

CASE REPORTS

A probable fatal argon gas embolism during resection of a cutaneous biliary fistula – a case report



Karlyn Powell 

Baylor College of Medicine, Department of Anesthesiology, Houston, Texas, USA

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KEYWORDS

Argon beam coagulation system; Venous gas embolism; Pulmonary gas embolism

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Sistemas de coagulação por feixe de argônio; Embolia venosa gasosa; Embolia pulmonar gasosa

Abstract

Background: The Argon Beam Coagulator (ABC) achieves hemostasis but has potential complications in the form of argon gas embolisms. Risk factors for embolisms have been identified and ABC manufacturers have developed guidelines for usage of the device to prevent embolism development.

Case report: A 49 year-old male with history of recurrent cholangiocarcinoma status post resection presented for resection of a cutaneous biliary fistula. Shortly after initial use of the ABC, the patient underwent cardiac arrest. After resuscitation, air bubbles were observed in the left ventricle via Transesophageal Echo (TEE).

Conclusion: Although argon embolisms have been described more commonly during laparoscopies, this patient most likely experienced an argon gas embolism during an open resection of a cutaneous biliary fistula via the biliary tract or vein with possible transpulmonary passage of the embolism. Consequently, a high degree of suspicion should be maintained for an argon gas embolism during ABC use in laparoscopic, open, and cutaneous surgeries.

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Provável embolia letal por gás argônio durante ressecção de fístula cutânea biliar–relato de caso

Resumo

Introdução: A Coagulação por Feixe de Argônio (CFA) promove hemostasia, mas pode levar a complicações na forma de embolia por gás argônio. Os fatores de risco para embolias foram identificados e os fabricantes de aparelhos de CFA desenvolveram diretrizes para o uso do dispositivo para impedir a ocorrência de embolia.

E-mail: Karlyn.Powell2@bcm.edu

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Relato de caso: Paciente masculino de 49 anos com história de colangiocarcinoma recorrente pós-ressecção foi submetido à ressecção de fístula cutâneo-biliar. Logo após o início do uso do aparelho de CFA, o paciente apresentou parada cardíaca. Após o retorno da atividade cardíaca, a Eecocardiografia Transesofágica (ETE) detectou bolhas de ar no ventrículo esquerdo.

Conclusões: Embora a embolia associada ao argônio seja mais frequentemente descrita durante laparoscopia, este paciente mais provavelmente apresentou embolia provocada pelo argônio durante cirurgia aberta para ressecção de fístula cutâneo-biliar, após o argônio ganhar acesso à circulação sanguínea através das vias biliares ou da veia biliar e possível passagem do embolo pela circulação pulmonar. Desta maneira, deve-se suspeitar de embolia por argônio, de forma judiciosa, durante o uso de CFA em procedimento cirúrgico laparoscópico, aberto ou cutâneo. © 2020 Sociedade Brasileira de Anestesiologia. Publicado por Elsevier Editora Ltda. Este é um artigo Open Access sob uma licença CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Background

The Argon Beam Coagulator (ABC) has increased in popularity by surgeons for achieving hemostasis as it allows coagulation of surface tissue with a reduced risk of damage to underlying tissues. The ABC is able to achieve this through the application of an ionized argon gas beam to tissue, which clears the bleeding from the field and permits coagulation of the surface tissue.

Potential adverse outcomes of ABC use may not be fully appreciated by anesthesiologists or surgeons. Argon has low blood solubility compared to CO₂, which means that it is absorbed slowly from the bloodstream. Consequently, argon can pass readily into the circulation and cause right ventricle and pulmonary artery outflow blocks.

Several risk factors for the development of an argon gas embolism have been identified. High argon flow rates have been shown to be associated with an increased number of gas emboli, as evidenced in an animal study.¹ Embolisms can be caused by ABC use near an open vessel. When the argon gas pressure exceeds the pressure in open vessels, an argon gas embolus can be created. ABC use during laparoscopic surgery can lead to mixed argon CO₂ embolisms. Argon acts as a supplemental source of pressured gas in addition to CO₂ during insufflation. Laparoscopic insufflators can regulate CO₂ pressure if high insufflation pressures are reached, but the ABC can continue to supply argon gas.

