Surgical Technique of Lower Lobe Lung Transplantation

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Among patients with end-stage lung disease awaiting lung transplantation, pediatric and small adult patients have a significantly lower chance of getting size-matched pulmonary grafts in time because of the severe scarcity of small donors. It is our strategy to perform lobar lung transplantations in small recipients with restrictive pulmonary disease once their clinical status demands urgent transplantation. Here we describe our surgical technique and discuss the benefits and risks of this procedure.

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In 2009, of 1062 lungs allocated by Eurotransplant and offered to German centers, only 138 (13.0%) had a predicted donor total lung capacity (TLC) of less than 5 liters. Of those lungs offered, only 74 (53.6%) were acceptable and were finally transplanted. Currently, there are approximately 330 patients with TLC $<$ 5 liters on the active Eurotransplant lung waiting list for small donor grafts. Transplantation of oversized grafts can lead to recurrent atelectasis, ventilation disorder, or distortion of the bronchial system with the risk for infections and graft failure [1, 2]. Should rapid deterioration of the clinical status of the patient occur, complementary surgical approaches are required to permit timely transplantation.

Technique

A thoracosternotomy and intraoperative cardiopulmonary bypass were used for all cases of lower lobe lung transplantation (LLTx). Recipient lungs were explanted in a standard fashion.

For back-table bilobectomy of the right donor lung, the interlobar artery was approached through the oblique fissure (Fig 1A). Posterior ascending arteries to the upper lobe and middle lobe arteries were identified, and the oblique fissure was completed by dividing parenchymal bridges with commercially available stapler devices (Endo GIA, Convidien Surgical, Dublin, Ireland). Arterial branches to the upper and middle lobes were ligated and the interlobar artery was divided proximally (Fig 1B). The middle lobe bronchus was divided and closed using open staplers (TA, Convidien Surgical) or suture closure. Because of the significant lumen step-down from the intermediate bronchus to the lower lobe bronchus, and the close proximity of the middle lobe bronchus take-off, and the vis-à-vis origin of the superior segmental bronchus, we advocate to preserve this segment and divide the intermediate bronchus just proximally. The pulmonary venous system was inspected for aberrant venous branches of the lower lobe. A small cuff of the left atrial tissue was preserved around the lower pulmonary vein inflow. The lower lobe was separated and the bilobectomy was finalized.

For back-table upper lobectomy of the left lung, the upper lobe is retracted anteriorly and the interlobar pulmonary artery is dissected within the fissure. The distal posterior segmental arteries to the upper lobe as well as the lingular arteries were identified, ligated, and divided (Fig 2A). Remaining parenchymal bridges were stapled. To divide the bronchus at the appropriate level, the space between the lingular bronchus and the lower lobe bronchus was defined by rolling the pulmonary artery posteriorly, thus exposing the bifurcation of the left main bronchus (Fig 2B). If the lower lobe bronchus had at least one intact cartilage ring before the first segmental branch take-off, the lower lobe bronchus was divided at its origin. Otherwise, we recommend resecting the upper lobe bronchus, creating a short stump, and using the last cartilage ring of the main bronchus before the bifurcation for the anastomosis. Again, the pulmonary veins were inspected and a small lower vein cuff was created and the upper lobectomy was concluded.

The lower lobe was wrapped in cold, wet surgical gauze during implantation. The bronchus was connected first (Fig 3). Although there always was a size discrepancy, we tried to avoid significant telescoping and use one continuous running 4-0 Prolene suture (Ethicon, Somerville, NJ) for the anastomosis. It is our standard to use Prolene running

