CASE REPORT

Harnessing the Potential of ECMO: A Game-changer for Tracheal Stenting

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Abstract

The use of extracorporeal membrane oxygenation (ECMO) can be beneficial when conventional ventilation methods are unsuccessful. Here, we successfully managed a patient with advanced tracheal malignancy and impending airway obstruction by implementing venovenous ECMO (VV-ECMO) before performing a critical endotracheal procedure. The VV-ECMO was securely established through the right jugular vein and the left femoral vein, under local anesthesia. The placement of a tracheal stent was then performed under the guidance of a rigid bronchoscope and fluoroscopy. Extracorporeal membrane oxygenation effectively maintained adequate oxygenation and ventilation. Venovenous extracorporeal membrane oxygenation serves as a valuable tool in supporting airway interventions for complex tracheal pathologies, especially when conventional ventilation may not be sufficient or feasible.

Keywords: Awake extracorporeal membrane oxygenation, Case report, Respiratory failure, Tracheal stenting, Venovenous extracorporeal membrane oxygenation.

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Key Points

The application of venovenous extracorporeal membrane oxygenation (VV-ECMO) represents a cutting-edge approach to treating individuals with severe and complicated airway problems.

This approach offers the most effective ventilatory support in situations where conventional methods are not feasible.

By utilizing ECMO, patients can undergo complex airway interventions in a safe environment, with acceptable rates of complications.

We suggest taking into account the preoperative initiation of ECMO in particular high-risk patients who may face the potential of disastrous airway obstruction during airway procedures, particularly in cases of high-grade tracheal stenosis where complete airway obstruction is a potential worry.

Introduction

Extracorporeal life support is utilized to treat patients with refractory cardiac and/or respiratory failure when conventional treatments have been ineffective. Venovenous extracorporeal membrane oxygenation is a life-saving technique that offers ventilatory support to patients with severe hypoxia and/or hypercapnia. It has demonstrated its effectiveness in several other situations, including severe upper central airway obstruction.

This case study highlights the successful management of advanced tracheal malignancy with the use of pre-emptive VV-ECMO to avoid impending airway obstruction during critical endotracheal procedures.

Case Description

A woman, aged 56, was admitted to the hospital's intensive care unit. She had a known case of carcinoma of the left lung (T4N2M0) that was diagnosed 4 months ago and was receiving palliative chemotherapy. The patient experienced gradually worsening shortness of breath, blood-stained sputum, and stridor, beginning two weeks prior to the presentation.

She exhibited tachypnea and stridor at rest during the presentation. The patient displayed tachycardia with a heart rate of 130 beats per minute, accompanied by labored breathing. The physical examination revealed inspiratory stridor and decreased breath sounds in the right hemithorax. X-ray/CT chest and bronchoscopy showed extrinsic compression of both the left and right main bronchi along with the distal trachea with near complete opacification of the right hemithorax due to collapse/consolidation (Fig. 1). Arterial blood gas (ABG) results indicated severe hypoxia and mild hypercapnia. Electrocardiogram (ECG) and 2D echocardiography suggested ACS-STEMI involving the LAD territory with an ejection fraction of 40%. A multidisciplinary team meeting was held, and therein it was planned that the patient would undergo tracheobronchial stenting after cardiac evaluation for ACS. The intensivists who participated in the meeting expressed their belief that the utilization of standard airway management techniques during the endotracheal procedure would carry a considerable level of risk, citing low tracheal stenosis and involvement of both main bronchi. The patient had a poor cardiopulmonary reserve. Initiation of VV-ECMO prior to coronary angiography was considered, but the

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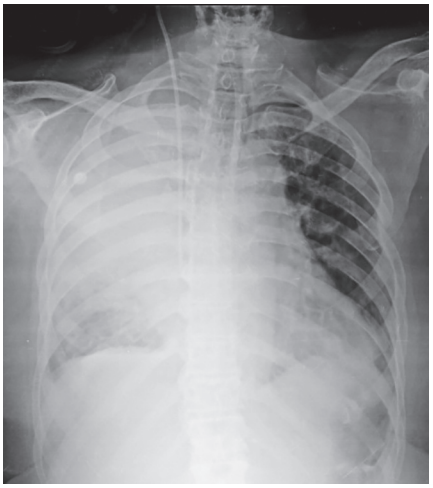

Fig. 1: Pre-ECMO cannulation

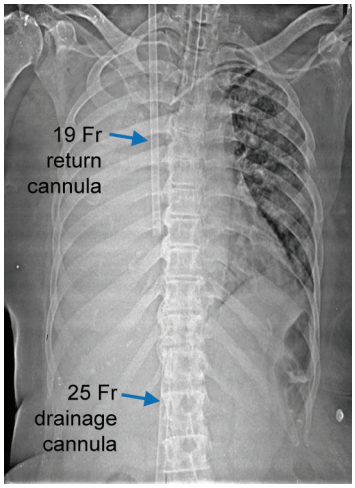

Fig. 2: Upper arrow showing 19Fr return cannula, lower arrow showing 25 Fr venous cannula

family's opinion was to defer tracheal stenting in case of significant coronary artery disease.

