

Treat Venous Air Embolism Induced Acute Hypoxemic Respiratory Failure during Retinal Surgery by ECMO (V-V Mode)

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INTRODUCTION

Venous air embolism (VAE) is a rare, potentially life-threatening event, especially occurring during or after vitreoretinal surgery. VAE occurs when air is forced into the venous system under pressure.¹ Percutaneous cardiopulmonary support (V-A Mode) to treat suspected VAE with cardiac arrest during open eye surgery had been reported.²

We describe an unusual case of VAE hypoxemic respiratory failure during the process of air-fluid exchange for pars plana vitrectomy (PPV). This case highlights the importance of immediate recognition for VAE, and applying associated management will be beneficial. To the best of our knowledge, it may be the first reported case of VAE during vitrectomy confirmed with transesophageal echocardiography (TEE).

CASE

A 59-year-old woman with hypertension, cervical cancer (stage IIIb), and traumatic retinal detachment status post four times of microincision vitreoretinal surgery.

After the induction of general anesthesia, the patient underwent PPV by inserting a 23G trocar; subsequently, the air-fluid exchange was performed at a pressure of 35 mm Hg and more than 30 cc of air was in-

fused. Within 10 minutes after beginning of the air-fluid exchange, a sequence of electrocardiographic changes suddenly developed, accompanied with progressive oxygen desaturation (SpO₂: 81%) and bradycardia (heart rate: 45/min). Changes of electrocardiography started from ST elevation to Mobitz II heart block and blood pressure dramatically dropped down to 60/30 mm Hg. A sharp decrease of end tidal CO₂ (ETCO₂: 10 mm Hg) was also noticed. Patient developed acute hypoxemic respiratory failure associated with impending cardiovascular collapse. Ambu bagging with 100% of O₂, inotropes and the transcutaneous cardiac pacing were applied. However, there was no sign of improvement for O₂ saturation even after getting more stable cardiac hemodynamic condition. Assuming the acute hypoxemic respiratory failure caused by VAE induced during air-fluid exchange process, extracorporeal membrane oxygenation (ECMO) was immediately applied after all the infusion lines were checked to exclude the air embolus. ECMO (V-V Mode) was performed percutaneously by inserting a 21 V tube (MAQUET) for inferior vena cava and a 17 A tube through right jugular vein down to superior vena cava. Meanwhile, TEE was done immediately and revealed that significant dilatation of the right atrium associated with lots of air bubbles cumulated in the right ventricle and blocked the ventricular outflow tract and led to sudden compromise of cardiac circulation (Figure 1, 2). Later patient was sent to intensive care unit with stable hemodynamic condition and woke up with clear consciousness in the following morning (E4M6V5). ECMO was weaned and the endotracheal tube was removed on the first and the sixth postoperative day, respectively. This patient also had another cardiac catheterization and transthoracic echocardiography to ascertain good ventricular contractility, insignificant stenotic lesion of coronary arteries and no existence of a patent foramen ovale (PFO). Patient survived to hospital dis-

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Figure 1. Air bubbles still cumulated in the right ventricle (RV) after initiation of extracorporeal membrane oxygenation (ECMO).

charge without any neurologic deficit during outpatient clinic follow up.

DISCUSSION

Gayer S, et al.'s porcine studies clearly demonstrated that during air-fluid exchange, pressurized air infused into the supra-choroidal space, via sheared vortex vein, is able to reach the central venous circulation and produces fatal VAE.³ Ophthalmologic surgeons and the anesthesia team must be aware of this potential fatal complication of air infusion. Monitoring the status of the infusion cannula is suggested, and the infusion should be halted immediately if a choroidal detachment is noticed during air infusion. The conventional treatments for VAE are well-known,⁴ and ECMO might be applied when respiratory or hemodynamic support is indicated.²

The number of reports of these dreaded complication in both anesthesiology and ophthalmology literature is limited. Merely five cases were published through 2005-2018. As a summary, three underwent cardiopulmonary resuscitation (CPR),^{2,5,6} and one of them received V-A mode ECMO after 87 minutes of CPR.² Two of these

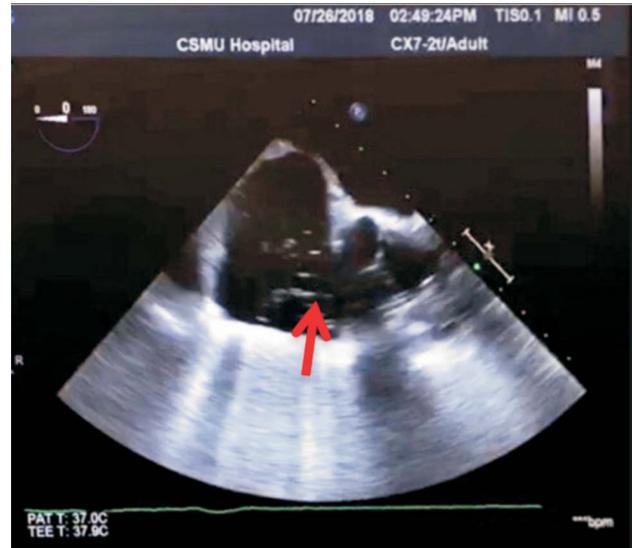


Figure 2. Very few air bubble after hemodynamic condition stabilized.

cases had a PFO,^{2,5} one of them resulted in death⁵ and the other ECMO case was able to ambulate independently after two months.² Therefore, in a patient with cardiopulmonary collapse after air-fluid exchange during vitreoretinal surgery, ECMO support as early as possible may provide a better outcome. This is certain especially in refractory CPR cases because there is a high possibility of a pre-existing PFO. To date, there were no prior experiences of real-time ultrasound approach to diagnose the VAE; suspected diagnosis mostly relied on symptoms and post-operative imaging.^{2,7,8} The value of TEE as a monitor of VAE was underscored by the fact that intracardiac air was detected before any other monitoring device aberrations. It is noteworthy that ETCO_2 , declined at an early stage, hypotension and peripheral oxygen desaturation were late changes that only manifested shortly before cardiac arrest. Currently, TEE is currently the most sensitive diagnostic method for detecting air embolism.⁴ We provide a practical case of VAE occurring after vitreoretinal surgery with acute hypoxemic respiratory failure which was diagnosed by real-time TEE and successfully treated by ECMO (V-V mode). Real-time TEE provided a valuable insight into the cause of the initial VAE event.

LEARNING POINTS

- During ophthalmic surgery (especially PPV), continuous

intraoperative monitoring (TEE) and increased awareness of such an event is crucial in preventing fatal outcomes.

- Prompt diagnosis of VAE with real-time TEE during air-fluid exchange may provide valuable information for detecting air embolism in such situations, and should be considered if the clinical situation permits.
- There may be a treatment benefit of V-V mode ECMO at patients with venous air embolism induced acute hypoxemic respiratory failure.

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CONFLICT OF INTEREST

All the authors declare no conflict of interest.

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