

CASE REPORT

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Successful management by employing situational extracorporeal membrane oxygenation strategies in a patient with acute type A aortic dissection: a case report

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Abstract

Background We successfully treated a case of acute type A aortic dissection in a patient with acute inferior wall infarction as well as severe circulatory and respiratory disorders.

Case presentation A 69-year-old woman was diagnosed with acute type A aortic dissection. She received emergency partial aortic arch replacement and coronary artery bypass grafting. After the cardiopulmonary bypass, extracorporeal membrane oxygenation (ECMO) with central cannulation was performed due to severe right heart failure and extensive alveolar hemorrhage. Since the surgery, transesophageal echocardiography was used to monitor her hemodynamic status. The positive end-expiratory pressure (PEEP) was managed based on end-expiratory transpulmonary pressure. Replacement of the ECMO circuit was required every 2–3 days due to intra-circuit thrombus, and continuous renal replacement therapy was started on postoperative day (POD) 8. On POD 13, improvement of cardiac function was observed; we therefore attempted closure of the chest and conversion to veno-venous (V-V) ECMO. However, the patient's hemodynamics were unstable due to diastolic impairment after the chest closure; thus, peripheral veno-arteriovenous (V-AV) ECMO was introduced. The patient was converted to V-V ECMO on POD 16 and weaned from ECMO on POD 17. The patient was extubated on POD 19. She left the intensive care unit with non-invasive ventilation on POD 20.

Conclusions The favorable outcome in the current case can be attributed to the following three points: (1) appropriate ECMO strategies were employed according to the patient's condition, (2) the patient's lung condition improved due to transpulmonary pressure monitoring and fluid balance management from an early stage, and (3) we observed respiratory and hemodynamic status during the 50–90-s circulatory arrest periods that occurred during ECMO circuit changes, and this observation contributed to the evaluation of weaning from ECMO.

Keywords Extracorporeal membrane oxygenation (ECMO), Veno-venous extracorporeal membrane oxygenation (V-V ECMO), Veno-arteriovenous extracorporeal membrane oxygenation (V-AV ECMO)

Background

Circulatory collapse after open-heart surgery is a serious condition with a high mortality rate, even today. According to a recent study, the mortality rate when extracorporeal membrane oxygenation (ECMO) with central cannulation is used for shock after cardiac surgery is 67.3% (Kowalewski et al. 2021); thus, the management of

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post-cardiotomy shock has been extremely challenging. Herein, we describe a successfully treated case of acute type A aortic dissection in a patient with acute inferior wall infarction as well as severe circulatory and respiratory disorders in the intensive care unit (ICU) by employing situational strategies with ECMO. Written informed consent for the publication of this article was obtained from the family of the patient.

Case presentation

A 69-year-old Japanese woman (height 151 cm, weight 53 kg) without any past medical history was diagnosed with acute type A aortic dissection and acute coronary syndrome by contrast-enhanced computed tomography. She received emergency aortic root replacement (Bentall procedure), partial aortic arch replacement, and coronary artery bypass grafting to the anterior descending branch. After the cardiopulmonary bypass, ECMO with central cannulation (right atrial and left ventricular—ascending aorta) was used due to severe right heart failure and extensive alveolar hemorrhage (Fig. 1). A large amount of bloody fluid came up from the endotracheal tube due to severe pulmonary edema and alveolar hemorrhage. Intraoperatively, blood viscoelasticity test (TEG[®]6 s system, Haemonetics Corp., MA, USA) revealed that 3080 mL of red blood cells, 3360 mL of fresh frozen plasma, 800 mL of platelet concentrates, 6 g of fibrinogen concentrates, and 7 g of tranexamic acid were needed after the cardiopulmonary bypass for hemostasis. The cardiopulmonary bypass time was 530 min, the operative time was 843 min, the anesthesia time was 945 min, and the bleeding volume was approximately 11,500 mL. After the surgery, the patient was transferred to the ICU with an open chest and artificial respiration.

In the ICU, propofol 100–150 mg/h, ketamine 30 mg/h, and morphine 2.5 mg/h were used for sedation/analgnesia during mechanical ventilation and ECMO use. Since the surgery, transesophageal echocardiography and

pulmonary artery catheter were used to monitor her hemodynamic status. Based on these parameters, we titrated milrinone, nitroglycerin, and carperitide to maintain an ECMO flow of about 4.0 L/min and a mean blood pressure of about 65 mmHg and to prevent elevation of lactate levels. The positive end-expiratory pressure (PEEP) was maintained at 10–15 cmH₂O to achieve the end-expiratory transpulmonary pressure stayed above 0 cmH₂O. The transpulmonary pressure was measured using an esophageal balloon catheter kit with a dedicated ventilator (HAMILTON-C6 ventilator, Hamilton Medical AG, Switzerland).

The patient's consciousness was confirmed on postoperative day (POD) 1, and sedative agents had managed to keep her score on the Richmond Agitation-Sedation Scale between –2 and 0. Continuous administration of heparin was started to keep he activated clotting time around 200 s on POD 3, when the risk of bleeding decreased. However, replacement of the ECMO circuit was required every 2–3 days in the ICU due to intra-circuit thrombus. Additional blood tests ruled out heparin-induced thrombocytopenia.

Continuous renal replacement therapy for fluid management was started on POD 8. On POD 13, because hemodynamics could be maintained even when the ECMO flow was reduced to 2.0 L/min, we judged the patient's cardiac function to have improved; we therefore attempted closure of the chest and conversion to venovenous (V-V) ECMO. However, the patient's hemodynamics were unstable due to diastolic impairment after the chest closure; thus, peripheral venoarteriovenous (V-AV) ECMO was introduced. The patient was converted to V-V ECMO on POD 16 and weaned from ECMO on POD 17, after confirming that oxygenation was maintained when the ECMO flow was reduced to 1.5 L/min. The patient was evaluated every day with spontaneous-breathing trials with pressure-support ventilation (Thille et al. 2022), and she was extubated on POD 19.

