Extracorporeal membrane oxygenation in lung transplantation: No longer a four-letter word

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There is considerable variability in practice for the use of extracorporeal life support during lung transplantation (LTx). Extracorporeal life support options include off support, extracorporeal membrane oxygenation (ECMO), and cardiopulmonary bypass (CPB). It is estimated that as much as 50% of LTx worldwide uses CPB, and there has been a recent increase in the use of ECMO due to reports from experienced centers, including ours. The approach and strategy chosen could have significant implications for short-term and long-term outcomes for patients and further solidify data-driven management decisions in this important area.

The approaches to intraoperative support for LTx have advantages and disadvantages that generally include the following:

1. No support

Pro: No anticoagulation, minimal inflammatory cascade

Con: Requirement for single lung ventilation in a newly perfused lung

2. ECMO

Pro: Supports the oxygenation and ventilation needs of the patient, less anticoagulation needs, smaller circuit than CPB

Con: No cardiac decompression, potentially worse hemodynamics and visualization, no safety margin for air, no reservoir

3. CPB

Pro: Cardiac decompression for less hemodynamic stress, return blood to patient

Con: Greater anticoagulation needs, greater inflammation, greater lung edema potential

Literature to date has been conflicting in the outcomes related to the use of intraoperative support. Bittner and colleagues¹ evaluated CPB versus ECMO in a small cohort of patients and concluded that CPB should remain the standard

Standard approach for bilateral sequential LTx.

Central Message

Data are emerging to support the routine use of intraoperative and prophylactic postoperative ECMO for LTx.

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given the relatively increase in amount of blood transfusions. Ius and colleagues² presented follow-up data in a larger series showing an advantage toward ECMO with a clear survival benefit over CPB. Our own group evaluated CPB versus ECMO and found in its early experience that ECMO was associated with decreased rates of pulmonary and renal complications.³ Early outcomes were no different in our study. More recently, Machuca and colleagues⁴ evaluated the Toronto experience that matched 33 ECMO cases with 66 CPB cases and found that ECMO was feasible and safe. They noted that the ECMO group had less mechanical ventilation time, shortened intensive care unit and hospital stay, and less transfusion requirement than the CPB group. Others have noted that in some series the poorest outcomes in patients were seen when the surgical team converted from an off-pump approach to CPB in an unplanned fashion. This conversion can happen as much as one third of the time.⁵

In the article from experienced Austrians, the authors report their experience in a large retrospective cohort.⁶ In their analysis over 6 years, they demonstrated that the use of ECMO was associated with improved 1-, 3-, and 5-year survivals when compared with patients without ECMO who were propensity matched. Furthermore, their high-risk group had improved survival at all time points. There was no impact on the development of bronchiolitis obliterans syndrome. This raises the issue of an increasingly used concept in LTx, that of prophylactic postoperative ECMO in a subset of patients to improve their postoperative course and outcomes. Their data would suggest that patients

with pulmonary hypertension and those with questionable graft dysfunction would have improved outcomes with this approach. The study is further underscored by the group's 15-year experience with ECMO during LTx. We can also tell you from our personal experience that we are taking a similar approach with these patients using the open chest and ECMO support for a smoother postoperative course.

The authors do a nice job of describing their approach based on the "lessons learned." Like many of the larger institutions that have gravitated toward the use of intraoperative ECMO, we are all experiencing similar trends in approach to where preemptive ECMO has become the standard. If implantation is performed without support, the first implanted lung is exposed to the full cardiac output, which makes it more prone to damage in the setting of already impaired function. Controlled reperfusion has been shown to be beneficial in several early experimental studies, and the use of intraoperative ECMO is an extension of this philosophy. With intraoperative ECMO, the newly transplanted lungs are protected from the damage of early overflow. In addition, the use of ECMO affords improved intraoperative hemodynamic stability and thus avoids the acidosis and cycle thereafter when one tries to perform transplantation off support. The extension of ECMO support to the immediate postoperative setting as a bridge is also something that has gained recent enthusiasm.

The recent trend by several centers toward the use of intraoperative ECMO as a standard in LTx is supported by the work presented in this issue of the *Journal*. The timing is ripe for more in-depth investigation into the advantages and disadvantages of these options at the multi-institutional level, and recent efforts to establish an international multicenter registry are currently being initiated. The results of such efforts will afford significant improvements in understanding of the optimal intraoperative strategy for a defined patient.

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