

Venovenous Extracorporeal Membrane Oxygenation to Facilitate Removal of Endobronchial Tumors

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Short-term extracorporeal membrane oxygenation is a useful adjunct to thoracic procedures. We report the cases of 2 middle-aged men who were supported with venovenous extracorporeal membrane oxygenation to facilitate tumor debulking and recanalization of the carina and mainstem bronchi. Neither patient had major complications or adverse events. These cases suggest that short-term extracorporeal membrane oxygenation is safe in patients undergoing complex resection or debulking of endobronchial lesions. (Tex Heart Inst J 2021;48(3):e197111)

Citation:

Miles B, Durham LA, Kurman J, Joyce LD, Johnstone DW, Joyce D, Pearson PJ. Venovenous extracorporeal membrane oxygenation to facilitate removal of endobronchial tumors. *Tex Heart Inst J* 2021;48(3):e197111. doi: 10.14503/THIJ-19-7111

Key words:

Cytoreduction surgical procedures; extracorporeal membrane oxygenation; lung neoplasms

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Case Reports

Patient 1

A 52-year-old man presented at another hospital with hemoptysis and respiratory failure that necessitated intubation, after which he was transferred immediately to our facility. His medical history included hemophilia A and hepatitis C. A computed tomogram showed a right suprahilar mass, consistent with neoplasm, that was completely obstructing the right mainstem bronchus and had possibly invaded the mediastinum (Fig. 1).

Bronchoscopic examination revealed upper airway edema and complete occlusion of the right mainstem bronchus. The obstructive bronchial clot was suctioned, but a solid mass that was also found in the bronchus could not be removed with conventional endobronchial techniques.

Eleven days after admission, venovenous ECMO was initiated through a double-lumen 27F crescent venovenous cannula placed percutaneously through the right internal jugular vein. Optimal cannulation of the retrohepatic vena cava was confirmed by fluoroscopy and transesophageal echocardiography. Anticoagulation was achieved with heparin, adjusted to maintain an activated clotting time of 160 to 200 seconds. The ECMO flow rate (4 L/min) had no adverse effect on the patient's systemic blood pressure or the maintenance of arterial oxygen saturation levels at >90%.

During ECMO support, the tumor within the right mainstem bronchus and bronchus intermedius was successfully debulked, thus reopening the airway to the right lung. The patient was weaned from ECMO after a total support time of 4 hours,

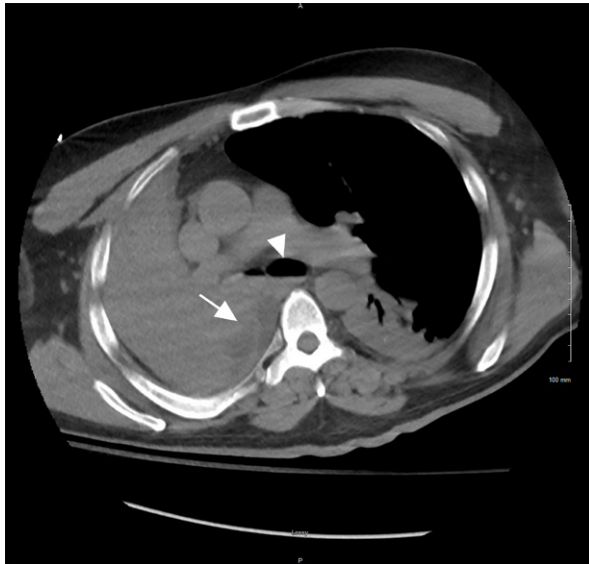


Fig. 1 Patient 1. Computed tomogram (axial view) shows a right suprahilar mass (arrow), consistent with neoplasm, completely obstructing the right mainstem bronchus and possibly invading the mediastinum. The arrowhead points to the carina.



Fig. 2 Patient 2. Computed tomogram (axial view) shows a soft tissue mass (arrow) at the carina, completely obstructing the take-off of the right mainstem bronchus and causing lung hyperinflation. The mass also partially obstructs the left mainstem bronchus.

and the venovenous cannula was removed immediately thereafter to reduce the risk of reexpansion injury. The patient's estimated blood loss was 150 mL. Pathologic examination of a specimen from the debulked tumor revealed a poorly differentiated stage IIB non-small cell lung carcinoma (T2aN1). Because the tumor resection was considered a rescue from respiratory distress and not curative, no tumor margin specimens were collected intraoperatively.

