



Intraoperative support with venovenous extracorporeal membrane oxygenation for complex thoracic oncologic resection

Flávio Pola dos Reis¹, Andre Nathan Costa², Leticia Leone Lauricella¹, Ricardo Mingarini Terra¹, Paulo Manoel Pêgo-Fernandes¹

TO THE EDITOR:

When locally advanced lung carcinoma invades vital structures such as the heart, great vessels, and carina, it is often considered unresectable and therefore incurable. This is mainly due to the difficulty in the intraoperative management of the airways and intrathoracic vessels, given that, in some cases, conventional mechanical ventilation cannot maintain gas exchange.⁽¹⁾ In addition, in patients in whom the tumor is locally advanced, the surgical option can only be considered if resection is complete, with free surgical margins, that is, oncologically adequate.

Alternatively, the use of extracorporeal membrane oxygenation (ECMO)⁽²⁾ can be the solution in such cases. ECMO is a method that can provide blood oxygenation, remove carbon dioxide, and ensure circulatory support when there is severe hemodynamic instability, as well as enabling protective/ultraprotective mechanical ventilation.⁽³⁾

We report two cases in which venovenous (VV) ECMO was used for intraoperative respiratory support for resection of lung tumors with proximal airway involvement, because conventional respiratory support was a limitation to surgery.

A 38-year-old woman presented with a 2-year history of exertional dyspnea. Chest CT (Figure 1A) showed a 4-cm heterogeneous solid lesion in the right lower paratracheal region, with signs of invasion of the right main bronchus (RMB) and medial extension to the carina and the origin of the (contralateral) left main bronchus. Bronchoscopy (Figure 1B) showed an exophytic infiltrating lesion causing subtotal obstruction of the RMB, and pathological examination revealed an adenoid cystic carcinoma with a low mitotic index infiltrating the airway wall. Because of the location of the lesion, we decided to perform carinal resection with right upper lobectomy and bronchoplasty with implantation of the bronchus intermedius into the residual carina with the assistance of VV ECMO. The patient was maintained in apnea during resection and anastomosis, and the endotracheal tube was retracted to allow for better visualization of the surgical field. After the procedure, the patient was decannulated from ECMO and extubated in the operating room and was referred to the ICU, where she remained for 2 days. The patient was discharged on postoperative (PO) day 5.

A 49-year-old male former smoker sought medical attention because of bronchopneumonia. During treatment, chest CT showed a right perihilar mass. A transthoracic biopsy revealed squamous cell carcinoma,

positron emission tomography-CT (Figure 1C) confirmed the lesions, with no evidence of distant disease, and mediastinoscopy was negative. Because the lesion was centrally located, the proposed surgery consisted of right pneumonectomy with carinal resection and implantation of the left main bronchus into the trachea, since bronchoscopy (Figure 1D) revealed carinal involvement. For respiratory management, we decided to use VV ECMO and maintain apnea in both lungs with endotracheal tube retraction. During the operation, the tumor was found to invade the RMB, and we decided to perform a pneumonectomy, without the need for carinal resection. After surgery, the patient was decannulated from ECMO and extubated in the operating room. The patient was discharged from the ICU on PO day 2 and from the hospital on PO day 7 to outpatient adjuvant chemotherapy.

In both cases, VV ECMO was performed using the Seldinger technique, with an outflow cannula in the right common femoral vein and an inflow cannula in the right internal jugular vein (Figure 1E). The position of the cannulas was confirmed with transesophageal echocardiography during the operation. A centrifuge magnetic pump with a polymethylpentene oxygenation membrane (Rotaflow/Jostra Quadrox PLS; Maquet Cardiopulmonary AG, Hirrlinger, Germany) was used. Anticoagulation with heparin (1,000 UI) was used to achieve an activated clotting time of 180-200 s.

ECMO can be used in two configurations: VV and venoarterial (VA).⁽³⁾ In VV ECMO, blood is drained from a vein, enters the ECMO circuit, and is returned through another vein. This configuration provides only respiratory support, providing blood oxygenation and carbon dioxide removal (Figure 1E). In complex surgical cases, VV ECMO allows adequate gas exchange independently of mechanical ventilation. In contrast, in VA ECMO, blood is drained from a vein, enters the ECMO circuit, and is returned through an artery, which combines cardiocirculatory support with the gas exchange function. In cases in which there is a risk of severe hemodynamic instability or in patients with pulmonary arterial hypertension, VA ECMO is an option for intraoperative management. VA ECMO can be performed via either the peripheral or central route, the latter by cannulating the heart base vessels, similarly to cardiopulmonary bypass (CPB).⁽¹⁾

Intraoperative ECMO has proved useful also in cases of severe respiratory involvement, such as in patients who have previously undergone pneumonectomy and have an indication for resection of the remaining lung or in

1. Divisão de Cirurgia Torácica, Instituto do Coração, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo, São Paulo (SP) Brasil.
2. Divisão de Pneumologia, Instituto do Coração, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo, São Paulo (SP) Brasil.

