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Transplant & Mechanical Support: Case Report

Use of Ex-Vivo Lung Perfusion for Planned Left Single-Lung Transplant

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The donor shortage in lung transplantation is further exacerbated by the highest organ turn-down rate among all solid organ transplants. Here we present a case of planned single-lung ex-vivo lung perfusion that enabled the use of a single lung for transplantation, that otherwise may have gone unallocated. Creative management of the donor trachea enabled use of both the left and right lungs for separate recipients. Techniques like this may inspire confidence in expansion in use of ex-vivo lung perfusion and a commensurate increase in donor organ utilization for lung transplantation.

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In lung transplantation, the number of patients waiting for a suitable lung far exceeds the number of donor lungs available. Lung transplantation is also associated with the lowest organ recovery rate, at 22%.[1,2] Ex-vivo lung perfusion (EVLP) offers a strategy to expand the donor pool and improve recovery of marginal or extended criteria donors, including donation after circulatory death.[3] This is primarily achieved through extended assessment as EVLP allows for prolonged functional and molecular assessment of the allograft for more confidence in a marginal allograft, and rehabilitation through rounds of therapeutic bronchoscopy, exogenous surfactant administration, and clearing of toxic metabolites with extended perfusion.[4] While bilateral lung EVLP is well described, left single-lung EVLP after donation after circulatory death is novel, and herein we describe our experience with it.

Our recipient is a 70-year-old woman who has a history of hypertension, hyperlipidemia, and idiopathic pulmonary fibrosis on 4 L of home oxygen, who was listed for single-lung transplantation with a lung allocation score of 38.3. She was admitted from home after a suitable organ became available for transplantation. Our donor was a 49-year-old man who was admitted to a hospital with catastrophic, nontraumatic intracranial hemorrhage. The donor never required inotropic support or chest compressions. The vertical height of the left lung of the donor and the left lung of our recipient was within 1.5 cm. Partial pressure of oxygen in the arterial blood over fraction of inspired oxygen was greater than 350. The right lung from the donor was allocated locally and we coordinated the procurement plan with the local team. Prior to extubation, a bronchoscopy demonstrated normal anatomy and a challenge gas was favorable.

The donor was extubated and was pronounced deceased within 13 minutes, a median sternotomy was performed, and procurement commenced in standard fashion. The lungs were placed en bloc onto ice on the back table and prepared for single-lung EVLP via the TransMedics Organ Care System (OCS) (Andover, MA)[5] (Figure 1A). The left atrium was divided between the left and right pulmonary veins, and the right pulmonary artery was divided at the bifurcation. The trachea was divided using two TA-30 staplers, one placed at the right mainstem bronchus proximal to the right upper lobe bronchus takeoff, approximately 1 cm distal to the carina, and the other obliquely along the carina (Figure 1B) to facilitate preservation of the trachea for OCS intubation. The right mainstem bronchus stump was oversewn, and the left lung was connected to OCS via the trachea. The pulmonary artery was secured to the cannula with a purse-string suture (Figure 2).

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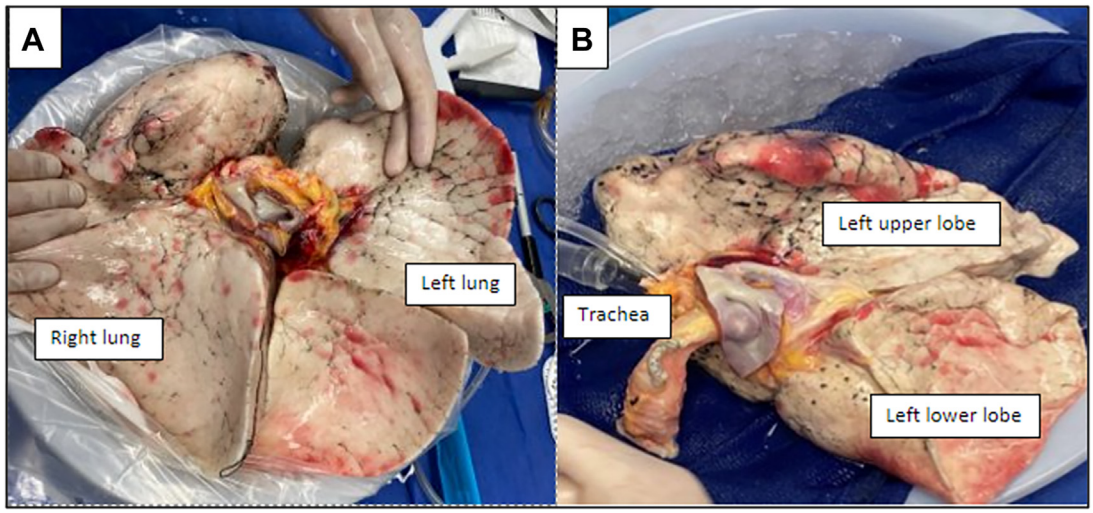

FIGURE 1 Left lung prepared for ex-vivo lung perfusion. (A) Demonstration of en bloc lungs prior to splitting. (B) Split left lung with preserved trachea, and right mainstem bronchus stump oversewn after removal of right lung.

This set up is shown in Video 1. Cold ischemic time from ice to EVLP was 82 minutes.

