

Iatrogenic Extracorporeal Membrane Oxygenator Rupture: Successful Management of a Unique Crisis

Kaushalendra Rathore, FRACS;* Garry Smith, RCVP, CCP;† Mark Newman, FRACS*

*Department of Cardiothoracic Surgery; and †Department of Perfusion, Sir Charles Gairdner Hospital, Nedlands, Australia

Abstract: We are presenting a case of successful resuscitation during accidental rupture of a venoarterial extracorporeal membrane oxygenator after surgical pulmonary embolectomy. This article reports a rare complication related to the

mechanical circulatory support and its successful management. **Keywords:** angina, cardiogenic shock, ECMO, aorta and great vessels, thrombus. *J Extra Corpor Technol. 2020;52: 242–4*

Indications for mechanical circulatory support using extracorporeal membrane oxygenation (ECMO) are increasing with growing clinical experience (1). There have been many improvements in technology and techniques which have resulted in improved safety and outcomes. ECMO is still responsible for numerous catastrophic patient- or device-related complications, such as major bleeding from the insertion or cardiotomy sites, thrombosis, vascular ischemia, thromboembolism, hematological issues, mechanical or technical failures, and systemic infections (2). This case describes a catastrophic complication of a ruptured membrane in an ECMO-dependent patient which was successfully managed with internal cardiac massage, fluid, and pharmacological replacement, although the perfusionist primed another ECMO.

DESCRIPTION

A 57-year-old known case of multiple myeloma was presented with a 4-day history of worsening of shortness of breath and hypotension. Gated computed tomography pulmonary angiogram (CTPA) showed large saddle

pulmonary embolism (PE) with clots extending into the branch pulmonary arteries (Figure 1), and the right ventricle (RV) was severely dilated (Figure 2). Transthoracic echocardiogram showed clots in the right atrium (RA) and severe RV systolic dysfunction with moderate pulmonary arterial hypertension. Hematology results showed raised venous lactate and high-sensitivity troponin I (2 Mmol/L and 108 ng/L, respectively). Consensual decision of a multidisciplinary team was to perform emergency surgical pulmonary embolectomy (SPE). During sternotomy, the patient lost cardiac output, internal cardiac massage was performed for 3 minutes, and cardiopulmonary bypass (CPB) was established promptly by cannulating the ascending aorta, superior vena cava, and inferior vena cava. The SPE was performed on the warm, empty beating heart on full CPB support. Clots were retrieved from the RA, main pulmonary artery (MPA), and both left and right pulmonary arteries, including their major branches. Weaning of the CPB was attempted twice with the support of inotropes and nitric oxide, but the RV was severely dilated with poor contractility. Second CPB run was performed in an attempt to remove residual clots, but it made no difference to the RV systolic functions. Eventually, CPB was separated with the support of venoarterial ECMO (VA ECMO, Rotaflow, Maquet, Germany), which was instituted by cannulating the right femoral artery and vein. The patient had long CPB time (258 minutes), and he was shifted to the intensive care unit (ICU) with open chest. After 48 hours of low cardiac output, RV systolic functions started to improve, and on the third postoperative day, the

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Address correspondence to: Kaushalendra Rathore, FRACS, Consultant Cardiothoracic Surgeon, Sir Charles Gairdner Hospital, Hospital Avenue, Nedlands 6009, Australia. E-mail: kaushalendra.rathore@gmail.com
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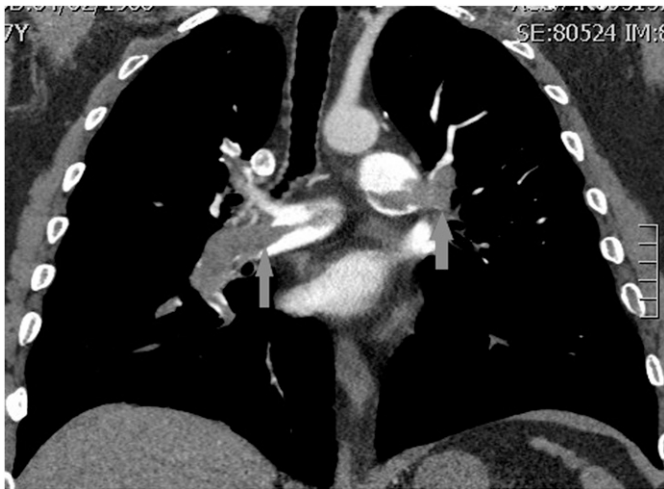


Figure 1. Coronal view of CTPA: massive clots extending into the branch pulmonary arteries.

plan was to close the chest and wean the patient off the ECMO.

