SAGE Open Medical Case Reports
JCMS Case Reports
Volume 6: 1–3

DOI: 10.1177/2050313X18809265
journals.sagepub.com/home/sco
SAGE

Head-down tilt position successfully prevent severe brain air embolism

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Abstract

Air embolisms are rare life-threatening complications that develop under various conditions, including surgery. During segmentectomy for thoracic surgery, air is blown into the selected bronchus for segment margin detection. This may result in the formation of an air embolus. Herein, we report a case of successful recovery from sudden intraoperative cardiac arrest due to an air embolism in a patient undergoing left superior division segmentectomy via open thoracotomy. Intraoperatively, the patient was positioned head-down. Upon blowing air into the bronchus, the patient suddenly developed cardiac arrest. Open-chest cardiac massage and low-temperature therapy were commenced and the patient recovered. The head-down position prevents the air embolus from reaching the brain and thus prevents severe brain damage, whereas continuous open-chest massage and low temperature prevents severe body damage from anticipated cardiac air embolism. Thus, operation in the head-down position is useful in preventing severe brain damage from brain air embolisms.

Keywords

Air embolism, head-down tilt position, lung cancer, open-chest massage, low-temperature treatment

Date received: 27 March 2018; accepted: 4 October 2018

Introduction

Air embolism is a rare but life-threatening complication that occurs during surgery.[1,2] Herein, we report a case of successful recovery from an air embolism during lung cancer surgery. Open-chest cardiac massage and low-temperature treatment prevent whole body damage, and placement of the patient in the head-down tilt position prevents severe brain damage in such cases and enables recovery without any sequelae.

Case report

An 82-year-old man was admitted to our department for lung cancer surgery. He had a history of hypertension and colon carcinoma, which were treated with medication and surgery, respectively. The patient's cardiovascular condition was normal, but his respiratory function demonstrated an obstructive pattern. Hence, after obtaining informed consent from the patient, he was scheduled for a left superior division segmentectomy for lung cancer, considering his age, respiratory function, and the ground-glass opacity of the tumor. Posterolateral thoracotomy was performed through the fifth intercostal space with the patient in the right lateral decubitus and head-down tilt positions to prevent severe brain damage in the event of an air embolism. After resecting the pulmonary vein, pulmonary artery, and bronchus, the patient was laid in a supine head-down tilt position. An 18 G needle was inserted into the resected bronchus, and air was blown through the needle to create a surgical margin after confirming the absence of blood backflow. Subsequently, oxygen was delivered at 2 L/min.

One minute after starting air inflation, the desired segment was inflated; however, to clear the borders of the segment, we continued inflation. One minute later (2 min after starting the air inflation), the patient developed low blood

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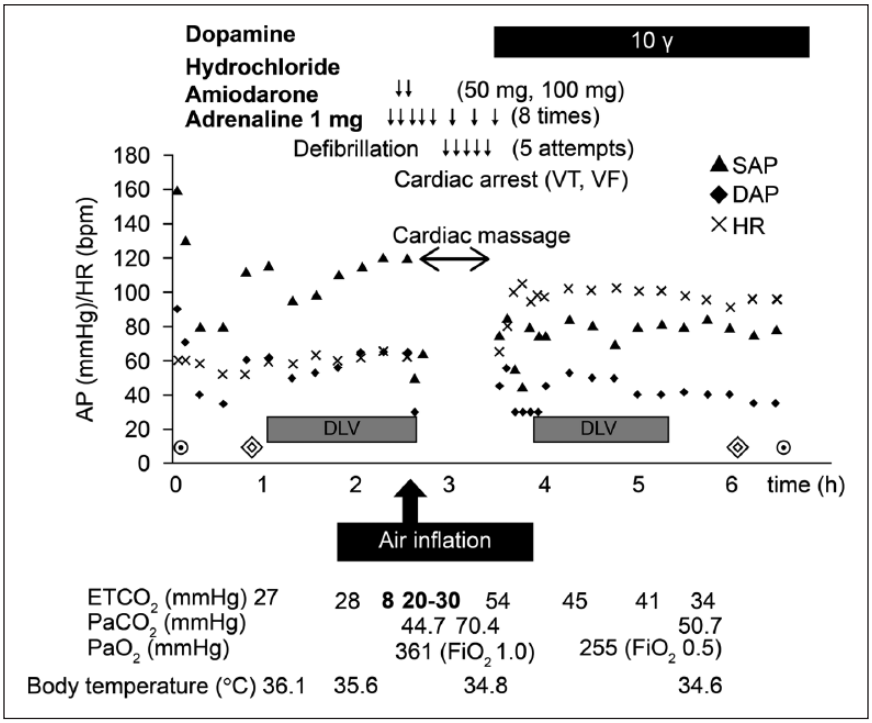

Figure 1. Chart showing information regarding anesthesia used during the procedure.
DAP: diastolic arterial pressure; ETCO2: end-tidal carbon dioxide; FiO2: fraction of inspired oxygen; HR: heart rate; PaCO2: partial pressure of carbon dioxide in arterial blood; PaO2: partial pressure of oxygen in arterial blood; SAP: systolic arterial pressure; VF: ventricular fibrillation; VT: ventricular tachycardia.