ABC manufacturers have developed recommendations for equipment usage to prevent potential complications from embolisms. These include:

1. The use of the lowest gas flow necessary, which ranges from 2 to 4 L.min⁻¹ maximum for laparoscopic procedures and 10 L.min⁻¹ maximum for open procedures.¹⁻⁵
2. The avoidance of directing the beam into large, open blood vessels at high gas flows.⁵
3. The continuous monitoring of intra-abdominal pressures and the use of active venting by leaving one cannula open to atmosphere to prevent overinsufflation during laparoscopic procedures.²

4. The positioning of probe tip at least 3 mm away from the tissue, at a 45°–60° angle during ABC use, and away from tissue between activations.^{4,5}

Case report

A 49 year-old male with history of recurrent cholangiocarcinoma status post partial hepatectomy, hepatojejunostomy, and roux-en-Y surgeries presented for resection of a right biliary cutaneous fistula as an outpatient procedure. The patient had no history of intracardiac defects or other comorbidities.

The patient underwent an uneventful induction via a 20G peripheral IV and intubation. Within minutes of the initial use of the ABC unit (Conmed HelixAR ABC, Utica, NY), which occurred about ten minutes after incision, the end tidal CO₂ tracing was lost with the patient abruptly becoming bradycardic with subsequent cardiac arrest. The 1.5 cm long incision was located in the midclavicular line inferior to the right rib cage. Surgery performed a right chest tube thoracostomy given the close location of the procedure to the lungs, but there was insignificant air or blood output. The patient underwent Advanced Life Support (ALS) with a return of systemic circulation in 28 minutes. During ALS, the patient was placed in a slight head-down position to facilitate blood flow to the brain. Central venous access was obtained through the right femoral vein and an arterial line was placed in the left femoral artery. TEE after resuscitation demonstrated a dilated right ventricle with poor function and gas bubbles in the left ventricle. For the rest of the case the patient was tachycardic with systolic blood pressure in the 90s to 100s under inotropic and vasopressor support using adrenaline, noradrenaline, vasopressin, and dobutamine and epoprostenol for pulmonary hypertension. Exploratory laparotomy did not reveal any obvious injuries. However, diffuse oozing was noted from the peritoneum and liver requiring the transfusion of blood products. The liver was packed, and the abdomen was temporarily closed.

Postoperatively, the patient was transferred to the cardiovascular recovery room, where he developed progressive refractory hypoxemia despite maximal ventilator support. He was subsequently placed on Extracorporeal Membrane

Oxygenation (ECMO) within a few hours of arrival. He remained dependent upon inotropes and vasopressors. He was acidotic and anuric prompting placement on continuous renal replacement therapy. The patient remained comatose, and anoxic brain injury was suspected. Attempts to wean off ECMO were unsuccessful. Care was withdrawn on postoperative day four.

Conclusion

This patient most likely experienced an argon gas embolism during an open resection of a cutaneous biliary fistula with possible transpulmonary passage of the embolism. Intraoperative diagnosis was a pulmonary embolism, given the patient's cancer history after a pneumothorax had been ruled out. However, event occurrence within minutes after the first use of the ABC leads to the suspicion of an argon gas embolism. The air seen in the left ventricle on TEE was thought to have been caused by air entering the open vasculature during chest compressions, but it might have been evidence of transpulmonary passage of the embolism. Risk factors for an embolism in this case include:

1. The ABC setting on gas flows of 10 L.min⁻¹, instead of the lowest flow possible.
2. Lack of probe tip positioning as recommended by the manufacturer.
3. Altered biliary and hepatic anatomy from previous surgeries, which may have increased the patient's susceptibility to an embolism.

Most reported argon gas emboli have occurred during laparoscopies.^{2,3,6,7} In this case, the embolism may have passed through the biliary tract or vein to pass through the pulmonary vasculature during an open cutaneous procedure.

This case supports the belief that a high degree of suspicion should be maintained for an argon gas embolism during ABC use in laparoscopic, open, and cutaneous surgeries.

Consent for publication

The Institutional Review Board for the hospital does not require approval for case reports.

Conflicts of interest

The authors declare no conflicts of interest.

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