The patient was electively intubated and underwent coronary angiography, which showed normal coronaries. It was then decided to initiate VV-ECMO to assist with tracheobronchial stenting and mitigate intraprocedure hypoxia. Venovenous ECMO was initiated by percutaneously placing a 19 French return cannula in the right internal jugular vein and a 25 French multistage drainage cannula in the right femoral vein. This procedure was performed under ultrasound guidance (Fig. 2). At the time of cannulation, a dosage of 5000 IU of heparin was administered, and a heparin drip was initiated at a rate of 10 units per kilogram per hour. The following protocol was implemented to achieve a target A.C.T. of approximately 160–180s through heparin infusion.

ACT (i-STAT Kaolin) Titration

ACT (seconds)	*Bolus units/kg*	*Action*
≥20 below range	15	Increase heparin infusion by 4 units/kg/hr
6–19 below range		Increase heparin infusion by 4 units/kg/hr
1–5 below range		No change
Within ordered range		No change
1–5 above range		No change
6–40 above range		Decrease heparin infusion rate by 2–4 units/kg/hr
>40 above range		Decrease heparin infusion rate by 6 units/kg/hr and notify MD

The rota flow ECMO system was employed for the initiation of ECMO. The ECMO clinical settings remained stable throughout, with flows of 4 lpm delivered at an RPM set at 2850/min, venous pressure recorded at –32 mm Hg, and SvO_2 maintained at 56%. After ECMO insertion, the patient's pH was 7.43, $PaCO_2$ was 33, PaO_2 was 226, and lactate was 2.1 with FiO_2 of 0.3 PEEP of 6, and PS of 12 cm/s. The procedure was uneventful, and after instituting ECMO, her dyspnea significantly reduced. 16 hours after initiation of ECMO patient was extubated and was safely shifted to the interventional pulmonology room. Anticoagulation was stopped 6 hours prior to initiation of

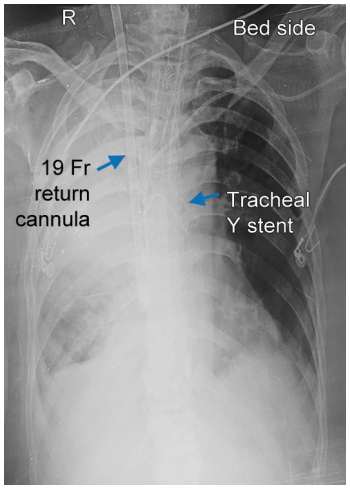

Fig. 3: Left arrow showing 19Fr return cannula, right arrow showing tracheal Y stent

tracheal stenting. During the heparin-free run, the membrane lung and the pump head were visually monitored for any new clots along with monitoring of delta P for new onset membrane lung dysfunction. A combination of flexible and rigid bronchoscopy was used during the procedure. BF-MP190F flexible bronchoscope was used for surveillance before and after stent placement. Karl Storz rigid bronchoscopes were used for deploying the stent under fluoroscopic guidance. BF-XT190 was used for clearance of airways before stent deployment. JAVASTENT® Tracheal covered Y-Stent stent (40 mm × 12 mm) was placed using a 14 rigid bronchoscope for Y-stent placement (Fig. 3). In the course of the Y-stent placement procedure, the patient's oxygenation was exclusively supported by VV-ECMO. Anesthesia was administered exclusively for the purpose of providing patient comfort during airway manipulation. Extracorporeal life support (ECLS) allowed for stable oxygenation of the patient, enabling the tracheal procedure to be performed. Propofol and fentanyl were utilized for the induction of general anesthesia, followed by maintenance through a propofol infusion. Bleeding during the procedure was controlled using a cryoprobe. The patient was intubated poststenting as the pulmonologist said he needed a conduit for bronchoscopy as she requires repeated

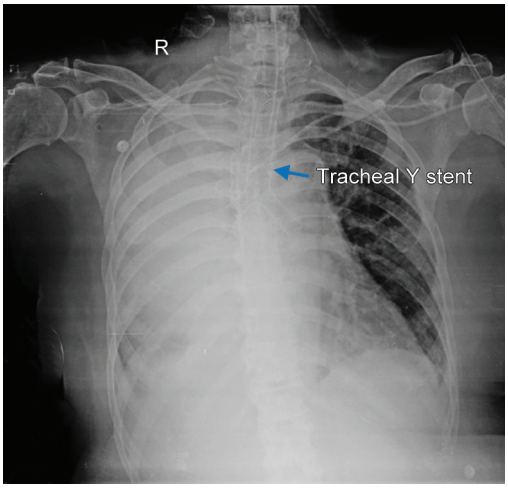

Fig. 4: Arrow showing tracheal Y stent

therapeutic airway suctioning poststenting because of purulent tracheal secretions.

