CASE REPORT

Venovenous Extracorporeal Membrane Oxygenation Elective Therapy Time to Rethink: A Case Report and Review of Literature

Vinod Kumar Singh[1], Saurabh Taneja[2], Sanjeev Mittal[3], Pranshuta Sabharwal[4], Brijendra Kumar Rao[5]

Received on: 27 January 2023; *Accepted on:* 16 February 2023; *Published on:* 09 March 2023

Abstract

Acute airway obstruction poses a therapeutic challenge to treating physicians. There can situations where one is unable to secure the airway along with complete airway obstruction. In such conditions, ECMO can be considered as one of method that can protect from hypoxic damage simultaneously by giving time for adequate surgical access to airway. We present a case of complete airway obstruction where time for adequate surgical access was provided by use of VV-ECMO without any hypoxic damage.

Keywords: Acute airway obstruction, Difficult airway, Extracorporeal membrane oxygenation, Tracheostomy.

Indian Journal of ECMO (2023): 10.5005/jaypee-journals-11011-0005

Introduction

Acute airway obstruction can be life-threatening condition, which requires emergent airway access. Management of a difficult airway is a critical element of emergency practice. Difficulty can be in form of difficult intubation, supraglottic device placement, or surgical access. Tumors causing extrinsic airway compression, especially of the trachea pose a therapeutic challenge. Airway management of such patients needs the development of a strategy keeping in mind the relevant anatomy as well as the physiology of such patients. There are situations though not very frequently encountered, where one is unable to secure the airway along with complete airway obstruction. Such situations are nightmares for the physicians as they can be fatal. Extracorporeal membrane oxygenation (ECMO) can be an answer to such desperate situations by providing time window till adequate surgical access can be obtained. We describe a case of life-threatening, malignant tracheal obstruction managed successfully with ECMO rescue. The objective of reporting this case is to highlight the importance of ECMO in acute airway emergencies where other measures of securing airway might fail.

Case Report

A 48-year-old male underwent radical surgery followed by local radiotherapy for squamous cell carcinoma of the right buccal mucosa in 2012. He had a local recurrence in June 2015 and underwent right commando resection with free fibula graft surgery with a tracheostomy. He was decannulated one month after the surgery. Five months later, follow-up positron emission tomography–computed tomography (PET–CT) scan revealed a recurrence of the disease for which he was started on palliative chemotherapy. After three cycles of chemotherapy, he started having difficulty in breathing and presented to our emergency with severe respiratory distress. His pulse rate was 204/minute; blood pressure was 144/66 mm Hg; respiratory rate was 45/minute, oxygen saturation was 85–86% on O_2 by high flow Venturi mask. On auscultation, bilateral air entry was reduced in intensity with wheezing. He was managed with non-invasive mask ventilation, nebulized with bronchodilators, intravenous steroids, and antibiotics.

Computed tomography scan of the neck revealed tracheal obstruction due to tumor recurrence at the tracheostomy site with a vertical length of 2 cm and over 90% luminal compromise (Figs 1 and 2). The patient was admitted to the intensive care unit (ICU). He needed immediate relief from obstruction. Both distorted anatomy and a very small tracheal lumen were predictors of anticipated difficulties with bag–mask ventilation, supraglottic airway placement and tracheal intubation. Therefore, all these were dismissed as viable options. Cricothyroidotomy and cervical tracheostomy were not possible due to tumor recurrence with severe tracheal obstruction at the previous tracheostomy site. Mediastinal tracheostomy needed general anesthesia, which was not possible. Rigid bronchoscopy to core out the tumor, was not possible as his neck could not be extended due to recurrence and previous radiotherapy. Fiberoptic bronchoscopic debulking of the tumor to relieve tracheal obstruction was considered an option. However, the same could have led to complete obstruction and choking during the procedure, and the absence of any surgical access to the trachea in the neck would have led to immediate arrest due to hypoxia. To avoid this eventuality and provide

[1–5]Department of Critical Care Medicine, Sir Ganga Ram Hospital, Delhi, India

Corresponding Author: Vinod Kumar Singh, Department of Critical Care Medicine, Sir Ganga Ram Hospital, Delhi, India, Phone: +91 9810301011, e-mail: vinodksingh66@yahoo.co.in

How to cite this article: Singh VK, Taneja S, Mittal S, *et al*. Venovenous Extracorporeal Membrane Oxygenation Elective Therapy Time to Rethink: A Case Report and Review of Literature. Indian J ECMO 2023;1(1):25–28.