The transport team was organized to shift the patient from the ICU to the operating room, which included an anesthetist, a clinical perfusionist, a surgical registrar, nurses, and an orderly. The bed was motorized and inadvertently was engaged at the start of the transfer. This resulted in the bed crashing into the membrane of the ECMO circuit which fractured the temperature probe port of the oxygenator (Figure 3). Blood was spurted out of the port because of pump pressure which was temporally stemmed by the perfusionist by placing his fingertip over the hole. The perfusionist was compelled to reduce the ECMO flow, and eventually, he clamped both venous (drainage) and arterial (reperfusion) lines because of



Figure 3. Temperature port of the rotaflow oxygenator.

continuing blood loss. A second pump was sent for, and it was quickly primed. Unfortunately, the patient did not tolerate this precipitate weaning, and the patient developed ventricular fibrillation and lost cardiac output. The patient was resuscitated by giving internal cardiac massage for 17 minutes, and finally, VA ECMO was reinstated. Transesophageal echocardiography (TOE) showed recurrence of significant clots in the RA and MPA because of a low-flow condition. The patient was shifted to the operating room, and another run of CPB was performed to retrieve fresh clots. On this occasion, the patient was promptly separated from CPB with the support of VA ECMO, and the chest was closed. VA ECMO was decannulated within the next 48 hours, and ventilatory support was weaned off with the help of percutaneous tracheostomy in the next 10 days. The patient was discharged home on day 25 after the surgery. On the 6-month follow-up, CTPA and ventilation perfusion scan (^{99m}Tc Technegas and ^{99m}Tc macroaggregates of albumin [MAA]) showed no residual PE.

COMMENTS

The incidence of post-cardiotomy refractory shock is not that common (.5–1.5%), but its mortality is still significant (3). A meta-analysis of post-cardiotomy refractory cardiogenic shock managed using VA ECMO has shown a successful decannulation rate among various studies

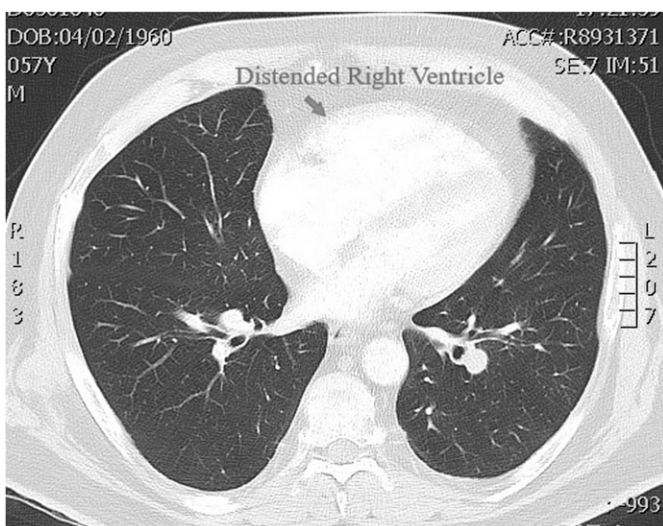


Figure 2. Axial view of CTPA: severe right ventricular distension and under filled left ventricle.

