Transplantation of lungs after ex vivo reconditioning in a patient on semi-elective long-term veno-arterial extracorporeal life support

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Abstract

We present the case of a 41-year old patient suffering from end-stage pulmonary hypertension secondary to veno-occlusive disease who underwent implantation of a veno-arterial extracorporeal membrane oxygenator as a bridge to lung transplantation (LTx) due to significant deterioration of myocardial pump and liver function. After 33 days on support, lungs with extended donor criteria were offered. Owing to the deteriorating clinical condition of the patient, the lungs were assessed using our ex vivo lung perfusion system. After reconditioning of the graft, a bilateral LTx was performed.

Keywords: Extracorporeal membrane oxygenation • Transplantation • Lung

A 41-year old female patient initially presented with haemoptysis. A computed tomography demonstrated fibrotic changes, and a lung biopsy revealed veno-occlusive disease. She was accepted on the lung transplantation (LTx) waiting list, but continued to deteriorate clinically. As she developed signs of right heart failure with systolic pulmonary artery pressure in excess of 85 mmHg and significantly deranged liver function, it was decided to offer her a semi-elective implantation of a veno-arterial extracorporeal membrane oxygenator as a bridge to transplantation.

To meet the requirements of long-term extracorporeal life support (ECLS), a HiLite®7000 (Medos®) oxygenator and a Levitronix® CentriMag® (Thoratec, CA, USA) centrifugal pump were used. Percutaneous implantation was performed under local anaesthesia via the right femoral vessels using Seldinger’s technique with a 19-Fr BioMedicus® (Medtronic®) arterial and a 24/29-Fr two-stage venous cannula BioMedicus® (Medtronic®). Distal leg perfusion was secured with an additional 12-Fr cannula to the femoral artery.

While on ECLS, a flow of 4 l/m was maintained and the patient remained self-ventilating, without any inotropic support and with good kidney function. The liver function also normalized due to the venous unloading and increased perfusion. To optimize her for the surgery, the patient was undergoing physiotherapy twice a day; she began with resistance and stretching exercises and then progressed to sitting. However, after 28 days, her overall status deteriorated with her psychological status declining and neurological dysfunction in the lower extremities. Thus, it was decided to extend the donor criteria for the patient.

The donor was a 21-year old gentleman, who sustained severe lower lobe injury. Emergency chest exploration had demonstrated a right ventricle perforation and a 10-cm deep laceration of the right lower lobe, which was sutured. He had a cardiac arrest lasting 40 min and required massive blood transfusion in excess of 40 units. Brain stem death was confirmed, and consent was obtained for organ donation.

Chest X-ray revealed bibasal consolidation, and bronchoscopy showed haemorrhage into the trachea. An arterial blood gas on FiO2 1 and positive end-expiratory pressure (PEEP) 14 cm H2O showed a PaO2 of 24 kPa and a PaCO2 of 8.6 kPa. Owing to the poor gas exchange combined with severe lung injury, the lungs were deemed to be non-transplantable, but were accepted as a rescue offer.

The lungs were procured with ante-retrograde Perfadex (Vitrolife) flush, and placed into the ex vivo lung perfusion (EVLP) system upon arrival at our hospital according to our institutional protocol [1]. After reconditioning for 240 min, the venous effluent had a PaO2 >50 kPa on a FiO2 1 and a PEEP of 5 cm H2O. Selective pulmonary venous gases revealed excellent gas exchange in all lobes. Consequently, the lungs were accepted for implantation.

The lungs were transplanted using a minimally invasive approach on ECLS [1, 2]. The chest was entered bilaterally through a 12- to 15-cm anterolateral thoracotomy via the fourth intercostal space. The ischaemia time, calculated from explantation, was 549 min for the right lung and 640 for the left. The patient was weaned off ECLS at the end of the surgery with a total support time of 33 days.

The patient was weaned off the ventilator on the first post-operative day (POD), but required re-intubation due to overall weakness. A percutaneous tracheostomy was performed on POD4 and she was weaned off ventilation on POD13. There was a prolonged bilateral air leak, probably related to the previously sustained donor lung laceration, and for this reason both apical drains were maintained for 9 days. As she had developed a critical care neuropahty, she required prolonged physiotherapy, but was gradually mobilized and discharged home 6 months postoperatively. The predischarge echocardiogram showed mildly reduced right ventricular function. At the 1-year follow-up, the patient was in a...
good clinical condition and the lung function tests were continuously improving.

**DISCUSSION**

Despite the extended donor acceptance criteria introduced in recent years, aimed at increasing the pool of lung donors, the mortality on the waiting list remains high with patients with pulmonary hypertension often deteriorating rapidly [3]. Extended ECLS may present a new technique useful in this patient group in order to successfully bridge these patients to transplantation.

The duration of ECLS in adults is limited by various factors, and the incidence of complications increases significantly over time. In our case, we had to exchange the circuit and adjust the anticoagulation protocol, but could maintain ECMO support for 33 days without any major complications. This demonstrates that prolonged use of this technique is feasible and may provide a successful bridging strategy to lung transplantation. As bridging patients with ECLS to LTx cannot usually be done with regular donors, any available lung should be assessed and likely used for patients on ECLS. Unfortunately, as the recipient blood group was O and due to the reduced native lung volumes, this was the first offer with regard to size that became available while she was on ECLS.

*Ex vivo* reconditioning of primarily rejected organs has resulted in successful transplantations with short-term results similar to the rest of the transplant population [4]. A successful bilateral sequential single lung transplantation (BSSLTx) using *ex vivo* reconditioned lungs in a patient supported with veno-venous ECMO has recently been published [5]. However, in our case, a veno-arterial ECLS was required due to right ventricle failure and haemodynamic instability. We used a static EVLP system to recondition lungs that had sustained severe traumatic injury.

Based on the above, we conclude that EVLP and ECLS represent two new exciting factors in clinical LTx, which, when combined, not only allow for supporting patients with end-stage lung disease and rapid clinical deterioration on ECLS, but also actually help in bridging them to successful transplantation, as EVLP significantly increases the donor pool if applied appropriately in the case of true extended donor criteria organs.

**Conflict of interest:** none declared.

**REFERENCES**