Following the procedure, the patient remained hemodynamically stable and required minimal oxygen support, leading to the swift weaning and removal of VV-ECMO the next day (Fig. 4).

Discussion

In our case, ECMO insertion was preemptively performed before the clinical worsening of the patient, both ventilatory and hemodynamically in view of ACS. Furthermore, it was performed preemptively in anticipation of ventilation difficulties that may arise during stent placement.

Deployment of VV-ECMO should be considered prior to the induction of anesthesia in patients with severe airway obstruction and where the advancement of a rigid bronchoscope into the distal airway or ventilation through a rigid bronchoscope is anticipated to be technically difficult.[1]

In 1986, Hicks reported the first use of pre-emptive ECMO in patients with impossible airways.[2] With the rising number of individuals suffering from lung cancer and tracheal malignancies, there is a corresponding increase in the probability of occurrence and the risk of central airway obstruction, particularly among the elderly population. Thus, the potential indication for preventive use of ECMO in such a situation will also increase.[3]

Hong et al. preemptively initiated VV-ECMO in 18 cases to facilitate ventilation in severe airway obstruction.[4] According to Kim et al., it is recommended that pre-emptive ECMO support be made available if the tracheal lumen measures less than 5 mm on a computed tomography scan prior to any airway procedures.[5] Park et al. examined the use of VV-ECMO for tracheal stent placement.[6] Of 17 patients, 13 had an endotracheal tube placed prior to ECMO. Additionally, its usage is becoming more prevalent in cases that involve complex tracheal surgeries, including carinal resection and reconstruction, or the resection of tracheal tumors spanning long segments.[7]

The utilization of ECMO also provides enhanced visualization of the surgical site in comparison to conventional ventilation techniques such as maintenance of spontaneous ventilation, intermittent positive pressure ventilation via the side port of rigid bronchoscope, and low-frequency or high-frequency jet ventilation.[8]

Extracorporeal membrane oxygenation serves the dual purpose of preventing perioperative mortality during the induction of general anesthesia in complex airways and improving intraoperative stability and safety. However, it does not come without inherent complications. The most common complication is bleeding secondary to the use of anticoagulation and the presence of coagulopathy, resulting from prolonged exposure of the blood to the foreign external circuit.

However, we recommend that the preemptive utilization of VV-ECMO in an awake patient who is breathing spontaneously is potentially a safer course of action compared to deploying ECMO after inducing anesthesia in patients with benign diseases. The continuous stability provided by intraoperative ECMO can provide clinicians more time to maneuver the stent into the optimal location in these difficult patients, resulting in fewer procedural problems.[6] Initiation of VV-ECMO in a stage IV lung cancer for respiratory failure would be considered as an absolute contraindication under conventional standards of care but it can still be considered as an adjunct for assisting other palliative therapies aimed at reducing discomfort. However, if the therapeutic procedure fails, weaning ECMO would present an ethical and moral dilemma for the parties concerned. The use of ECMO as a "bridge to nowhere" for these patients can be detrimental, as it prolongs their pain and raises the chances of complications such as neurological catastrophe or exsanguination. This can be distressing for patients, families, and medical personnel.

While discussing the possibility of a time-limited trial as part of the informed consent process can help prepare for the withdrawal of ECMO in case a patient cannot be successfully weaned off it, this pursuit poses a challenge. Informed consent discussions for ECMO are typically brief, and even if patients have previously agreed to a time-limited trial, they retain the right to change their decision at any point during ECMO treatment.[9] If this situation arises, medical professionals should respect the preferences of patients to the best of their capabilities. Furthermore, there is apprehension that patients might feel pressured, either directly or indirectly, to agree to a clinician's suggestion of a time-limited trial. This pressure could stem from the belief that agreeing to the trial is essential in order to receive potentially life-extending care with ECMO.

We believe that it is of utmost importance to prudently select appropriate cases for treatment through multidisciplinary discussions involving interventional pulmonologists, surgical oncologists, ECMO specialists, intensivists, and anesthesia teams. It is crucial to take into account variables including the suitability, affordability, availability, and expertise of ECMO services in order to maximize results in these circumstances. Moreover, we recommend maintaining a database of relevant ECMO cases for future reference. Despite the benefits of ECMO in our patient's treatment, most cases of malignant central airway obstruction can be effectively treated without it and hence ECMO should not be seen as the sole strategy for managing malignant central airway obstruction.

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