Source of support: Nil

Conflict of interest: None

Fig. 1: The CT scan of sagittal section showing near a complete tracheal obstruction

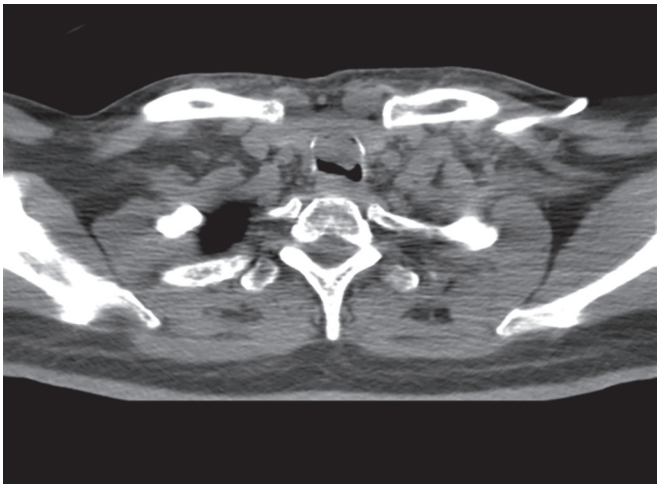

Fig. 2: The CT scan showing the low location of the tumor in the trachea at the level of the suprasternal notch

Fig. 3: V.V. ECMO Canulation

sufficient time for to pulmonologist to debulking, we planned the procedure to be done under venovenous (VV) ECMO support (Fig. 3).

Bedside bifemoral VV ECMO was instituted immediately. The ECMO team cannulated the right femoral vein with a 23-Fr catheter and the left femoral vein with a 20-Fr catheter (Edward) under local anesthesia. Quadrox PLS oxygenator with RotaFlow was used. An unfractionated heparin bolus of 5,000 IU was given at the time of cannulation without the requirement of additional heparinization. Oxygen saturation of 98% was achieved with a blood flow rate of 3 L/minute, FiO_2 of 1.0, and sweep gas flow of 3.0 L/ minute. Once ECMO flow was established, the patient was deeply sedated with intravenous fentanyl and midazolam.

After initiating ECMO, a bronchoscopy was done *via* the nasal route. Oropharyngeal and vocal cord anatomy were completely distorted. The tumor was visualized 2 cm away from the vocal cords almost completely occluding the tracheal lumen. Access to the bronchoscope was convoluted and it was very difficult due to the distorted anatomy of the epiglottis, vocal cords, and pharynx. As a result of which neither the electrocautery nor the cryoprobe could be passed through the channel of the bronchoscope. During the procedure, despite ECMO support he started desaturating and developed hypotension. The ECMO flow was increased, and ionotropic support was started, with which he stabilized. The decision for low tracheotomy was made as the procedure of bronchoscopic debulking could not be successfully performed, while continuing to maintain his oxygenation on ECMO. At this stage, he received vecuronium along with sedation and analgesia.

An incision was given below the previous tracheostomy site, the strap muscles were quickly separated in the midline to reach up to the trachea, and quick blunt (finger) dissection was done anterior and lateral to trachea in a retrosternal manner (as we do while performing cervical mediastinoscopy), which allowed trachea below the previous tracheostomy site to be pulled up. With the left index finger on the trachea as a guide, a wide tracheotomy was done, and a No. 7 endotracheal tube was passed into the trachea distally under finger guidance to establish ventilation. The patient now could be easily ventilated, and the endotracheal tube was later changed with a 7.5-Fr tracheostomy tube using Cook's airway bougie. The position of the tracheostomy tube was confirmed by bronchoscopy and adequate suctioning was done.

The ECMO support was removed after one hour and the inotropes and ventilator were weaned off over the next 4 hours. The patient was spontaneously breathing on oxygen mask, and was comfortable with a respiratory rate of 20/minute 4 hours after the procedure. He was continued on intravenous antibiotics, corticosteroids, and aggressive chest physiotherapy. One week later, he was discharged in a comfortable condition for further chemotherapy. The patient survived the entire procedure only due to the oxygenation provided by venovenous ECMO, which provided the time window to perform a difficult emergency tracheostomy.

Discussion

Establishing a secure and patent airway is the most important goal in the management of acute airway obstruction. Total tracheal obstruction represents a therapeutic challenge for physicians, experienced anesthesiologists, and thoracic surgeons.

