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CASE REPORT

Artificial Lung / ECMO

Venovenous extracorporeal membrane oxygenation for the management of critical airway stenosis

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Abstract
Venovenous extracorporeal membrane oxygenation (VV-ECMO) is used not only support gas transfer of patients suffering from respiratory failure, but also to manage hypoxic patients with critical airway obstruction during various procedures. We present a case in which we electively used VV-ECMO to facilitate tube placement and tracheal biopsy in a 67-year-old female with critical tracheal stenosis. The patient was transferred to our hospital for a surgical treatment after emergent tracheostomy for postoperative management of cerebral hemorrhage in right putamen. Her trachea was severely stenotic and just enough for a 5.5 mm tracheostomy tube. Removal of tracheostomy tube, tracheal wall biopsy and intra-tracheal tube placement were successfully performed under VV-ECMO support, drainage from inferior vena cava returned into the right ventricle (RV). RV perfusion was a very useful and effective method in VV-ECMO system, although some careful wire management was needed under fluoroscopic guidance.

Keywords VV-ECMO · Critical airway stenosis

Introduction

The development of extracorporeal membrane oxygenation (ECMO) technology allows a new approach for the intensive care management of acute cardiac and/or respiratory failure in adult and congenital patients who are not responsive to conventional treatment [1]. Venovenous ECMO (VV-ECMO) can provide quite complete respiratory support, even if this highly complex technique presents substantial risks, such as bleeding, thromboembolic events and infection [2]. For complex surgical cases and in patients with near total occlusion of the airways, ECMO is reported to be a good and safe option to support a patient's respiratory function during the surgery [3]. ECMO for respiratory failure in adults is usually managed with VV configuration, i.e., blood from right atrium (RA) or superior vena cava (SVC) and inferior vena cava (IVC) and returned into the RA [4].

We present a case in which we electively used VV-ECMO to facilitate safe intubation and tracheal biopsy in a 67-year-old female with severe tracheal stenosis.

Case report

The 67-year-old female was emergently transferred to the previous hospital for sudden left hemiplegia. Her brain CT scan showed cerebral hemorrhage in right putamen. Emergent removal of hemorrhage was performed. Her respiratory status gradually worsened at first postoperative day, and, intubation management tried to fail in spite of some efforts. Emergent tracheostomy was done because of worsened respiratory status, and subcutaneous and mediastinal emphysema suddenly appeared after tracheostomy. She was transferred to our hospital for the surgical correction under ECMO support. Her CT showed severe tracheal stenosis, just enough for a 5.5 mm tracheostomy tube (Fig. 1). Huge multiple renal and liver cysts existed in her abdomen, and her renal function was deteriorated because of her renal cysts. Her huge liver and kidneys compressed her thorax,

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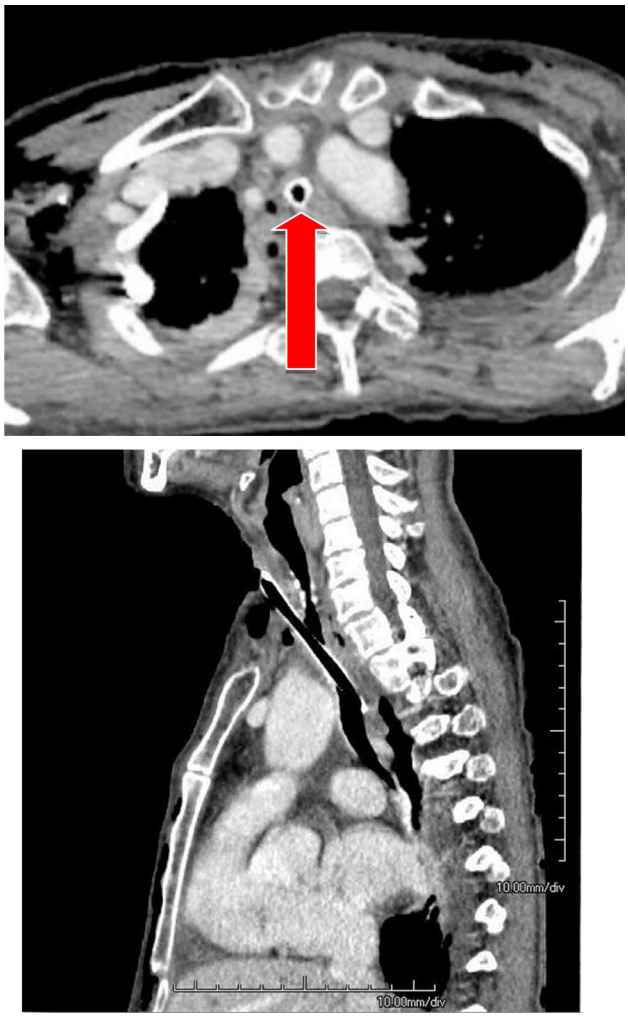