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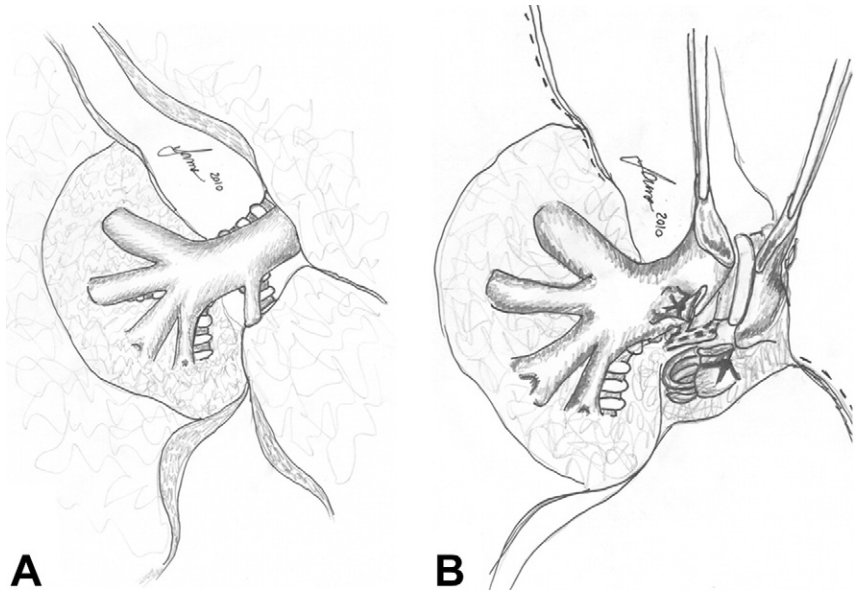

Fig 1. Back-table right upper and middle bilobectomy. The major fissure is completed (A) and the upper and middle lobes are removed while preserving the interlobar artery and the distal bronchus intermedius (B). A small cuff of left atrial tissue is preserved around the lower pulmonary vein.

sutures (Ethicon) for all airways as it was originally described [3], and we have not seen granuloma formation caused by foreign body reaction. If the donor bronchus is cut back to the right lower lobe bronchus, it might be advantageous to use the recipient proximal intermediate bronchus for the anastomosis to reduce the luminal difference and minimize anastomotic complications.

The recipient main pulmonary artery was anastomosed to the shortened donor interlobar artery with 5-0 Prolene sutures. It must be emphasized that if left too long, the artery is prone for kinking. The lower vein cuff of the donor lobe was connected to the standard left atrial cuff of the recipient. Gradual controlled reperfusion is performed. Figure 4A depicts the left hilum after implant. Chest roentgenograms after LLTx demonstrate adequate size matching without persistent atelectasis or pneumothoraxes (Fig 4B).

We have used this technique in 3 patients so far. Primary graft dysfunction occurred in 1 case requiring postoperative extracorporeal membrane oxygenation support for 7 days until lung function completely recovered. We did not encounter pleural or pulmonary infectious complications. One patient had intermittent stent placement for beginning luminal narrowing of the right-sided bronchial anastomosis. However, the stent could be removed 4 weeks later and the bronchus lumen remained widely patent 10 months after surgery.

Comment

We performed LLTx only in small females with restrictive lung disease. Because of concerns that transplantation of only one lobe would not provide enough

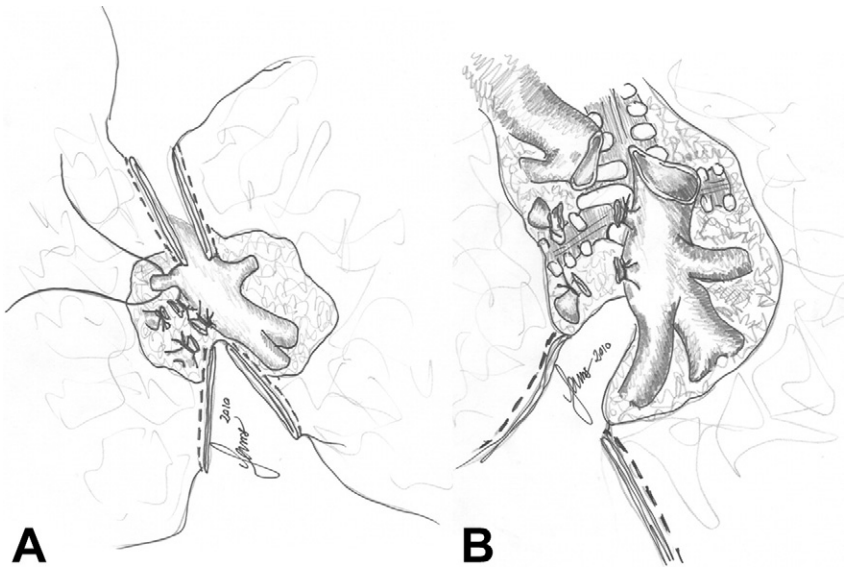

Fig 2. Back-table left upper lobectomy. The upper lobe is retracted anteriorly and the fissure is completed (A). The interlobar artery is preserved and the lower lobe bronchus is divided at its take-off (B). The lower pulmonary vein is isolated with a small cuff.