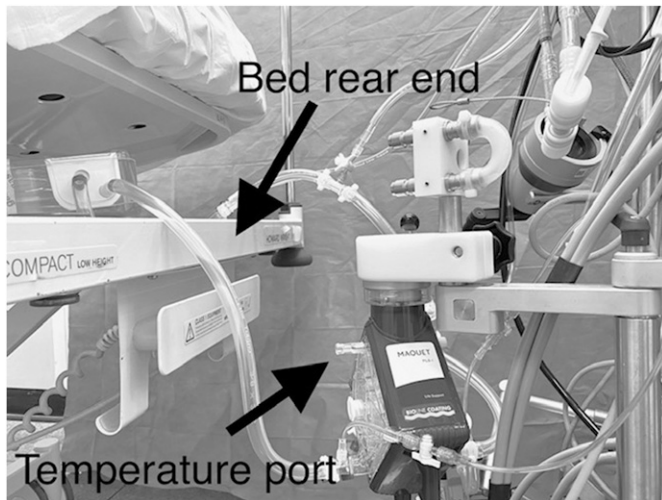


Figure 4. VA ECMO circuit setup.

between 55 and 60% and a rate of survival at hospital discharge of 30.8% (4). They have reported major hemorrhage as the commonest complication following ECMO use, followed by the need of renal replacement therapy, limb ischemia, stroke, coagulation complications, and sepsis. A recent meta-analysis showed no difference in the survival outcomes and complication rates between the transplant vs. non-transplant unit in the cases of post-cardiotomy shock (5). Our hospital is a non-transplant unit, which institutes 25–30 VA ECMOs per year, and as a protocol, we always keep a dry assembled ECMO circuit in the operating room.

Various iatrogenic complications have been reported (air embolism through the central venous line, wrong connections, line rupture due to clamping, and vascular complications), but accidental fracture of the temperature port of the oxygenator was not found on the literature search (6,7). Obviously, chances of immediate air embolism were not high because of the positive pressure, but breach in the sterility of the circuit, blood volume loss, and eventually losing cardiac output were potential threats. Best possible management in this situation could be to reduce ECMO pump flows, try to tamponade the leak, volume replacement, and escalate inotropes and ventilatory support while a new circuit was primed; as such,

precipitate weaning of ECMO is not well tolerated as seen in this case.

The location of the temperature port in Rotaflow design is in between the oxygenator and the patient (Figure 4). On investigation of this incident, it became apparent that the design of the membrane exposed the temperature port in a vulnerable position which could allow it to be hit from front. Because of this event, we have changed the orientation of the membrane to protect the temperature probe port.

Important lessons learned from this case are designating a “team leader,” better communication between the perfusionist and other team members, deactivating the “motorized” bed while transporting the patient on ECMO, keeping the ECMO circuit dry in the ICU, and using newer designs such as Cardiohelp and Blood Monitoring Unit (BMU 40) which facilitate logistics of patient transport (8).

All ethical protocols were followed, and the patient signed consent for the research publication.

REFERENCES

1. George M, Wang I-W. Extra corporeal membrane oxygenation (ECMO) review of a lifesaving technology. *J Thorac Dis.* 2015;7: E166–76.
2. Xie A, Phan K, Tsai Y-C, et al. Venoarterial extracorporeal membrane oxygenation for cardiogenic shock and cardiac arrest: A meta-analysis. *J Cardiothorac Vasc Anesth.* 2015;29:637–45.
3. Voeller RK, Kelly R. Postcardiotomy shock: Which patients benefit from extracorporeal membrane oxygenation? *J Thorac Cardiovasc Surg.* 2018;156:1883–4.
4. Khorsandi M, Dougherty S, Bouamra O, et al. Extra-corporeal membrane oxygenation for refractory cardiogenic shock after adult cardiac surgery: A systematic review and meta-analysis. *J Cardiothorac Surg.* 2017;12:55.
5. Kowaleski M, Raffa GM, Zielinski K, et al. The impact of centre’s heart transplant status and volume on in-hospital outcomes following extracorporeal membrane oxygenation for refractory post-cardiotomy cardiogenic shock: A meta-analysis. *BMC Cardiovasc Disord.* 2020; 20:10.
6. Aizawa M, Ishihara S, Yokoyama T. ECMO circuit embolism: A potentially hazardous complication during ECMO therapy. *J Clin Anesth.* 2019;54:162–3.
7. Koerner MM, Harper MD, Gordon CK, et al. Adult cardiac venoarterial extracorporeal life support (VA-ECMO): Prevention and management of acute complications. *Ann Cardiothorac Surg.* 2019;8: 66–75.
8. Alwardt CM, Wilson DS, Alore ML, et al. Performance and safety of an integrated portable extracorporeal life support system for adults. *J Extra Corpor Technol.* 2015;47:38–43.