Case report

Early experience with the Levitronix Centrimag® device for extra-corporeal membrane oxygenation following lung transplantation

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Abstract

Extra-corporeal membrane oxygenation (ECMO) is accepted as a salvage therapy to treat life-threatening complications following lung transplantation such as primary graft dysfunction, acute rejection or airway dehiscence. Levitronix Centrimag® (Levitronix LLC, Waltham, MA) is a centrifugal pump that consists of a magnetically levitated bearing-less rotor designed to reduce blood friction. ECMO using the Levitronix Centrimag® pump may be an ideal medium-term support for lung transplant recipients suffering these serious complications. We describe our early experience of using ECMO with Levitronix Centrimag® device and the Hilite hollow fibre membrane oxygenator (Medos Hilite® LT, Medos Medizintechnik AG) in three cases following lung transplantation. The device is technically easy to implant and manage with a low complication rate on minimal anticoagulation.

Keywords: Levitronix Centrimag®; Extra-corporeal membrane oxygenation; Lung transplantation

1. Introduction

Primary graft failure (PGF) and airway disruption are life-threatening complications following lung transplantation (LTx), accounting for about 30% of the early mortality [1]. Extra-corporeal membrane oxygenation (ECMO) may be necessary to provide lifesaving support when maximal conventional cardio-respiratory support strategies are inadequate [2].

The usual circuit for ECMO includes heparin-bonded tubing, a centrifugal pump and a hollow fibre membrane gas exchanger. It is established via a veno-arterial or a veno-venous route. Despite improvements in technology, use of ECMO is often associated with increased risk of complications including bleeding, thromboembolism, plasma leakage and infection [2,3].

With state-of-the art bearingless, magnetic levitation (maglev) rotor technology the Levitronix Centrimag® device appears appropriate for ECMO in this particular group of patients. It works with minimal shear trauma to blood cells, therefore reducing the risks of hemolysis and thrombus formation [4]. We have previously reported its use as a bridge to recovery in a lung transplant patient with bronchopleural fistula [5]. Here we extend our early experience with Levitronix Centrimag as ECMO in adult lung transplant recipients.

1.1. Case summaries

Table 1 describes a summary of cases where ECMO was successfully used after lung transplantation at our institution.

2. Discussion

ECMO is an established therapeutic option for severe primary graft failure (PGF), rejection or airway complications following LTx [2,6]. Our institutional criteria for using ECMO in these cases are inadequate gas exchange (PaO2 less than 8 kPa despite maximum ventilatory support) and/or hemodynamic instability.

A conventional ECMO device utilises centrifugal pump system (e.g., BioMedicus, Medtronic) connected to a membrane oxygenator. A suitable level of anticoagulation has to be maintained, which increases the risk of bleeding in this particular group of patients. Other reported complications include thromboembolism, hemolysis, renal failure, sepsis, or vascular complications [3].

The Levitronix Centrimag® device features bearing-less technology; the rotor is levitated into the housing by the
magnetic force generated by the motor, hence minimizing friction and improving hemocompatibility. The risk of thrombus formation is reduced by uniform unidirectional flow and less stagnation, while reduced shearing stress attenuates hemolysis [4]. A maximum flow of 9.99 l/min can be achieved at a maximum operating pressure of 600 mm Hg, a total priming volume of 452 ml (including the pump, oxygenator and tubing). It is currently used to provide mechanical circulatory support for potentially reversible cardiac failure [7]. We used this device along with the hollow fibre membrane oxygenator (Hilite LT, Medos Medizintechnik AG) equipped with a Rheoparin-coated, plasma tight membrane of polymethylpentene. This device is therefore ideal for medium term ECMO support in combination with Levitronix Centrimag®.

