



Lung transplantation with extracorporeal membrane oxygenation as intraoperative support

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TO THE EDITOR:

Improvements in sequential bilateral lung transplantation techniques have made it possible to perform lung transplantation without the need for extracorporeal circulation (ECC). The use of ECC continues to be restricted to certain situations, such as hemodynamic instability, intolerance to single-lung ventilation, and pulmonary hypertension. ECC is associated with primary graft dysfunction and excessive bleeding due to the use of coagulation factors. Support devices, such as extracorporeal membrane oxygenation (ECMO), have been used not only in the treatment of primary graft dysfunction but also as a bridge to transplantation and, more recently, for intraoperative support.

We report the case of a 23-year-old male patient diagnosed with pulmonary fibrosis caused by chronic fibrosing interstitial pneumonia and secondary pulmonary hypertension, with a mean pulmonary artery pressure of 45 mmHg and resistance of 6.52 WU. The patient had grade 3-4 dyspnea, as determined with the modified Medical Research Council scale, under continuous oxygen therapy. He also presented leg edema, controlled after optimization of diuretic usage. The brain natriuretic peptide level was 538 pg/ml. His echocardiogram showed marked enlargement of the right heart chambers, right ventricular dysfunction, marked tricuspid insufficiency, and a pulmonary artery systolic pressure of 65 mmHg. He was on the waiting list for transplantation, presenting relevant increase in the cardiac silhouette and signs of right heart failure. Therefore, we recommended bilateral transplantation involving circulatory support with ECMO.

The patient was submitted to bilateral anterior transsternal thoracotomy (clamshell incision), together with opening of the pleural and pericardial cavities. We observed an increase in the cardiac silhouette, due to right heart chamber enlargement and marked dilatation of the right ventricle. We performed central cannulation, cannulating the aorta with a 20 Fr cannula and the right atrium with a two-stage 28 Fr cannula (Medtronic-Synectics, Skovlunde, Denmark), after which we set up an ECMO system (ECMO PLS System[®]; Maquet, Rastatt, Germany), maintaining a flow of 3 L and 2,630 pm. The patient had firm pleuropulmonary adhesions, mainly on the right, requiring decortication, which caused significant bleeding. We performed the conventional sequential transplantation technique, initially on the right, with an

ischemia time of 6 h on the right side, compared with 7 h and 40 min on the left. We also used a continuous autotransfusion system (C.A.T.S.[®]; Fresenius Medical Care, Bad Homburg, Germany), with recovery of 986 mL of packed red cells. Due to the coagulation disorder and right ventricular dysfunction, we opted to delay the closure, externalizing the cannulas and maintaining the central ECMO. An echocardiogram obtained on postoperative day (POD) 1 confirmed relevant dyskinesia of the right ventricle. The patient underwent a second operation, due to bleeding, on POD 2. On the basis of the activated coagulation time or the activated partial thromboplastin time, anticoagulation with unfractionated heparin was maintained. On POD 5, the ECMO flow was reduced to 1.5 L/30 min, with good hemodynamic impact, and thoracic closure. During the cardiopulmonary support the patient was maintained under sedation (with midazolam and fentanyl) and paralysis (with cisatracurium). On POD 10, an echocardiogram showed normal systolic function of the right ventricle. On POD 13, he was tracheostomized after two extubation failures, remaining in the ICU for 26 days, being decannulated and discharged on POD 48. During hospitalization, he presented no organ dysfunction other than the cardiac dysfunction, which prompted the maintenance of the ECMO. Immunosuppression followed institutional guidelines: use of basiliximab in anesthetic induction and on POD 4, along with corticosteroids, cyclosporine, and mycophenolate. The patient did not present any noteworthy pulmonary infection; during hospitalization, the most significant clinical complication was perforated acute abdomen on POD 20, leading to right colectomy and ileostomy, due to Ogilvie's syndrome. After the end of the ECMO, anticoagulation was maintained at a prophylactic dose. Figure 1 shows chest X-rays obtained preoperatively and at month 6 after transplantation, demonstrating significant cardiac remodeling.

