STUDYING HEMODYNAMIC SUPPORT DURING LUNG TRANSPLANTATION IN AN ANIMAL MODEL: DO WE NEED THE MECHANICAL PUMP?

Michaela Orlitová(1), Dieter Van Beersel(1), Anna E Frick(1), Kristof Van de Voorde (2), Karlien Degezelle(2), Joachim Hellinck(1), Melanie Nolmans(1), Xin Jin(3), Bart M Vanaudenaerde(3), Robin Vos(3), Dirk E Van Raemdonck(3), Laurens J Ceulemans(3), Piet Claus(1), Arne P Neyrinck (1), Tom Verbelen (1)

1. Department of Cardiovascular Sciences, KU Leuven, Leuven, Belgium; 2. Department of Cardiac Surgery, division perfusion, UZ Leuven, Leuven, Belgium; 3. Department of Chronic Diseases and Metabolism, Laboratory of Respiratory Diseases and Thoracic Surgery (BREATHE), KU Leuven, Leuven, Belgium

Introduction

The gold standard for intraoperative hemodynamic and respiratory support during sequential single-lung transplantation (SSLTx) is veno-arterial extracorporeal membrane oxygenation (VA-ECMO). It is used to prevent right ventricular (RV) failure and severe pulmonary ischemia-reperfusion injury (IRI). However, its use is not risk free: blood activation and trauma, cannulation complications, unclear association with incidence of severe primary graft dysfunction. We aimed to compare traditional VA-ECMO with a novel approach, using a pumpless artificial lung as a shunt between pulmonary artery (PA) and left atrium (LA), in our porcine model simulating hemodynamics of SSLTx.

Methods

The left lung (LL) hilum was clamped in situ for 3 hours (LL ischemia, 1H – 3H) and reperfused for 2 hours (4H – 5H). Consequently, the contralateral non-ischemic lung was clamped for 1 hour (6H), creating the hemodynamic and respiratory challenge. In the clamping group ([CLA], n=9), no extracorporeal life support (ECLS) was used. In the intervention groups an oxygenator (Hemovent GmbH, Aachen, Germany) was inserted between PA and LA ([PALA], n=7); or a centrally cannulated VA-ECMO was placed ([ECMO], n=7). ECLS was initiated when LL was clamped. Conductance catheter (CC) was placed in RV. We measured: CC data, mean PA pressure (mPAP), RV cardiac output (CO), ECLS circuit flow, LL wet-to-dry (W/D) ratio and LL computed tomography (CT)-measured density. One- or Two-way ANOVA were used.

Results

RV failure developed in 5/9 animals in [CLA], but not in [PALA] or [ECMO]. There was no difference in mPAP between groups. RVCO was higher at 6H in [PALA] and [ECMO] vs. [CLA] (fig. 1A; p=0.0001, p= 0.04, respectively). There was no difference between ECLS circuit flow between [PALA] and [ECMO] (fig. 1B; p=ns). RV stroke work decreased significantly in [CLA] at 6H compared to baseline, and was at 6H higher in [PALA] vs. [CLA] (fig. 1C p=<0.0001, p=0.0396, respectively). RV end-systolic elastance at 6H was higher in both [PALA] and [ECMO] compared to [CLA] (fig. 1D, p=0.033, p=<0.0001), and was higher in [ECMO] vs. [PALA] (p=0.0167). W/D ratio was lower in [PALA] vs. [ECMO] (fig. 1E, p= 0.0315), a same trend was observed in LL CT-density (fig.1F p=0.0631).

Discussion

Both PALA and ECMO prevented RV failure in our animal model. Pumpless PALA strategy is non-inferior to traditional ECMO configuration in providing sufficient hemodynamic support. Avoiding passage of blood cells through a extracorporeal pump and using a shorter extracorporeal circuit might even be protective towards lungs suffering from IRI, as reflected by our results. Further hemodynamic, tissue and molecular analyses should clarify this relationship.

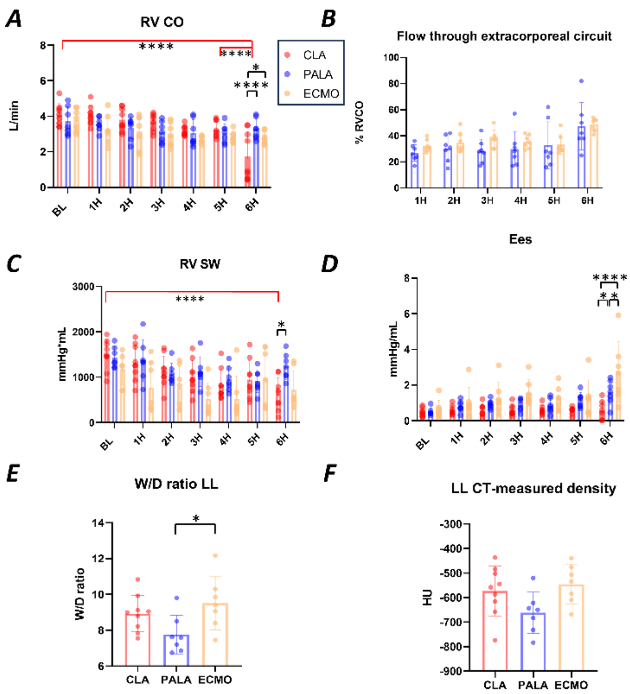

Figure 1: RV CO, right ventricular cardiac output; SW, stroke work; Ees, end systolic elastance; W/D wet-to-dry; LL, left lung; CT, computed tomography; HU, Hounsfield units