



Case Report

Paradoxical Carbon Dioxide Embolus: Rare Cause of Morbidity during Laparoscopic Cholecystectomy

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Abstract

Laparoscopic cholecystectomy is a very common surgical procedure with a low complication rate (2.0-2.5%), but one rare complication, venous gas embolism, can be potentially lethal. Venous gas embolism occurs when a gas embolism, carbon dioxide in the case of laparoscopic surgery, is entrapped either in a vein, artery, solid organ, leading to entrapment in the right sided circulation and ultimately circulatory collapse. A patent foramen ovale (PFO) is a congenital cardiac lesion that exists in approximately 20-30% of the population. If a patient with a PFO undergoing a laparoscopic procedure suffers from venous gas emboli during carbon dioxide insufflation, he or she may not only have hemodynamic collapse requiring cardiopulmonary resuscitation, but also paradoxical air emboli to the coronary and cerebral circulation. We presented such a case experienced at our institution.

Keywords: Attention bias; Temperament; Depression; Internalizing disorders; Anxiety; Cognitive emotion regulation

Introduction

Laparoscopic cholecystectomy is one of the most common surgical procedures performed in the developed world. As with any surgical procedure, complications do occur. Based on several studies, serious complications occur in approximately 2.0-2.5% of cholecystectomies [1]. One rare complication, venous gas embolism, can be potentially lethal [2]. Although most commonly associated with neurosurgical procedures with an incidence as high as 70-80% [3], it has been reported to occur during laparoscopic procedures although the incidence varies depending on the type of procedure [4]. Venous gas embolism occurs when a gas embolism, carbon dioxide in the case of laparoscopic surgery, is entrapped either in a vein, artery, solid organ, leading to entrapment in the right sided circulation and ultimately circulatory collapse.

A patent foramen ovale (PFO) is a congenital cardiac lesion that exists in approximately 20-30% of the population. This is based on several studies reviewing post-mortem findings [5]. Studies utilizing transesophageal echocardiography demonstrated a similar incidence of patent foramen ovale [6]. Closure of the PFO is typically complete by age 2 in approximately 70-75% of the population. Reasons leading to the failure of closure are said to be multifactorial—genetics and environmental [7].

If a patient with a PFO undergoing a laparoscopic procedure suffers from venous gas emboli during carbon dioxide insufflation, he or she may not only have hemodynamic collapse requiring cardiopulmonary resuscitation but also paradoxical air emboli to the coronary and cerebral circulation. While these patients are salvageable, quick response from the operating room team including cardiac anesthesiologists is essential for diagnosis and management. The following is a recent case experienced at our institution.

Case Presentation

A 61 year-old Hispanic female with a past medical history of hypertension, hyperlipidemia, and diverticulosis presented for elective outpatient laparoscopic cholecystectomy in the setting of cholelithiasis. Social history indicates that she is a chronic alcohol user, and a chronic smoker. Home medications include Toprol XL. There were no known medication allergies; however she has an allergy to shellfish.

On the day of surgery, the patient was brought into the operating room and placed supine on the operating table. A 20-gauge peripheral intravenous catheter was inserted. Midazolam 1 mg IV was administered pre-induction. Patient was pre-oxygenated with 100% FiO₂ via facemask. Induction was achieved with Fentanyl 100 mcg IV, and Propofol 100 mg IV. She was easy mask ventilation with the aid of an oral airway. Succinylcholine 100 mg IV was administered for paralysis. Direct laryngoscopy and intubation was straightforward. A Grade I view was obtained with a Machintosh size 3 blade. The airway was secured with a 7.0 cuffed endotracheal tube. Anesthetic maintenance was achieved with inhaled Sevoflurane.

The patient was prepped and draped in the usual fashion by the surgical team. Pneumoperitoneum with carbon dioxide was established via a Veress needle. Shortly after insufflation of the abdomen started, the anesthesia team noted a sudden decrease in heart rate to the 40 s, blood pressures to 40/20 s, and end tidal carbon dioxide to 5. Glycopyrolate 0.3 mg IV, Atropine 0.4 mg IV, and Ephedrine 20 mg IV were administered. Peripheral pulses were not appreciated, and advanced cardiac life support was initiated per protocol. Additional help was requested. Return of spontaneous circulation was achieved after 5 minutes. The planned cholecystectomy was aborted.