In order to avoid system coagulation, the use of extracorporeal circulation requires total heparinization, with a higher usage of coagulation factors and leads to an inflammatory process due to the contact of the blood with the air and with the extracorporeal circuit. These factors increase the risk of bleeding and, consequently, the need for transfusion of blood products, which causes systemic inflammation. This inflammatory process is associated with the development of pulmonary edema and primary graft dysfunction.⁽¹⁾

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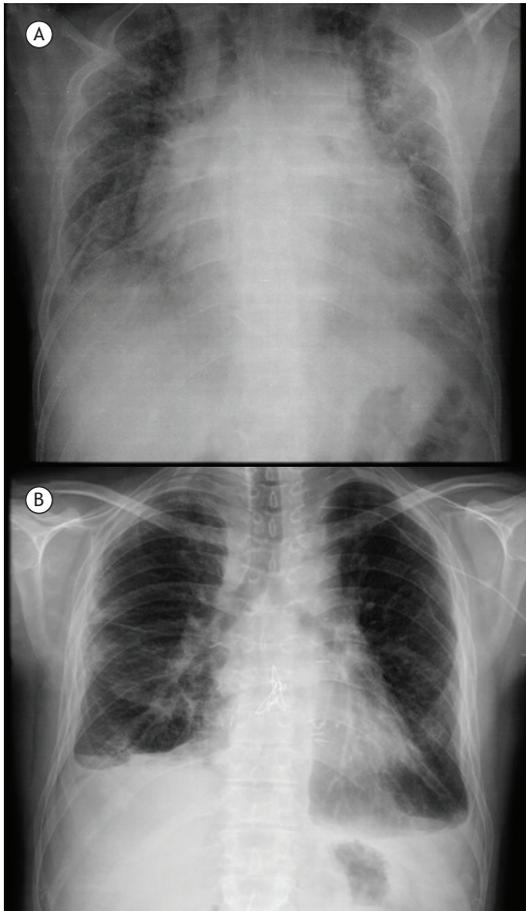


Figure 1. Chest X-rays: in the preoperative period (A); and six months after transplantation (B), showing significant cardiac remodeling.

Conventional polypropylene membrane oxygenators maintain good function for periods shorter than 3-4 hours; after which they start to show a loss of exchange function and plasma leakage, further impairing coagulation and inflammation. Bilateral transplantation can easily take longer than that, mainly in cases with firm pleuropulmonary adhesions. In such cases, the risk of bleeding due to pulmonary decortication increases the risk of the development of primary graft dysfunction and of postoperative mortality.⁽²⁾

The development of polymethylpentene membrane oxygenators radically changed the circulatory support setting, allowing the maintenance of the system for days, rather than hours. There is no doubt that the development of this polymer was the biggest change

in this technique in recent years.⁽³⁾ In conjunction with this technological development, the H1N1 influenza epidemic widened the use of ECMO as respiratory support in severe cases.

In lung transplantation, ECMO can be associated with either primary graft dysfunction treatment or as bridge to treatment in the pretransplantation period. Its use as circulatory support during surgical procedures was initially described for patients with peripheral pulmonary arterial hypertension, which might or might not persist after surgery. Peripheral cannulation was initially preferred because it provides a tube-free surgical field and facilitates exposure for the transplantation, with minor incisions.⁽⁴⁾ In lung transplantation, ECC with cardiotomy reservoir has the advantage of allowing faster management of the volume and blood aspiration of the cavity and its reinfusion, although its mandatory use is restricted to cases in which there is a need for the correction of heart defects or for myocardial revascularization. Because these concomitant procedures are rare, it is possible to replace ECC with ECMO in most of the cases in which support is required. Heparin-coated circuits and the possibility of controlling the reperfusion of a newly transplanted lung make the use of ECMO feasible and advantageous as intraoperative support.⁽⁵⁾

Recent studies comparing intraoperative circulatory support with ECMO and conventional ECC have shown that the former presents advantages, such as less need for transfusion of blood products, shorter time on mechanical ventilation, shorter ICU stays, and less primary graft dysfunction.⁽⁵⁻⁹⁾ Only Bittner et al.,⁽⁴⁾ in their comparative study, showed disadvantages of the use of ECMO, with higher mortality and more need for transfusion. In the only meta-analysis on this topic, Hoechter et al.⁽¹⁰⁾ did not note a decrease in the use of blood products, although there was a decrease in the length of ICU stays. However, the authors concluded that more studies on the subject were required.

To our knowledge, this is the first report of a case in which ECMO was used for intraoperative support during lung transplantation in Brazil, the ECMO being maintained in order to avoid primary graft dysfunction and to wait for myocardial remodeling. Although this was an isolated case, recently studies have shown advantages of using ECMO as support, mainly shorter ICU stays, lower rates of reoperation, less bleeding, and less need for blood transfusion. Therefore, the use of ECMO should be considered when there is a need for circulatory support during lung transplantation.

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