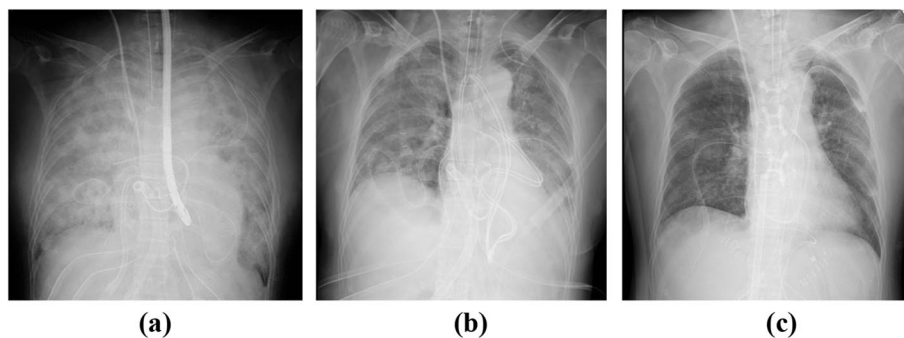


Fig. 1 Chest X-ray images on the day of the surgery (a), on POD 14 (b), and POD 18 (c). Image (a) shows severe alveolar hemorrhage and pulmonary congestion, in addition to a transesophageal echocardiography probe

She left the ICU with non-invasive ventilation on POD 20.

Discussion

Based on the findings of a recent study investigating 7185 patients supported with ECMO for postcardiotomy cardiogenic shock (Kowalewski et al. 2021), the present case had multiple factors of poor prognosis, including ECMO with central cannulation, intervention of the thoracic aorta and coronary artery, and concomitant severe left and right heart failure, in addition to severe lung condition associated with pulmonary edema and acute respiratory distress syndrome. However, the favorable outcome in the current case can be attributed to the following three points: (1) appropriate ECMO strategies were employed according to the patient's condition, which fluctuated daily; (2) the patient's lung condition improved due to transpulmonary pressure monitoring and fluid balance management from an early stage; and (3) we observed respiratory and hemodynamic status during the 50–90-s circulatory arrest periods that occurred during ECMO circuit changes, and this observation contributed to the evaluation of weaning from ECMO.

ECMO with central cannulation is side by side with the risk of mediastinitis. Thus, we tried closing the chest and transitioning from ECMO with central cannulation to peripheral access as soon as possible. In critically ill patients with combined respiratory failure and cardio-circulatory shock, V-AV ECMO is a valid rescue strategy (Mihu et al. 2021); therefore, we chose this approach. One of the other strategies is the use of an Impella® (Abiomed, Danvers, MA, USA), which is a catheter-based left ventricular assist device that is inserted into the left ventricular cavity by arterial access. Left ventricular unloading by using Impella® improves mortality in patients with cardiac shock (Schrage et al. 2020), and several studies have reported the usefulness of V-A ECMO with Impella® (called ECPELLA or ECMELLA) to treat such patients (Pappalardo et al. 2017). In the present case, because of the lack of experience with Impella® after aortic replacement, we did not choose to use ECPELLA for early weaning from central ECMO.

Fluid balance management to avoid volume overload is recommended for patients with acute respiratory distress syndrome from an early stage (Seitz et al. 2020), and fluid management was also performed in this patient from an early stage. In the present case, we performed fluid management based on her pre-operative weight.

Because there is no established protocol for weaning or changing ECMO (Al-Fares et al. 2021), we managed our patient with multifaceted assessments by using transesophageal/thoracic echocardiography, pulmonary artery catheter, X-ray, lung ultrasound, and transpulmonary

pressure. In particular, ventilatory management using transpulmonary pressure may contribute to successful ECMO withdrawal (Wang et al. 2020). Hence, excessive high PEEP also affects hemodynamics, monitoring of transpulmonary pressure was useful in the management of PEEP to prevent both lung collapse and lung hypertension, with minimal impact on hemodynamics. Moreover, respiratory and hemodynamic status during ECMO circuit changes provided valuable information for weaning from ECMO.

Conclusions

We successfully treated a case of acute type A aortic dissection in a patient with acute inferior wall infarction as well as severe circulatory and respiratory disorders in the ICU by employing situational strategies with ECMO. In such cases, careful management with multifaceted assessments should be provided through close collaboration among anesthesiologists, intensivists, cardiovascular surgeons, ICU staff, and clinical engineers.

Abbreviations

ICU	Intensive care unit
ECMO	Extracorporeal membrane oxygenation
PEEP	Positive end-expiratory pressure
V-V ECMO	Veno-venous extracorporeal membrane oxygenation
V-AV ECMO	Veno-arteriovenous extracorporeal membrane oxygenation
POD	Postoperative day

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Authors' contributions

KS, KY, and TH managed perioperative care and prepared the manuscript. ST performed anesthetic management during the surgery. SI helped to draft the manuscript. All authors have read and approved the manuscript.

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Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

At our institution, Institutional Review Board approval is not required for a case report. The IRB of Fukushima Medical University (Fukushima, Japan) determined that there were no problems with describing the course of treatment for this presentation if written informed consent was obtained.

Consent for publication

Written informed consent for publication of this case report and the accompanying images were obtained from the family of the patient. A copy of the written consent is available for review at the request the Editor-in-Chief of *Ain-Shams Journal of Anesthesiology*.

Competing interests

The authors declare that they have no competing interests.

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