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CORRESPONDENCE

Carinal resection using an airway exchange catheter-assisted venovenous ECMO technique

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To the Editor,

Airway management during tracheal resection is one of the great challenges confronting anesthesiologists, especially when carinal resection is involved. When ventilation through the mainstem bronchi is not an option due to surgical exposure, extracorporeal oxygenation techniques become a vital tool. Venovenous extracorporeal membrane oxygenation (VV-ECMO) is a preferred mode of assuring adequate oxygenation in patients with normal right ventricular function. However, its oxygenation efficacy is lower than either cardiopulmonary bypass (CPB) or venoarterial ECMO (VA-ECMO).[1] We describe herein a case where an airway exchange catheter (AEC) was effective in assisting oxygenation during carinal resection with VV-ECMO.

A 52-yr-old male presented with hoarseness, chronic cough, and hemoptysis. Flexible bronchoscopy revealed a squamous cell carcinoma located in the distal trachea just proximal to the carina and occluding about 50% of the tracheal lumen. The patient's medical history was significant for hypertension, gastroesophageal reflux disease, and lumbar disc displacement. Preoperative pulmonary function tests showed a reduced FEV1/FVC ratio compatible with mild airflow obstruction, normal diffusion capacity, and normal measured lung volumes. Mediastinoscopy and distal tracheal and carinal resection with primary anastomosis were planned. In the operating room, after thoracic epidural catheter placement, general anesthesia was induced slowly with titration of sodium thiopental while the patient maintained spontaneous respiration. Once an adequate level of anesthesia was obtained using additional volatile anesthetic, a single-lumen endotracheal intubation was performed under direct laryngoscopy. Pancuronium was administered after adequate ventilation had been confirmed. Traditional lung isolation techniques were not an option due to the presence of the mass lesion at the carina and both main stem bronchi. Thus, the VV-ECMO was planned to assure adequate gas exchange during surgery. While the patient was in the supine position, mediastinoscopy was performed, followed by VV-ECMO cannula placement. The VV-ECMO was instituted via femoral and right internal jugular venous access with a flow rate of 3 $L \cdot min^{-1}$. In order to assure proper cannula positioning to avoid recirculation phenomenon, the surgical team measured the location of the cannula tips from the insertion site. The patient was then repositioned into the left lateral decubitus position. The trachea and carina were dissected via the extended right thoracotomy incision. After the surgeon obtained adequate exposure to the trachea and carina, ventilation was stopped and VV-ECMO was initiated. With the VV-ECMO, the oxygen saturation persisted close to 80% (Table). At this point, a decision was made to insufflate supplemental oxygen to the patient's lungs. With its flexibility and small size, a 14 Fr 100-cm soft-tip Cook Airway Exchange Catheter® (Cook Medical, Bloomington, IN, USA) was inserted via the endotracheal tube into the right bronchus with a 6 $L \cdot min^{-1}$ oxygen insufflation through its lumen (Figure). We decided not to use a bronchial blocker due to the increased resistance to the gas flow and the possibility of lung overinflation from gas entrapment with the inflated balloon. Upon the completion of the right bronchial anastomosis,

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Table Arterial blood gas values during pre-ECMO initiation, post-ECMO initiation, and post-ECMO with O_2 insufflation

	Pre-ECMO initiation	Post-ECMO initiation	Post-ECMO with O_2 insufflation
pH	7.35	7.34	7.38
pCO_2 (mmHg)	40.8	43.8	37.3
pO_2 (mmHg)	293	74.9	102
Base excess	−2.9	−1.7	−2.2
SaO_2 (%)	97.2	92.0	96.0

ECMO = extracorporeal membrane oxygenation; SaO_2 = arterial oxygen saturation

the AEC was then redirected into the left bronchus under direct surgical visualization. With the combination of two techniques, the oxygen saturation was improved to 100% with PaO_2 102 mmHg. After completion of anastomoses, the AEC was removed, ventilation was resumed with a standard endotracheal tube, and the patient was weaned from ECMO. The total surgery time was six hours. The patient's trachea was extubated in the operating room without complication.

When an extracorporeal oxygenation circuit is needed during tracheal-carinal resection, VV-ECMO is a viable option for patients with normal right ventricular function.[2] Venovenous ECMO has several benefits over VA-ECMO, including a lower risk for arterial embolism, avoidance of differential upper body hypoxia, and a lower risk of limb ischemia.[1,3] Venovenous ECMO usually provides only 85-95% SpO_2 because of recirculation and direct bronchial venous drainage into the left atrium.[1,2] Without compromising the surgical exposure, oxygen insufflation through the AEC effectively improved oxygenation by decreasing intrapulmonary shunting. In addition, we were able to avoid potential complications (e.g., air embolism, arterial injury, and increased systemic inflammatory response) from VA-ECMO or from cardiopulmonary bypass.[3] Nevertheless, pulmonary barotrauma is a potential risk of this technique, especially if jet ventilation is performed through the AEC.[4] Another limitation is the inability to use this technique in patients who have parenchymal lung disease. If the hypoxia had not been resolved with this technique, a small microlaryngeal tube could have been inserted into the main bronchus to provide one-lung ventilation. Cardiopulmonary bypass or VA-ECMO via femoral vessel cannulation could have been utilized as a primary or rescue method to provide gas exchange. However, femoral arterial cannulation is associated with potential complications, such as retrograde femoral arterial dissection and lower limb ischemia. Thus, neither VA-ECMO nor CPB was our first choice in this patient. Regardless of the gas exchange technique, close communication between the thoracic surgeon and the anesthesiologist is essential. In summary, we show an effective, alternative to improving oxygenation during tracheal-carinal resection utilizing VV-ECMO.

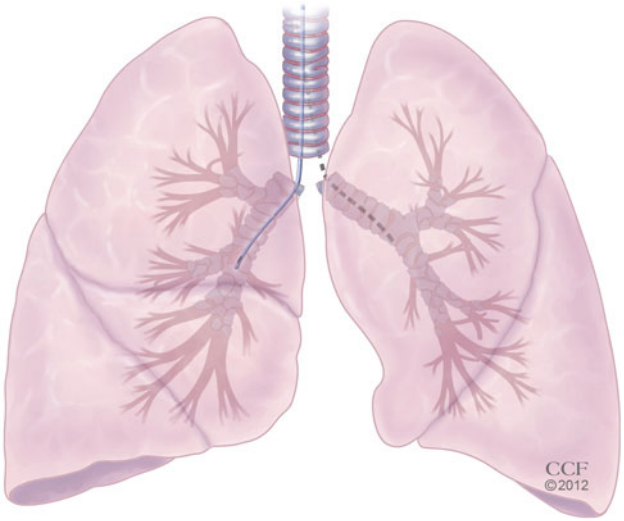

Figure Position of the airway exchange catheter, dotted line shows repositioning into the opposite bronchus. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2012. All Rights Reserved

Competing interests None declared.

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