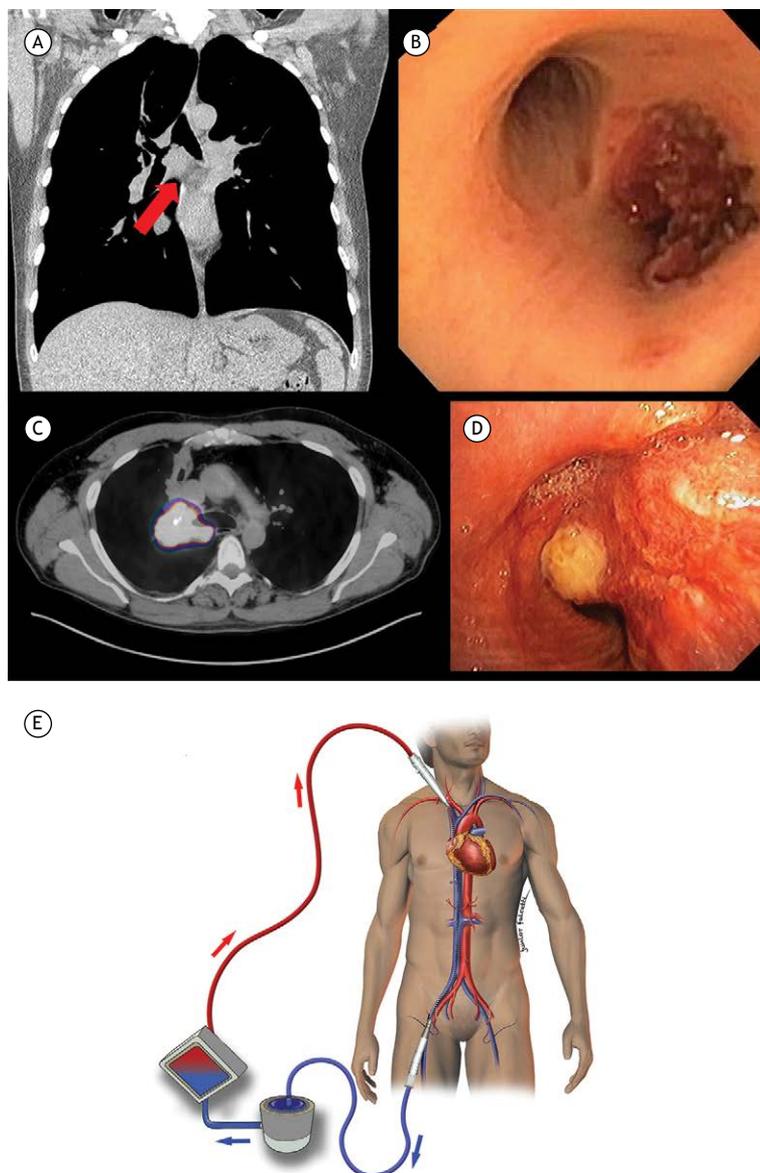


Figure 1. In A, chest CT showing a centrally located tumor with carinal involvement (arrow). In B, bronchoscopy showing the carina and tumor. In C, positron emission tomography of the chest showing a centrally located tumor with carinal involvement. In D, bronchoscopy showing the right main bronchus at the level of the carina and carinal involvement. In E, schematic illustration of venovenous extracorporeal membrane oxygenation with an outflow cannula in the right common femoral vein and an inflow cannula in the right internal jugular vein.

patients who cannot tolerate intraoperative one-lung ventilation because of lung disease, such as severe COPD or advanced interstitial lung disease with low DLCO.⁽⁴⁾

One of the advantages of intraoperative ECMO over CPB is that, because it is a heparin-coated closed circuit, lower doses of heparin are used or heparin could even be dispensed with if flows are greater than 3 L/min.⁽⁵⁾ In addition, in peripheral ECMO, the fact that the cannulas are not within the surgical field facilitates the surgical procedure, because they are not in the surgeon's field of view.⁽⁶⁾

A possible alternative to ECMO is mini-CPB, which consists of a closed-circuit cardiocirculatory support

system that results in a lower inflammatory response and requires a lower priming volume (volume of solution within the circuit) than does conventional CPB. However, the cannulas are not heparin coated such as those of ECMO, and, therefore, anticoagulation should be similar to that of conventional CPB; in addition, the oxygenation membrane lasts 6 h and can be used only during the operation.⁽⁷⁾ Another use of ECMO in airway surgery has been described in complex therapeutic endoscopic procedures and in congenital stenosis in children.^(8,9) Because children's airways are small, minimal edema can lead to airway impairment. The use of ECMO in the postoperative period makes it possible to maintain clinical stability until the edema

is reduced and bronchoscopy is performed, with no impairment of gas exchange.⁽¹⁰⁾

The most commonly described complications of ECMO are thrombosis, bleeding at the site of cannula insertion, blood flow limitation, and infection. However, these complications are related to the timing of ECMO initiation.⁽¹¹⁾

Despite initial concern, there is no evidence of tumor dissemination due to the use of ECMO, just as there is

no evidence of tumor dissemination due to the use of CPB.⁽¹⁾ Therefore, in extensive oncologic lung resection or in oncologic lung resection with severe involvement of central airways, VV ECMO, when available, has proved to be a safe option for ensuring patient oxygenation and ventilation, allowing airway manipulation and turning some complex cases that are difficult to resect into potentially curable cases.

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