

# Bridge to second double lung transplant with an extracorporeal carbon dioxide removal system in situs inversus patient

Masashi Furukawa<sup>1</sup>, Ernest Chan<sup>1</sup>, and Pablo Sanchez<sup>1</sup>

<sup>1</sup>University of Pittsburgh Department of Cardiothoracic Surgery

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## Abstract

We report a first case with the use of extracorporeal carbon dioxide removal system as a bridge to re-do lung transplant in complete situs inversus patient. A 29-year-old female with Kartagener syndrome and complete situs inversus underwent a double lung transplant for end stage lung disease. Within one year after transplant the patient had primarily hypercapnic respiratory failure with radiographic signs of chronic lung allograft dysfunction. To optimize her nutritional status and muscle strength before re-do lung transplantation, we decided to bridge her with an extracorporeal carbon dioxide removal system due to anatomical difficulty. She was listed and underwent an uneventful re-do double lung transplant with cardiopulmonary support.

## INTRODUCTION

The use of extracorporeal life support (ECLS) as a bridge to lung transplantation has increased over the last decade, however its use in re-do lung transplantation is limited due to poor outcomes<sup>1,2</sup>. Extracorporeal circulation with a single duo-lumen cannula provides the advantage of more comfortable mobilization particularly in patients in which we expect a longer bridge to transplant. The Hemolung Respiratory Assisted System (HRAS) (ALung Technologies, Pittsburgh PA) is a venous-venous extracorporeal carbon dioxide removal (ECCO<sub>2</sub>R) system that allows for effective removal of carbon dioxide via a small French double lumen catheter<sup>2,3</sup>.

In this report the decision to bridge our patient with an HRAS was based on primary hypercapnic respiratory failure and anatomical limitations due to her complete situs inversus.

## CASE PRESENTATION

A 29-year-old female with Kartagener syndrome and complete situs inversus underwent a double lung transplant for end stage lung disease. Her postoperative course was uneventful. Within 6 months of transplant, she experienced an aspiration event leading to a persistent decline in her lung function within the first year. She ultimately was hospitalized requiring mechanical ventilation and a tracheostomy. The patient had primarily hypercapnic respiratory failure with radiographic signs of chronic lung allograft dysfunction (bronchitis obliterans syndrome). At the time of admission, the patient ventilatory rate was 30 breaths/min and her arterial carbon dioxide tension (PaCO<sub>2</sub>) was 80 mmHg. Her increased respiratory work resulted in high calorie consumption with a significant impact on her body mass index (16.5 to 14.4 in 6 months). To optimize her nutritional status and muscle strength before re-do lung transplantation, we decided to bridge her with extracorporeal membrane oxygenation (ECMO). Initially, our intention was to use a dual-lumen cannula to facilitate mobility but due to her anatomy we decided that an Avalon or Crescent cannula was not suitable as the outflow jet will be directed against the atrial wall. We decided to proceed with the HRAS after emergency FDA authorization. A dual-lumen 15.5Fr catheter was placed via the left internal jugular vein into the superior vena cava (Figure 1A, 1B). After the initiation of ECCO<sub>2</sub>R, the patient's PaCO<sub>2</sub> improved

by adjusting sweep between 7-9 L/min resulting in a carbon dioxide (CO<sub>2</sub>) removal of 80-90 ml/min (Figure 2). We used bivalirudin for anticoagulation and targeted goal was activated partial thrombin time 45-60 s. Three days after placing the HRAS, she was listed for re-do double lung transplantation. As she waited for a viable donor offer, she was awake, able to get out of bed, stand up and actively participate in rehabilitation program. In addition, she stopped losing weight, her BMI plateau at 15 and her prealbumin at 20 mg/dl. Donor lungs became available 8 days after the initiation support. After induction of general anesthesia, the HRAS was removed after confirming that the patient was hemodynamically stable, and cardiopulmonary bypass was introduced when the donor lungs arrived in the operating room. She underwent an uneventful re-do double lung transplant. After transplantation, the patient developed an increased need for oxygen, potentially due to extensive volume and product resuscitation and ischemic reperfusion injury. We decided to put her on venous-venous ECMO (VV-ECMO). Her chest was left open due to coagulopathy for 3 days. We decannulated VV-ECMO on postoperative day 7. She was discharged 43 days after lung transplantation (Figure 1C).

## DISCUSSION

Lung transplantation in patients with Kartagener's syndrome and situs inversus challenges include: dextrocardia with discrepancies between donor and recipient vessels and airways<sup>4-7</sup>. In addition, the chest cavity mismatch between the donor right lung between and the recipient's dextrocardia can result in right lower lobe atelectasis and kinks of the pulmonary artery. In the present report we did not experience any anastomotic or postoperative challenges. We only preserved donor pulmonary arteries to remain long enough for anastomosis.

We previously reported a case of using HRAS to bridge re-do double lung transplant; transplant was performed 20 days after the induction of HRAS<sup>2</sup>. Bonnin et al. reported using HRAS for severe chronic obstructive pulmonary disease bridge to lung transplant; transplant was performed 31 days after induction of HRAS<sup>3</sup>. HRAS has also been reported to improve acidosis in acute respiratory failure from coronavirus disease 2019<sup>8</sup>.

Rajab et al. reported the use of VV-ECMO via a right internal jugular Avalon cannula as a bridge to heart and lung transplantation in a patient with dextrocardia<sup>9</sup>. In our patient this was not an option because her superior and inferior vena cava were on the left side and her tricuspid valve was facing right. We decided to proceed with the Hemolung because our patient mainly required CO<sub>2</sub> removal to reduce ventilatory need, reduce work of breathing and reduce calory consumption. In addition, the 15.5Fr was easy to place inside the right atrium via the left internal jugular vein.

This experience demonstrates that ECCO<sub>2</sub>R can be safely and effectively used to bridge lung transplant patients with hypercapnic respiratory failure in which anatomical challenges limit cannulation options. To our knowledge this may represent the first experience with the use of ECCO<sub>2</sub>R as a bridge to lung re-transplantation in a patient with complete situs inversus.

## References

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Figure 1, A: Hemolung, B: X-ray with Hemolung, C: X-ray at discharge

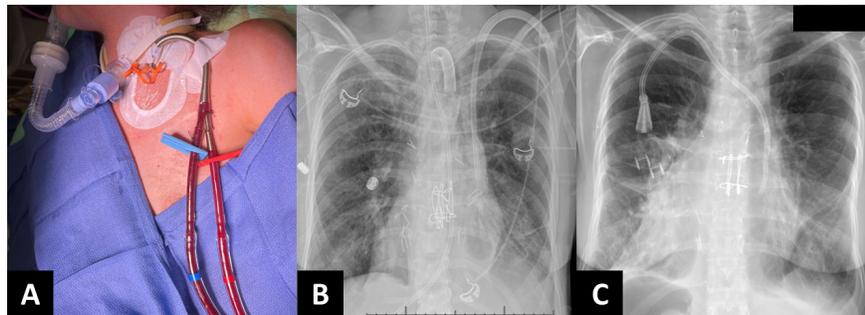


Figure 2:

Top: CO<sub>2</sub> removal and sweep gas flow during 8 days of Hemolung support.

Bottom: Patient's PaCO<sub>2</sub> during 8 days of Hemolung support.