A cardiac anesthesiologist was requested and a transesophageal echocardiography probe was placed. Large

amounts of air were appreciated in the left pulmonary artery (Figure 1).

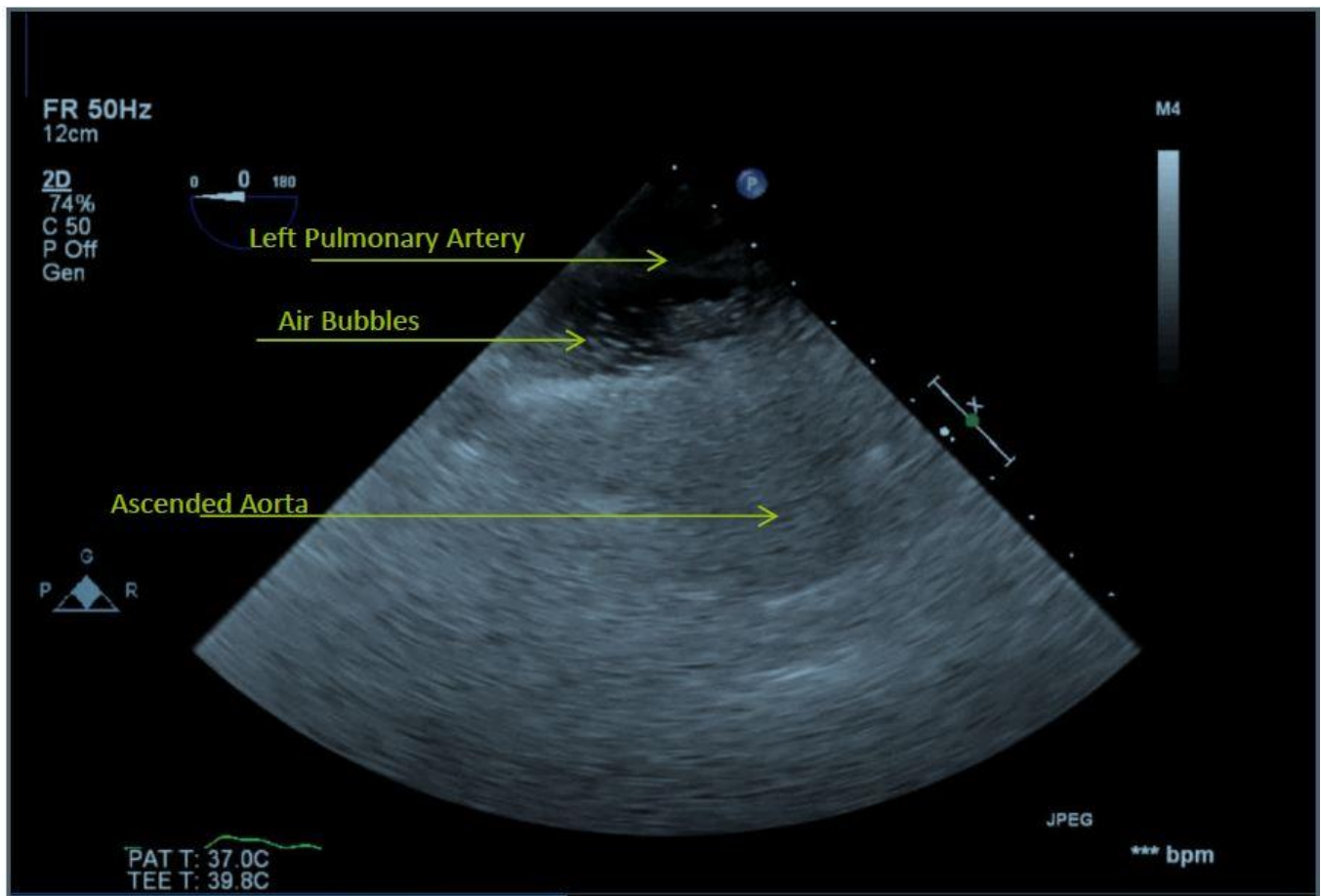


Figure 1: Mid-esophageal view of ascending aorta and left pulmonary artery demonstrate air bubbles in the left pulmonary artery.