A conventional ECMO is established using heparin-bonded circuits to reduce the need for anticoagulation [6,8]. We used non-coated cannulae (Medtronic®) and connecting tubes (Centrimag®) with the Levitronix device. Our unit policy is not to commence anticoagulation for ECMO if established within the first 24 h after lung transplantation. Following this period, anticoagulation can be started if the patient is not bleeding and has normal clotting profile, to achieve an activated partial thromboplastin time ratio at 1.5—2.5 and an activated clotting time above 160 s. As shown in Table 1, we did not use anticoagulation in two of the three cases. Our second patient had bled profusely during and immediately after transplant due to intrapleural adhesions and deranged coagulation status. He later developed bronchopleural fistula that was treated surgically using Levitronix Centrimag® as a bridge to recovery [5]. The third case had profound coagulopathy due to multiple blood transfusions; hence no extra anticoagulation was administered. There was no evidence of clots in the pump head, tubings or cannulae when removed in all the three patients. We did not measure plasma free hemoglobin or haptoglobin to quantify hemolysis since Centrimag device is known to cause significantly lower rates of hemolysis compared to the conventional centrifugal pump [4]. In addition our third case was on hemofiltration due to renal impairment and therefore measurement of plasma free hemoglobin would have been inaccurate. The other surrogate markers of blood trauma including serum bilirubin and lactate dehydrogenase (LDH) remained in the normal range.

ECMO can be established in two ways: veno-arterial (VA) or veno-venous (VV), depending on the patient’s hemodynamic stability [6,8—10] (Table 2). Venoarterial cannulation can be intrathoracic or extrathoracic, via peripheral (internal jugular vein and femoral vein) or central (right atrium and aorta) routes. Venovenous cannulation is typically established through the femoral and the internal jugular veins. Cannulae are placed percutaneously using a modified Seldinger technique and transesophageal echocardiography to assess the position of the cannulae.

Weaning from VA ECMO involves reducing the flow gradually while monitoring the hemodynamics. An increase in anti-coagulation is recommended at the time of wean. Weaning from VV ECMO involves discontinuing membrane gas flow and increasing ventilatory parameters as needed. No increase in anticoagulation is required for VV ECMO weaning because the flow is maintained.
We did not experience any complications related to the Levitronix device in any of the patients. Our third case had developed catastrophic bleeding from the internal mammary artery 10 days post-transplant, with a period of profound hypotension. He developed renal failure, which was more likely a result of the hemodynamic instability, rather than a consequence of ECMO. He also developed prolonged paralytic ileus with severe abdominal distension and respiratory compromise that led to the adverse outcome. CT scan or the post mortem did not show any evidence of bowel ischemia.

We found that handling of the ECMO using Levitronix device was not very demanding. It was easily monitored by an ICU nurse, while a perfusionist was available on-site for 24 h to give advice.

Although it is difficult to draw firm conclusions from this small series, we have safely used Levitronix Centrimag device as ECMO following LTx with minimal or no anticoagulation. Larger studies are required to further elucidate the efficacy of this device and help draw guidelines regarding anticoagulation in this particular group of patients.

Acknowledgment

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References


Table 2

Summary of the published data for veno-arterial (VA) and veno-venous (VV) ECMO for primary graft failure following lung transplantation.

<table>
<thead>
<tr>
<th>Author</th>
<th>n</th>
<th>ECMO type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meyers et al. [2]</td>
<td>12</td>
<td>VA (4 peripheral, 8 central)</td>
<td>Significant complications rate (coagulopathy and multiple transfusions 83%, re-exploitation 58%, renal failure 58%, stroke 25%, and mortality 41.6%)</td>
</tr>
<tr>
<td>Oto et al. [3]</td>
<td>10</td>
<td>8 VA (80%), 2 VV (20%)</td>
<td>Improved survival in recent group (after 2000), no survivor in VV group (the first two patients)</td>
</tr>
<tr>
<td>Hartwig et al. [6]</td>
<td>23</td>
<td>15 VA (65%), 8 VV (35%)</td>
<td>Better survival and fewer complications in VV group.</td>
</tr>
<tr>
<td>Mason et al. [8]</td>
<td>22</td>
<td>12 VA (52%), 11 VV (48%)</td>
<td>No difference in complication rate and survival between VA and VV ECMO.</td>
</tr>
<tr>
<td>Zenati et al. [9]</td>
<td>8</td>
<td>5 VA (62.5%), 3 VV (37.5%)</td>
<td>VV ECMO is preferred if patient is hemodynamically stable and long term graft survival is anticipated</td>
</tr>
<tr>
<td>Glassman et al. [10]</td>
<td>17</td>
<td>13 VA (76.5%), 4 VV (23.5%)</td>
<td>Better survival in early (&lt;7 days of transplant) ECMO, no difference in VV versus VA ECMO</td>
</tr>
</tbody>
</table>

n: number of patients receiving ECMO, PGF: primary graft failure.