Simultaneous Bilateral Lobar Lung Transplantation: One Donor Serves Two Recipients
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Lung transplantation is an accepted therapy in selected patients with end-stage lung disease. However, there is a shortage of suitable donor organs, in particular for small or pediatric patients. Simultaneous bilateral lobar lung transplantation derived from one large donor into two small recipients is reported. The upper lobes were transplanted into the smaller female recipient, and the middle and right lower lobe and left lower lobe were transplanted into the male recipient.


Donor shortage is a major obstacle to lung transplantation. To overcome this problem, we and others regularly perform size-reduced lung transplantation by lobar transplantation, anatomic, and nonanatomic resections [1–3]. We report the first simultaneously performed bilateral lobar lung transplantation derived from one donor into two recipients at the same institution.

Case Reports
Recipient 1
Recipient 1 was a 17-year-old boy with cystic fibrosis (CF) (156 cm, 43 kg, body mass index 18 kg/m²), diagnosed in childhood because of recurrent respiratory symptoms and found to have a delta F508 homozygous CF genotype. Forced expiratory volume in 1 second (FEV₁) and forced vital capacity (FVC) were 0.66 L, 27% of predicted, and 1.42 L, 48% of predicted, respectively.

Recipient 2
Recipient 2 was a 14-year-old girl with CF (149 cm, 42 kg, body mass index 19 kg/m²) diagnosed in her first month of life because of failure to thrive and found to have a delta F508 homozygous CF genotype. The girl had a severe obstructive ventilatory defect (FEV₁ 0.55 L, 26% of predicted, and FVC 0.71 L, 28% of predicted).

Recipient Operations
The operations were performed by an extracorporeal membrane oxygenation (ECMO) system with a central arterial cannula through the ascending aorta and a two-stage venous cannula through the right atrium.

The pulmonary artery was prepared extrapericardially on both sides of the hilum and dissected as distally as possible into the parenchyma of the lung, beyond the upper lobe branch, to provide sufficient length for subsequent anastomoses [4]. The inferior and superior pulmonary veins were dissected free, encircled, and divided by a vascular stapler. The recipient’s main bronchus was divided one ring proximal of the branching of the upper lobe bronchus. The bronchial arteries were ligated, and electrocoagulation of the peribronchial tissue was avoided [5].

Preparation of Donor Lung
Back-table preparation and separation of the lobes was done in our center. The two upper lobes (left and right) were prepared for the smaller female recipient, and the middle and right lower lobe and left lower lobe were prepared for the male recipient.

The preparation of the right donor lung started with the separation of the oblique fissure. The parenchyma bridge between the upper lobe and lobes was divided by a TA-90 stapler device. The oblique fissure was dissected down to the interlobar pulmonary artery. The interlobar pulmonary artery was cut between the middle lobe artery and the apical segment branch artery. The proximal part (upper lobe side) was sutured with 5-0 Prolene (Ethicon, USA) (Fig 1). The lower lobe portion was left open for anastomoses.

The atrium cuff was divided between the lower lobe vein and the middle lobe vein on the right side and between the lower and upper lobe veins on the left side (Fig 2).

The right upper lobe bronchus was divided at the level of its origin from the main bronchus. The intermediate bronchus was divided at the level of the middle lobe bronchus and the apical segment bronchus of the lower lobe (Fig 3).

Back-table preparation of the donor left lung began with separation of the upper and lower lobes. The oblique fissure was dissected down to the pulmonary artery. The parenchymal bridge between the upper and lower left lobes was divided by a stapling device (TA-90). After completion of the fissure dissection, the pulmonary artery was divided obliquely between the apical branch of the lower lobe and the lingula artery. The upper part of this division (lingual artery side) was sutured with 5-0 Prolene (Fig 1). The two pulmonary veins were exposed on the mediastinal surface of the lung and divided, leaving a small cuff of atrium tissue (Fig 2). The left upper lobe bronchus was divided at the level of its origin from the main bronchus. The left lower lobe bronchus was separated at the level of the apical segment bronchus of the lower lobe (Fig 3).
First the bronchial anastomosis was carried out. A continuous suture of the membranous wall (PDS (Polydioxanone) 4-0 suture, Ethicon) and end-to-end anastomoses with interrupted single sutures (4-0 PDS) of the cartilaginous part was performed. Then we performed venous (atrium) followed by pulmonary artery anastomoses with continuous running suture. Deairing was performed in an antegrade manner.