pressure, and the carbon dioxide released at the end of expiration ($ETCO_2$) was 8 mmHg. Thereafter, ventricular fibrillation occurred, followed by cardiac arrest. Open-chest cardiac massage was started immediately and continued for about 60 min. Electric defibrillation was attempted five times, and dopamine (10 µg/kg/min), amiodarone (150 mg), and adrenaline (8 mg) were administered. Subsequently, the patient's heart rate increased, and the $ETCO_2$ improved to 20–30 mmHg. Rapid blood transfusion (total: 8 units) was administered because the open-chest cardiac massage had caused some lung damage and substantial blood loss because of tearing of segment 6 when cardiac massage was started. Simultaneously, a low body temperature was maintained (34.0°C–34.9°C; Figure 1). The findings upon admission to the intensive care unit (ICU) are shown in Table 1. There was no definitive diagnosis of cerebral air embolism because the patient was intubated, but under these circumstances, brain damage was possible. Hence, edaravone (30 mg) was administered twice for suspected cerebral infarction due to cerebral ischemia. The patient regained consciousness (Glasgow Coma Scale: E4VTM6) the next day. He was weaned from the respirator and transferred to the general ward on day 3 after admission to the ICU. Magnetic resonance imaging of the head and cardiac ultrasonography was performed, but no complications were detected. Finally, he was discharged, without complications, on postoperative day 13. He did not experience any complications or recurrence and died from natural causes at 24 months after surgery. His wife provided written informed consent for publication of this case.

Discussion

In the present case, the most probable cause of cardiac arrest was migration of air to the coronary artery in the left side of the heart. This is because pulmonary infarction was unlikely the basis of the patient's clinical course,[1–3] and transesophageal echocardiography showed multiple bubbles in the left ventricle. We had intended to remove the air by puncturing the ventricle, but the bubbles were too small to be removed; thus, recurrence of air embolization could not be prevented.

An air embolism can occur during various procedures. It is also reported to occur when oxygen is introduced for detection of the segmental margin.[1] As the "open-cut" procedure is not very popular, we selected the air blowing method for segment margin detection. We believed that cutting the segmental pulmonary artery and vein (in the open-cut method, the operator cuts only a bronchus and artery, and not a vein) would lead to a lower probability for air entering the left ventricle. We did not move the needle after insertion into the resected bronchus. Nonetheless, air entered the left ventricle. Occluding the adjacent segmental bronchi was an alternative method, but we did not have an anesthesiologist

Table 1. Patient's findings upon admission to the intensive care unit.

Conditions	Admission to the intensive care unit
Glasgow coma scale	E1VTM1
Arterial blood pressure	58/35 mmHg (dopamine 10 γ, noradrenaline 0.05 γ)
Heart rate	98 bpm
SpO_2	100%
Echocardiography	Normal left and right ventricular wall motion
Arterial blood gas analysis (FiO_2 0.6, PEEP 5 cmH_2O, PCV 12 cmH_2O, RR 12)	pH 7.384, $PaCO_2$ 40.3, PaO_2 212, HCO_3 –23.7, lactate level 64 mg/dL
Esophageal temperature	34.6°C
APACHE II score[a]	30
SOFA score[b]	7

FiO_2: fraction of inspired oxygen; $PaCO_2$: partial pressure of carbon dioxide in arterial blood; PaO_2: partial pressure of oxygen in arterial blood.
[a]Acute Physiology and Chronic Health Evaluation score.
[b]Sequential Organ Failure Assessment score.

who could perform the procedure. We believe that the patient's peripheral pulmonary vein had many anomalies and that a tiny peripheral vein to segment 4 remained (this could not be detected on chest CT) in the resected segment through which air entered the main pulmonary vein.

The preventive measures to avoid serious complications in the present case were as follows:

1. Prevention of cerebral embolism: Air entry into the brain was prevented using the head-down tilt position during inflation.[4]
2. Maintenance of circulatory blood flow: Cardiac massage was started promptly and was continued for more than 60 min.
3. Minimization of tissue damage: A low body temperature was maintained after cardiopulmonary resuscitation.

Complications such those in the present case may occur during thoracic operation. There are many reports on intraoperative air embolism, but they were associated with severe complications and death in a few cases. This is the only case of recovery from an air embolism without any complication. Several studies have indicated that the head-down tilt position reduces the incidence of complications because it prevents cerebral embolism.[4] Therefore, the head-down tilt position should be used during thoracic surgeries that require positive-pressure ventilation.

Conclusion

We reported a case of a patient recovering from an air embolism without any complications. The head-down tilt position prevents severe brain damage in the case of air embolization, whereas continuous open-chest massage and low temperature prevent whole body damage. Thus, operation in the head-down position and a low body temperature is useful in preventing severe damage from air embolisms.

Acknowledgements

The authors would like to thank Editage (www.editage.com) for English language editing and publication support.

Data availability

All data related to this study are provided in the manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

Our institution does not mandate ethical approval for reporting individual cases or case series.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Informed consent

Written informed consent was obtained from the patient's wife for the publication of details of this case.

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