The lung was transported to the recipient operating room while maintaining a peak end-expiratory pressure of 5 cm H_20, pump flow just under 1 L/min, tidal volume of 250 mL, and respiratory rate of 10 breaths per minute. Periodic arterial blood gases demonstrated partial pressure of oxygen in the arterial blood over fraction of inspired oxygen ratios greater than 350. Upon arrival, a bronchoscopy was performed (Video 2) and we proceeded with single-lung transplantation via left lateral thoracotomy, off

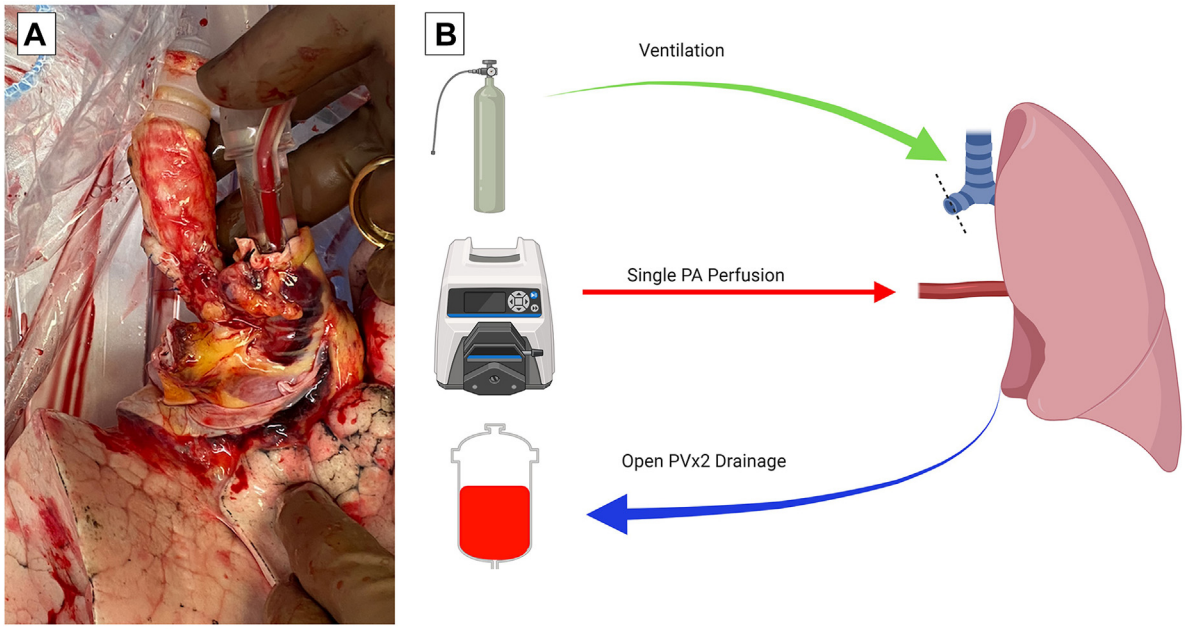

FIGURE 2 Single lung cannulated for ex-vivo lung perfusion (EVLP). (A) Final configuration of single-lung EVLP showing an intubated trachea with right mainstem stapled off, single pulmonary artery (PA) cannulation, and open venous drainage from 2 pulmonary veins (PVs). (B) Schematic demonstrating the setup of single-lung EVLP.

cardiopulmonary bypass. The donor left lung was disconnected from OCS, placed on ice, and flushed again with perfusate for a total EVLP time of 578 minutes. Implantation proceeded uneventfully, with a warm ischemic time of 49 minutes.

Postoperative bronchoscopy and blood gas were reassuring and the patient was taken to the intensive care unit for recovery, where she was extubated on postoperative day (POD) 0. She was transferred to the floor on POD2 and discharged home off oxygen on POD14 without complications. She had bronchoscopies on POD3, POD13, and postdischarge POD30, all of which showed an intact anastomosis and healthy mucosa.

COMMENT

We demonstrate a novel procurement strategy that preserved use of bilateral single lungs, while allowing us to perfuse a single lung on OCS. It is critical to ensure that the left mainstem bronchus is not stenosed when performing the oblique staple line for adequate ventilation on OCS, in a similar fashion to a carinal pneumonectomy. Right single-lung EVLP is also feasible, with fewer procurement considerations as typically division of the tracheobronchial tree occurs proximally on the left mainstem bronchus.[6]

Previously, Belli and colleagues[7] have shown use of a single lung for transplantation after bilateral lung en bloc perfusion with OCS, when one of the lungs deteriorated on transport. Our work offers a standardized approach for planned single left lung transplantation using EVLP.

Universally, EVLP involves perfusion and ventilation of the lungs.[4] Variation exists in the composition of the perfusate, and whether the left atrium is open or closed for drainage from the pulmonary veins into an open reservoir versus a cannula.[4] At our institution, we utilize OCS for bilateral lung EVLP, which involves open left atrial drainage. Notably, the modification we propose here can theoretically be applied to the conventional forms of EVLP and thus applicability is not limited by choice of EVLP platform.

Standardization of single-lung EVLP is an important step towards obviating the need for perfusing the block of bilateral lungs even when the contralateral lung is not planned for transplantation due to quality issues. This may avoid the putative risk of cytokine-mediated injury to the good lung from the injured contralateral lung, and may help improve organ recovery rate, increase single lung transplant utilization, and ultimately reduce waitlist mortality.[3]

The Videos can be viewed in the online version of this article [https://doi.org/10.1016/j.atssr.2024.07.025] on http://www.annalsthoracicsurgery.org.

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