

A Successfully Resuscitated Case of Air Embolism during Vitrectomy

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To the Editor: Air embolism is a well-recognized complication during surgery. While thousands of publications exist on intraoperative venous air embolism (VAE), during eye surgery, it occurs only rarely and so can possibly go unnoticed by surgeons. It could be easily ignored due to deficiency of diagnostic method and standard care. It was initially reported by Ledowski *et al.*^[1] in 2005 that a 55-year-old man who underwent three-port pars plana vitrectomy had sudden tachycardia during air-fluid exchange. However, in this study, the case we report here is definite, showing accurate data recorded of examinations, diagnosis, and resuscitation of the patients.

A 56-year-old man with choroidal melanoma in the left eye had no underlying disease or perioperative abnormality. After the induction of general anesthesia, the patient was mechanically ventilated at a FiO₂ of 0.4 to maintain oxygenation. The patient underwent vitrectomy by inserting a 23G infusion cannula; subsequently, the air-fluid exchange was performed with an initial pressure of 60 mmHg (1 mmHg=0.133 kPa). At that time, the patient suddenly had ventricular fibrillation, and cardiopulmonary resuscitation (CPR) was initiated immediately. Blood pressure dramatically dropped to 60/30 mmHg and the heart rate went up to 200/min. We also noted a sharp decrease of end tidal CO₂ (ETCO₂) from 38 to 16 mmHg, and the SpO₂ dropped from 100% to 90%. Assuming this as an air embolus, all the infusion lines were checked to exclude the air embolus. During the CPR, the blood pressure was maintained above 85/60 mmHg. After half an hour, the heart rate recovered to sinus rhythm of 140/min and the blood pressure was 145/90 mmHg, SpO₂ was 100% and, subsequently, the patient was admitted to the Intensive Care Unit with clear consciousness. After admission, computed tomography (CT) pulmonary angiogram and coronary CT angiography showed no significant signs. A bedside transthoracic echocardiogram showed that there was air in the interior vena cava and the hepatic vein [Figure 1].

We believe that the most likely reason was the air embolism via choroidal vein. During the operation, air-fluid exchange is performed after vitrectomy to close retinal tears by replacing intraocular fluid from the posterior segment of the globe with air. The fluid in the vitreous cavity is removed either passively or with active suction, and then the air is infused into the eye. During this process, the air may enter the torn vein and cause

further air embolism in the circulation through vortex veins. VAE can easily occur when the pressure in an open vein is lower than the atmospheric pressure. The clinical consequences of VAE are determined by the quantity and velocity of air. In patients with patent foramen, the air is allowed into the arterial circulatory system, which is even more dangerous.

By now, VAE has been only reported in three cases^[2] and one animal model in the whole world.^[3] Morris *et al.*^[4] found that the air may enter the circulation through vortex vein in four donor eyes, which provides a novel idea for improving the surgical procedures. In this case, a decrease of ETCO₂ was noticed in the early stage. CPR was initiated in a timely manner and thus the resuscitation was successful. Based on the ultrasound result, we believe that the air was pumped into the vena cava during the CPR, which was the key factor that saved the patient's life. Due to the timely CPR, the air embolus had already left the lung and migrated to the hepatic vein and inferior vena cava with blood.

From this case, we have concluded some experiences. First, a real-time transesophageal echocardiography during air-fluid exchange may provide sensitive, noninvasive, and valuable criteria for detecting air embolism. Choroidal elevation appears as the first warning sign to immediately stop the air infusion and investigate the source of choroidal elevation. We can also place the patients in the left lateral decubitus position (head down and foot up) so that the air in the left ventricle will float to the apex. This then makes it possible for the air to be broken into smaller bubbles with the heart beat so that only a small volume of air enters the pulmonary artery at one time. Notably, inspiration of high oxygen fraction can prevent helium entering the blood, and increasing the blood volume may also decrease the severity of VAE. CPR can improve the perfusion of the organs once there is cardiac arrest while also pushing the air embolus out of the lung. If the CPR is not successful, after

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Access this article online

Quick Response Code:



Website:
www.cmj.org

DOI:
10.4103/0366-6999.233951

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Received: 11-02-2018 **Edited by:** Li-Shao Guo

How to cite this article: Dai QQ, Liu WH, Li Y, Wang HQ. A Successfully Resuscitated Case of Air Embolism during Vitrectomy. Chin Med J 2018;131:1509-10.

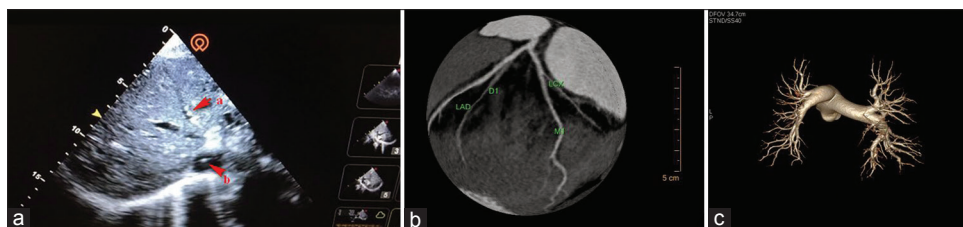


Figure 1: Representative image of the patient. (a) Ultrasonic cardiogram: red arrow a points to bubbles in the hepatic vein and red arrow b points to bubbles in the inferior vena cava; (b) Coronary CT angiography shows no significant abnormality; (c) CT pulmonary angiogram shows no significant abnormality. CT: Computed tomography.

the patient is stabilized, the patient should be transferred to the Intensive Care Unit for further advanced care and management. If the patient is still refractory to CPR, extracorporeal life support should be considered in fatal cases.

In conclusion, although being reported in several cases, VAE during eye surgery is quite rare. The case should arouse ophthalmologists' awareness about ocular air-fluid exchange which is not always completely safe and may even be fatal, especially in patients with patent foramen ovale. Intensive monitoring and standard care should be considered in clinical practice, which might be valuable in saving patients' lives.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understands that his name and initial will not be published and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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