Air bubbles were seen on the left side of the heart. Also appreciated was a large patent foramen ovale with an unobstructed right to left shunt and bubbles crossing to the left side (Figure 2). Left ventricular systolic function was mild to moderately depressed with an systolic ejection fraction of approximately 30%. There were no valvular abnormalities. A right radial arterial line was emergently placed. Blood gases and basic laboratory studies were drawn and sent. A right internal jugular triple lumen central venous catheter was placed. Attempts were made to aspirate remaining gas bubbles from the right atrium. Repeat echocardiography after several attempts at aspiration demonstrated no residual gas bubbles in the heart chambers.

The patient was emerged from anesthesia. She was following basic commands and was breathing spontaneously with acceptable minute ventilation. She was transferred to the post-anesthesia care unit intubated and subsequently extubated after several hours. Neurological exam in the post-anesthesia recovery room demonstrated marked right sided hemiparesis, dysarthria, a left gaze deviation, and a right homonymous hemianopia. Neurology was consulted. Initial Head CT demonstrated no acute intraparenchymal hemorrhage or acute infarction. The neurological symptoms

that were initially appreciated resolved slowly over an hour, eventually leading to mild residual right sided weakness.

The patient was admitted to the intensive care unit where she further regained right sided function. A repeat head CT two days post-cardiac arrest now demonstrated an acute left middle cerebral artery territory infarct as evidenced by hypodense areas of poor gray-white differentiation (Figure 4). Physical therapy, occupational therapy, and speech pathology worked with the patient throughout her hospital admission. She was ultimately discharged to a rehabilitation facility 23 days after suffering cardiac arrest.

Discussion

Laparoscopic cholecystectomy has several benefits over traditional open surgical technique including less post-operative pain, better cosmetic appearance of surgical wounds, decreased length of hospital stay, and decreased length of disability from work [8]. Interestingly according to some references, the rates of complications, specifically biliary injuries, appear to be higher with laparoscopic versus open technique. In the case of laparoscopic cholecystectomies, the most common complications include bleeding, infection, biliary injury, bile leak, bowel injury [9].

