Thoracic endovascular aortic repair under venovenous extracorporeal membrane oxygenation support in a patient with refractory pneumothorax

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Abstract

Intraoperative positive pressure ventilation may cause a pneumothorax in patients with pulmonary emphysema, resulting in intraoperative hypoxic events. Here we report a case of thoracic endovascular aortic repair (TEVAR) under venovenous extracorporeal membrane oxygenation (vvECMO) support. A 76-year-old man was diagnosed with a distal aortic arch aneurysm. He also had a pulmonary emphysema complicated with refractory pneumothorax. After endotracheal bronchial embolization, TEVAR was performed under general anesthesia with endotracheal intubation. To prevent intraoperative hypoxic events, vvECMO was employed during the stent-graft implantation. This technique may be useful for safely performing TEVAR in patients with pulmonary emphysema.

Keywords: thoracic endovascular aortic repair, extracorporeal membrane oxygenation, pulmonary emphysema, pneumothorax, endotracheal bronchial embolization

Introduction

Chronic obstructive pulmonary disease (COPD) may often become an impediment for performing open thoracic aortic surgery. Thoracic endovascular aortic repair (TEVAR) has recently become an alternative for the treatment of thoracic aortic aneurysm even in high-risk patients with COPD. Intraoperative positive pressure ventilation may cause an intraoperative pneumothorax in patients with pulmonary emphysema. However, general anesthesia combined with mechanical ventilation may be unavoidable in some cases, such as TEVAR via a transabdominal approach. Here we report the case of TEVAR for a distal aortic arch aneurysm in a patient with pulmonary emphysema complicated with refractory pneumothorax, which was performed under venovenous extracorporeal membrane oxygenation (vvECMO) support.

Case

A 76-year-old man was referred to our hospital for the treatment of a distal aortic arch aneurysm. He had been diagnosed with pulmonary emphysema and received home oxygen therapy (2 l/min). Chest radiography (Fig. 1a) and computed tomography (CT) (Fig. 2a, b) revealed that the patient had a left pneumothorax. Three-dimensional CT also demonstrated a 66-mm distal aortic arch aneurysm (Fig. 3a). Because TEVAR under general anesthesia with endotracheal intubation was planned, a bronchial embolization using endobronchial Watanabe spigots (EWS, Novatech SA, La Ciotat, France) was performed before aortic surgery. Chest radiography (Fig. 1b) and CT (Fig. 2c, d) after the EWS embolization demonstrated that there were no air leakages. Echocardiography demonstrated left ventricular ejection fraction of 69% and there were no valvular heart diseases.

After EWS embolization, TEVAR was performed under general anesthesia. Endotracheal mechanical ventilation was started with a pressure control (PC) of 10 cmH₂O, positive end-expiratory pressure of 4 cmH₂O, and respiratory rate (RR) of 10 breaths/min.

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To reduce the risk of hypoxic events due to possible intraoperative pneumothorax, vvECMO was established between the right subclavian and femoral veins. Heparin sodium (7000 U) was intravenously given as a bolus injection before vvECMO and activated clotting time was maintained at approximately 300 s. After the establishment of vvECMO, PC and RR were set at 8 cmH$_2$O and 4 breaths/min, respectively. The abdominal aorta as an access for TEVAR was exposed under a midline laparotomy because bilateral iliac arteries were severely calcified and accesses from these arteries would lead to vascular access–related complications. A sheath (24 Fr GORE DrySeal Sheath, W. L. Gore & Associates, Inc., AZ, USA) was inserted from the abdominal aorta. The first stent graft (GORE TAG Thoracic Endoprosthesis, 37 mm $\times$ 15 cm, W. L. Gore & Associates, Inc.) was deployed from the intra–aneurysmal distal arch to the descending thoracic aorta. The second stent graft (GORE TAG Thoracic Endoprosthesis, 40 mm $\times$ 15 cm) was deployed at just distal to the orifice of the left common carotid artery. After the closure of the laparotomy incision, the weaning of vvECMO and mechanical ventilation was uneventful. Heparin was neutralized by intravenous injection of protamine chloride after the operation. Postoperative CT revealed no endoleaks (Fig. 3b) and no recurrent pneumothorax.
Figure 3

a: Computed tomography demonstrated a distal aortic arch aneurysm (66 mm in diameter).

b: Three-dimensional computed tomography revealed that the aneurysm was completely excluded without endoleaks.

Discussion

Aortic aneurysm is a frequent complication in patients with COPD. Lower respiratory functions in these patients sometimes make it difficult to perform open surgery under general anesthesia with mechanical ventilation and may cause a ventilator discontinuation failure. On the other hand, TEVAR can be performed under regional (epidural and spinal) or local anesthesia even in such patients. However, general anesthesia with endotracheal intubation may be required in some cases of TEVAR. In patients with pulmonary emphysema, a tension pneumothorax is one of the most critical complications during positive pressure ventilation, which sometimes results in cardiac arrest. In addition, intraoperative pneumothorax is often overlooked until the incidence of hypoxic events. In the present case, because the patient had already been diagnosed with a left pneumothorax before the surgery, the risk of intraoperative pneumothorax appeared to be high. Therefore, EWS embolization was employed before the surgery under positive pressure ventilation.

Although TEVAR is performed in a catheterization laboratory or hybrid operating room, the treatment for a sudden pneumothorax may be difficult during the positioning and deployment of stent grafts. In the present case, vvECMO was employed to avoid intraoperative hypoxic events during stent-graft implantation. After the initiation of vvECMO, PC was successfully reduced from 10 to 8 cmH2O and RR from 10 to 4 breaths/min. The partial pressure of oxygen was maintained at approximately 200 mmHg during stent-graft implantation. Because Yanada and Toda reported the effectiveness of vvECMO support during surgical repair of bilateral spontaneous pneumothorax, vvECMO may allow surgeons sufficient time for the treatment of intraoperative pneumothorax. Although we need further experience of TEVAR under vvECMO support, we insist that vvECMO may prevent possible intraoperative hypoxic events in patients with pulmonary emphysema.

In conclusion, a combination of vvECMO and low pressure ventilation could be one of the useful respiratory support options to prevent possible intraoperative hypoxic events in patients with pulmonary emphysema. Although further experiences are needed, this technique may improve the safety of performing TEVAR in patients with severe pulmonary emphysema.

Disclosure

All authors have no conflict of interest to declare.

References