Fig. 1 CT showed severe tracheal stenosis and huge multiple liver and renal cysts. Her CT showed severe tracheal stenosis, just enough for a 5.5 mm tracheostomy tube

Fig. 2 CT showed huge multiple liver and renal cysts. Her CT showed huge multiple renal and liver cysts that compressed her thorax

which was worsened her respiratory status (Fig. 2). She was suspected to have congenital tracheal stenosis which complicated the other disease.

We planned to remove the tracheostomy tube and perform a biopsy of trachea wall for correct diagnosis, then place an intubation tube under VV-ECMO support.

After systemic heparinization with 5000 units of heparin, a long flexible 21-French venous cannula, BE-PVL 2155 (Maquet, Solna, Sweden) was inserted over the stiff wire to IVC through right femoral vein and used as a outflow cannula; the inflow cannula was 17 French in size, BE-PAL 1723 (Maquet, Solna, Sweden) and was inserted in the right jugular vein. Its tip was placed in the RA. We could not get efficient oxygenation with this system. (PaO_2 was 41 mmHg.) Therefore, this flexible 17 French cannula was introduced to right ventricle (RV) over the Radiofocus guide wire® (Terumo Medical, NJ, USA) 0.035 in. × 180 cm was inserted into the pulmonary artery and used as the outflow cannula. We could get 2.0 L/min. of VV-ECMO flow and PaO_2 was 113 mmHg. Pump rotation was 1700 rpm, and O_2 flow was 2 L/min, 70%.

We removed the tracheostomy tube and did a biopsy, and kept 6 mm intubation tube in her trachea under VV-ECMO. We needed a total of 81 min for these maneuvers and respiratory arrest. Pathology findings showed bronchial tissue with inflammation, and no malignancy. Re-tracheostomy with superior approach was done at 14th postoperative day, and Dumon® stent was implanted at 51th postoperative day. She was transferred to previous hospital for rehabilitation on 99th postoperative day. She has been followed by outpatient clinic.

Discussion

ECMO is typically used as a rescue strategy for patients with respiratory and/or cardiovascular failure. ECMO sustains life following acute lung failure, allowing enough time for diagnosis, treatment, and recovery [1, 2]. ECMO can provide sufficient oxygenation during airway interventional procedures, regardless of patient positions and status [3].

Respiratory support to optimize oxygenation is an important issue during interventional procedures for critical airway obstruction. Various ventilation modes, including maintenance of spontaneous ventilation, intermittent positive pressure ventilation, and low- or high-frequency jet ventilation have been introduced [5, 6]. Both spontaneous ventilation and intermittent positive pressure ventilation via ventilator port were thought not to be feasible because of severe and complicated airway obstruction. VV-ECMO provides time to plan strategy and implement adequate treatment, thereby minimizing procedure-related complications, especially for high-risk patients.

Recirculation, a phenomenon in which reinjected oxygenation blood is withdrawn by the drainage venous cannula without passing through the systemic circulation, decreases the effectiveness of VV-ECMO. Fifteen centimeters between the two cannulae are usually required to decrease recirculation, while larger drainage cannula may allow for comparable blood flow rates at lower pump speeds with less negative venous pressure, possibly diminishing the amount of recirculation [7]. Recently, Avalon Elite (Maquet, Rastatt, Germany), which is bicaval dual lumen cannula, is reported to be useful for less recirculation and less infection rate in VV-ECMO [8]. We could not use it clinically because it is not available for insurance in Japan.

So, we changed outflow cannula position to get more useful oxygen blood flow in this system. Takayama et al. reported on eight patients who underwent percutaneous insertion of a right ventricular assist device with immediate improvement of hemodynamics of hemodynamic parameters [9]. Although we could not place an outflow cannula in pulmonary artery because of less flexibility of the cannula, we could get efficient pump flow enough to maintain whole body oxygenation without harmful complications. The development of flexible cannula may progress its difficulty and clinical outcomes.

In summary, RV perfusion was very a useful and effective method in VV-ECMO system, although some careful wire management was needed under fluoroscopic guidance.

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