITA) graft is preferable to SVG for long-term patency, this bypass graft design without an ITA graft placed following bilateral lung transplantation, which was performed via the clamshell approach, is easier technically. Care should be taken about whether SVG disease and cardiac ischemia occur, because the patient is required to take steroids and immunosuppressants for the rest of his life.

To the best of our knowledge, this is the first report of a patient who underwent beating CABG concomitant with bilateral LDLLT.

Conclusion

It is estimated that over half of the patients with advanced lung disease have occult CAD. In Japan, LDLLT plays an important role in the field of lung transplantation, because of a shortage of cadaveric lung donors. We report a successful case of on-pump beating coronary artery bypass grafting (CABG) concomitant with bilateral living-donor lobar lung transplantation (LDLLT).

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Supplementary data

Supplementary data related to this article can be found at https://doi:10.1016/j.hrtlng.2018.08.008.

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