The patients received regular triple immunosuppressive therapy with cyclosporine, mycophenolate mofetil, and prednisone, including induction therapy with basiliximab and prophylaxis against *Pneumocystis carinii*, cytomegalovirus, and fungal infections. Antibiotic therapy was adjusted on the basis of the antibiotic sensitivities from preoperative sampling of the recipients’ and the donor’s bronchi before implantation.

**Postoperative Course and Follow-Up**

Recipient 1 was extubated on postoperative day 1. On day 4, he was transferred from the intensive care unit to the normal ward. An endoscopic sinus surgical procedure (sphenoethmoidectomy) was undertaken 3 weeks postoperatively as part of our standard care plan for lung transplant recipients with CF. He was discharged on day 34.

Recipient 2 was also extubated on postoperative day 1; however, the early extubation failed, and she required reintubation on the same day. Because weaning from ventilatory support was prolonged, a tracheostomy was performed on postoperative day 3; decannulation was finally achieved on day 13. Early postoperatively, the patient required hemofiltration for 2 days, but her kidney function recovered fully thereafter, and her serum creatinine level and glomerular filtration rate were normal at discharge.

Owing to progressive pleural effusions and increased inflammatory parameters during the following week, the girl underwent bilateral thoracoscopy. She was discharged home 2 months after the transplant procedure in good clinical condition.

Ten months after transplantation, she experienced posterior reversible encephalopathy syndrome and required conversion from cyclosporine A to tacrolimus.

Two years after transplantation, recipient 1 has an FEV₁ of 2.89 L (81%), an FVC of 3.37 L (82%), and a bronchiolitis obliterans syndrome of 0; recipient 2 has an FEV₁ of 1.43 L (73%), an FVC of 1.66 (53%), and a bronchiolitis obliterans syndrome of 0.

Both recipients have restarted their regular education and enjoy a good quality of life despite the demanding daily medical therapy protocol and regular outpatient clinic visits.

**Comment**

In this study, we report, to our knowledge, the first simultaneously performed bilateral lobar lung transplant procedure derived from one large donor into two small recipients in the same center.

The decreased supply of donor organs and increased number of potential recipients has resulted in longer...
waiting times and increases in deaths in patients on the lung transplant wait list. For this reason, interest has been directed toward the use of marginal donors, non–heart-beating donors, and living donors. Downsizing of lung grafts by either nonanatomic resection or lobectomy is another option to increase the donor pool, especially for small recipients in case of donor–recipient size mismatch (1–3, 6, 7). Nonetheless, it is not routinely performed in many transplant centers. In any case, the best functional outcome should have the highest priority when downsizing of lung grafts is performed.

The first report of lobar lung transplantation was published in 1994 by Bisson and colleagues [7]. Other reports followed, in which the results were similar to those of standard lung transplantation (1–3). Pulmonary bipartitioning is a modification of lobar transplantation, which divides the left lung into two lobes and uses the right donor lung for another recipient, which increases the donor pool [4]. This procedure is a little more complicated than lobar lung transplantation. Our technique was a kind of modified bipartitioning, inasmuch as it required careful division of the interlobar pulmonary artery and bronchi.

It is generally reported that lobar lung transplantations are performed with cardiopulmonary bypass or extracorporeal membrane oxygenation (ECMO) [3]. One of the reasons for this strategy is to prevent reperfusion edema in the first transplanted lobe [3]. The operations in our two recipients were done with ECMO. This allowed controlled reperfusion with low pulmonary artery pressures.

In our practice in lobar transplantation we perform the bronchial anastomosis at the level of the recipient’s main bronchus. We do not force telescoping unless it occurs naturally. In contrast to the technical report from Deuse and colleagues [6], we shorten the donor bronchus on the right side as distally as possible (Fig 3) but not a long intermediate bronchus as suggested by those authors. Since the year 2000, 75 recipients have undergone size-reduced lung transplantation in our center, and 23 of them underwent bilateral lobar lung transplantation without any bronchial anastomotic complications [8]. Another important step is to leave the pulmonary artery as long as possible during pneumonectomy in the recipient. This allows the surgeon to perform the arterial anastomosis without any tension.

To perform simultaneously two lung transplantations requires well-organized logistics. It is important to have trained two transplant teams, anesthesiologists, perfusion technicians, operating nurses, and operating room personal.

In conclusion, to transplant lobes from a large donor into two small recipients is a valuable option to increase the donor pool.

References