The patient was extubated on postoperative day 7 and discharged from the hospital the next day; his total length of stay was 19 days. He subsequently underwent adjuvant chemoradiation therapy with carboplatin and paclitaxel, followed by durvalumab. He had no immediate or long-term neurologic sequelae and, at last follow-up, was still undergoing chemotherapy.

Patient 2

A 66-year-old man, a former smoker, presented at our emergency department with dyspnea after several failed courses of antibiotic and steroid therapy for presumed pneumonia and COPD exacerbation. He was admitted to the medical intensive care unit with respiratory failure. A computed tomogram of the chest revealed a large endotracheal mass at the carina. The mass completely obstructed the right mainstem bronchus and partially obstructed the takeoff of the left mainstem bronchus (Fig. 2).

The patient's condition rapidly deteriorated over the next 3 days, despite 2 sessions of emergency external-beam radiation therapy, so urgent peripheral venovenous ECMO was initiated. A 25F QuickDraw femoral venous cannula (Edwards Lifesciences) was inserted

percutaneously and advanced, under fluoroscopic and transesophageal echocardiographic guidance, into the right atrium. The contralateral femoral vein was cannulated with a shorter 19F arterial cannula. The ECMO circuit drew desaturated blood from the shorter cannula in the iliac vein and returned oxygenated blood to the longer cannula in the right atrium, where it was pumped through the pulmonary circulation to the systemic circulation by the normally functioning right side of the heart. A suture-mediated closure device (Perclose ProGlide; Abbott Vascular) was placed so that the veins could be percutaneously secured at the end of the procedure. Anticoagulation was achieved with heparin, adjusted to maintain an activated clotting time of 200 to 230 seconds. The ECMO flow rate (3.5 L/min) had no adverse effect on the patient's systemic blood pressure and resulted in an arterial oxygen saturation level of 89%.

Bronchoscopic examination revealed a large mass in the distal trachea that almost completely obstructed the left and right mainstem bronchi. Purulent secretions pooled in the distal airways. The mass was debulked by means of rigid bronchoscopy. The patient was weaned from ECMO in the operating room after a total support time of 5 hours. His estimated blood loss was 100 mL. Pathologic examination of a specimen from the mass revealed invasive, moderately differentiated squamous cell carcinoma. Because the tumor resection was considered a rescue from respiratory distress and not curative, no tumor margin specimens were collected intraoperatively.

The patient was extubated while in the operating room and was discharged from the hospital on postoperative day 8. He subsequently underwent adjuvant

chemoradiation therapy with cisplatin. At 3-month follow-up, bronchoscopy with brushing and biopsy revealed inflamed bronchial mucosa, fibrinous exudate, and detached atypical squamous cells, but no malignancy. The patient had no immediate or long-term sequelae and, at follow-up one year after discharge, remained disease free.

Discussion

Without venovenous ECMO, removing the endobronchial tumors in our 2 cases would have required much more invasive cardiopulmonary bypass. Venovenous ECMO enabled apneic ventilation, lung deflation, and instrumentation of the tracheobronchial tree. In the treatment of endobronchial lesions, however, the risks and benefits of ventilation and bronchoscopic exposure must be considered. Intermittent apneic ventilation strategies are ultimately limited by gas exchange. Bronchial blockage permits selective lobar ventilation but may create excessive alveolar pressure and may not allow adequate oxygenation in all cases.¹⁰

Although risky, ECMO is safer than cardiopulmonary bypass. This is particularly true of venovenous ECMO, in which the primary aim is oxygenation and carbon dioxide removal. Nevertheless, complications may arise. Vascular and cardiac injuries can occur during cannulation, but more often when access is arterial rather than venous.¹¹ Bleeding may occur in response to increased anticoagulation.¹² Of note, our patient who had hemophilia A did not bleed excessively during tumor debulking. Antifibrinolytic agents, such as tranexamic acid, may be useful for suppressing fibrinolysis associated with longer-term ECMO.¹³ They were not needed in our 2 cases, however, because the periods of ECMO support were so short.

Paradoxically, ECMO-supported patients are at increased risk for thrombosis caused by activation of the clotting cascade from the blood-circuit interface.¹⁴ This is typically addressed by systemic anticoagulation with unfractionated heparin; however, based on anecdotal reports of bivalirudin use during ECMO, an open-label, randomized study is being conducted to compare anticoagulation with unfractionated heparin with that of bivalirudin in ECMO-supported adults.¹⁵

In conclusion, our 2 cases add to the literature on the adjunctive use of ECMO during thoracic procedures and suggest that ECMO may facilitate complex and otherwise prohibitive life-saving procedures in patients with endobronchial lesions.

Published: 9 July 2021

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