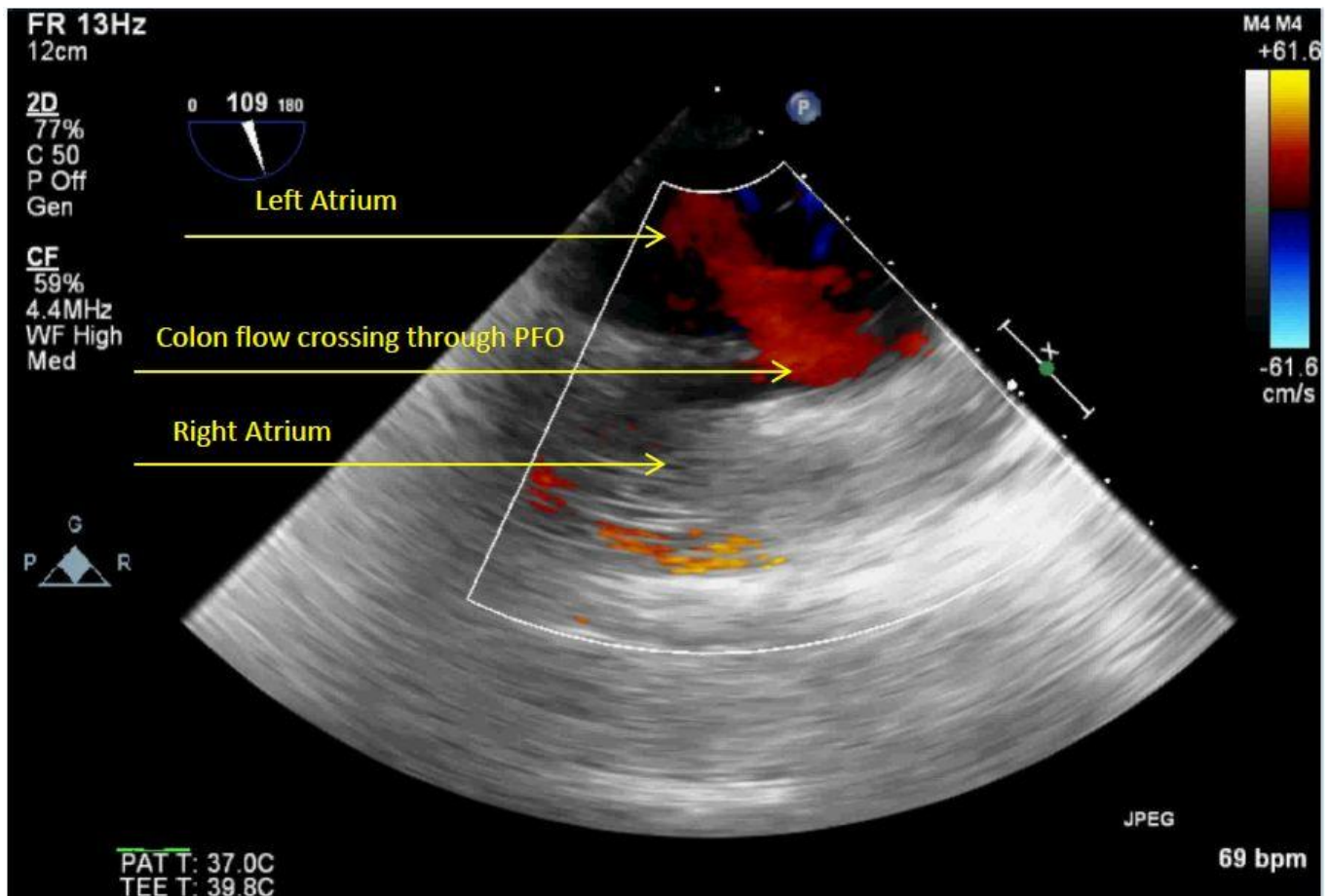


Figure 2: Mid-esophageal bicavalview demonstrate wide open patent foramen ovale (PFO) with color flow crossing from right to left atrium.

The phrase 'paradoxical embolus' refers to emboli originating in the venous system which cross from the right heart to the left by means of a shunt. These shunts are often times patent foramen ovals, however they can also exist as other types of atrial or even ventricular septal defects. Although paradoxical emboli could be 'clinically silent', these can potentially lead to catastrophic ischemia of an end organ. Aside from being thromboses, emboli can also originate as air, amniotic fluid, fat, tumor, and even carbon dioxide especially in the setting of laparoscopic surgery.

The case above is an example of paradoxical carbon dioxide emboli leading to cerebrovascular accident and cardiac arrest. Intraoperative cerebrovascular accident was recognized by performing a thorough neurological exam after the patient emerged from general anesthesia. It points out the fact that one develops physical symptoms long before computed tomography imaging demonstrates any changes suggestive of an acute stroke. In our case, changes on imaging manifested approximately 48 hours after the initial insult. Therefore, patients with focal neurological deficits post-operatively should be investigated further and closely followed even if initial imaging appear to be unremarkable.

Recovery from an intraoperative cardiac arrest hinges on rapid recognition of decompensation and subsequent treatment targeted at the inciting event. In our case, the use of transesophageal echocardiography by the cardiac anesthesiologist contributed to a successful resuscitation. Although not a standard per the advanced cardiac life support (ACLS) protocol, this case demonstrates the potential benefit of utilizing echocardiography as an aid during resuscitative attempts. By no means should echocardiography delay or interfere with basic resuscitative efforts.

Conclusion

Given that patent foramen ovals are found in approximately 20-30% of the population, there always exists an opportunity for paradoxical carbon dioxide emboli should any of these individuals undergo laparoscopic surgery. Per one review article, the incidence of carbon dioxide embolus during laparoscopic surgery ranges anywhere from <1% to approximately 50%. This large range is likely due to multiple factors—one being the type of surgery performed, and the other being the modality of detection of these emboli [4].

Logically, some surgeries have higher risks of carbon dioxide emboli compared to others. Likewise, certain modalities are more sensitive in detecting these emboli. Nonetheless, the absolute percentage of clinically significant emboli remains unclear. Although the use of routine echocardiography imaging is recommended in setting of thromboembolic events [10], one has to question the feasibility of routine echocardiography imaging prior to laparoscopic surgery in an attempt to prevent what is already an extremely rare complication.

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