Patients with critical airway disease present with a range of airway pathology, including tracheal tumors (31%), tracheal stenosis (20%), and head and neck cancers (20%).[1] Successful use of ECMO for the management of airway obstruction was first reported in

Table 1: Reported literature experience on the use of VV ECMO in acute tracheal obstruction

Authors	*Year*	*Age (years)*	*Obstruction*	*Obstruction site*	*ECMO mode*	*ECMO duration*	*Definitive procedure*	*Result*
Higashi et al.[5]	1989	17	Saw dust	Trachea, bronchi	VV	1.5 days	Fiberoptic bronchoscopy	Survived
Rosa et al.[7]	1996	51	Thyroid lymphoma	Upper trachea	VA	Operative case	Tracheostomy, resection	Survived
Shiraishi et al.[8]	1997	3	Fibrosarcoma	Distal trachea	VA	Operative case	Surgery	Survived
Bond et al.[9]	1998	19	Mediastinal tumor	Distal trachea	VA	2 days	Chemotherapy, radiotherapy	Survived
Belmont et al.[10]	1998	73	Thyroid Lymphoma	Supraglottic	VA	Operative case	Tracheostomy	Survived
Chao et al.[11]	2006	21	Mediastinal tumor	Distal trachea	VV	3 days	Chemotherapy	Survived
Hong et al.[6]	2013	19	Malignant tumors	Tracheal obstruction	VV	20.9 hours		Survived
Tian et al.[12]	2017	65	Tracheal tumor	Trachea, Bronchus	VV	2.2 hours	Surgery	Survived
Tian et al.[12]	2017	60	Tracheal tumor	Trachea	VV	1.61 hours	Surgery	Survived
Malpas et al.[1]	2019	77	Papillary thyroid carcinoma	Glottis	VA	Not known	Surgery	Survived
Jeong et al.[13]	2019	67	Intrathoracic goiter	Trachea	VV	4.55 hours	Surgery	Survived

1999 by Onozawa et al. in adults.[2] The cause of airway obstruction was due to thyroid carcinoma. Since then, ECMO has been utilized for variety of surgical procedures involving the respiratory tract for different purposes such as intubation to provide gas exchange and hemodynamic support during stenting and tracheotomy. Patients with upper tracheal tumors, obstructing tracheal lesions, and inappropriate intubation attempts may not result in successful oxygenation and ventilation and may result in cardiopulmonary arrest. Furthermore, ECMO is an excellent tool to maintain oxygenation in critical situations and provide a time window to secure access to the airway.

Moreover, "ECMO or extracorporeal life support (ECLS)" provides both cardiac and respiratory supports enabling an adequate amount of gas exchange. There are several forms of ECMO, the most common are the venoarterial (VA) and VV. In both modalities, blood drained from the venous system is oxygenated outside the body. In VA ECMO, this blood is returned to the arterial system and in VV ECMO the blood is returned to the venous system. Furthermore, ECMO provides time for intrinsic recovery of the lungs as well as of the heart while a standard cardiopulmonary bypass will provide support during various types of cardiac surgical procedures. Extracorporeal Life Support Organization (ELSO) publishes the guidelines describing the indications and practice of ECMO. Clinical situations that may prompt the initiation of ECMO include hypoxemic or hypercapnic respiratory failure, refractory cardiogenic shock, cardiac arrest, failure to wean from cardiopulmonary bypass after cardiac surgery, and as a bridge to either heart or lung transplantation or placement of a device. There is emerging evidence for the use of ECMO in these clinical settings. The conventional ventilatory support vs ECMO for severe adult respiratory failure (CESAR) trial reported the use of VV ECMO in adults with severe acute respiratory distress syndrome.[3] A recent case series have provided evidence for use of ECMO in cardiopulmonary resuscitation (CPR).[4] The application of ECMO in the management of life-threatening airway obstruction has been limited. Higashi et al. were the first to report the use of ECMO in the management of acute tracheal obstruction in 1989.[5] Since then, there have been case reports and a recent case series of 19 patients by Hong et al. using VV ECMO for managing central airway obstruction.[6] (Table 1).

When endotracheal intubation is deemed too risky, ECMO can be used for gas exchange as seen in our case.

Major reason limiting the use of ECMO in cases of acute, life-threatening airway obstruction is the time required for initiation. In centers where ECMO is not being routinely used, the decision to initiation time is minimum of 1–2 hours and the patient with life-threatening compromised airway may not survive this time without severe hypoxia and brain injury. The severity and the exact duration of hypoxia that can be tolerated without neurological injury varies considerably among various individuals. The efforts should be to somehow maintain ventilation and oxygenation as far as possible while the ECMO is being set up, as was the case with our patient.

Conclusion

Today, VV ECMO is an effective method of oxygenation in cases of life-threatening acute airway obstruction where conventional methods of airway access are not immediately possible without completely jeopardizing the airway. It provides that critical time window, with the patient adequately oxygenated, to be able to plan and secure airway access, as we did in our case successfully.

The application of ECMO for advanced cancer patients is debatable. However, Invasive intervention as a life-saving measure provides only a chance to get definitive and palliative treatment for such patients.

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