



Gas Embolism After a Patient's Ninth ERCP Procedure

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ABSTRACT

Gas embolism is a rare and potentially fatal complication of endoscopic retrograde cholangiopancreatography (ERCP). We present a 66-year-old man who developed gas embolism after undergoing therapeutic ERCP for cholangitis. Some risk factors of gas embolism in this patient included stones in the common bile duct with cholangitis and a history of multiple ERCP procedures. Early diagnosis and rapid treatment of this potentially fatal complication resulted in our patient's full recovery.

KEYWORDS: gas embolism; endoscopic retrograde cholangiopancreatography; choledocholithiasis; hepaticojejunostomy

INTRODUCTION

Endoscopic retrograde cholangiopancreatography (ERCP) has become an important tool for diagnosing and treating biliary and pancreatic duct pathology. This is a complex procedure with a relatively high rate of complications¹ including post-ERCP pancreatitis, bleeding or duodenal perforation after sphincterotomy, cholangitis, and gas embolism, which is a rare, catastrophic complication with significant morbidity and mortality. Gas emboli after endoscopic procedures have been reported in the literature and are most often associated with ERCP.² Therefore, it is crucial to identify clinical manifestations of gas embolism and risk factors to improve management.³

CASE REPORT

A 66-year-old man was admitted to the surgical department with cholangitis, which presented with right upper abdominal pain, fever, and jaundice. The patient had a history of sleep apnea, obesity, and distant cholecystectomy and had undergone therapeutic ERCP 8 times previously because of choledocholithiasis. Evaluation of the patient revealed an elevated white blood cell count, elevated alkaline phosphatase, total bilirubin of 7.8 mg/dL, and common bile duct (CBD) dilatation to 14 mm on ultrasound.

Twelve hours after admission, therapeutic ERCP was initiated in the operating room. The patient was anesthetized, intubated, and placed in the prone position for the procedure. The duodenoscope was inserted and advanced to the second part of the duodenum, revealing the papilla after papillotomy. Insufflation with O₂ was performed. The papillotome was inserted into the CBD; contrast dye injected through the papillotome revealed 3 filling defects. Subsequently, the balloon was inserted and 3 stones were extracted, each sized 15 mm, along with pus. A plastic stent was inserted into the CBD without complications.

After successful completion of the procedure, his status began to deteriorate and a rapid decrease of end tidal CO₂ was seen on the monitor. Initially, an obstruction or displacement of his ventilatory tube was suspected, so it was removed and a new one was inserted. However, the patient continued to deteriorate; his blood pressure dropped and he developed asystole. Cardiopulmonary resuscitation (CPR) was initiated immediately and performed for 10 minutes until return of spontaneous circulation was achieved.

Ensnuing CPR, an urgent evaluation of the patient was initiated. Electrocardiogram was normal without evidence of ischemic changes, and chest x-ray was normal without evidence of pneumothorax or pneumonia. However, a bedside echocardiogram revealed air bubbles in the right atrium and ventricle and a reduced ejection fraction of 30%. Chest and abdominal computed tomography angiography did not reveal pulmonary embolism or perforation but demonstrated air within the inferior vena cava and femoral veins (Figure 1).

The patient was admitted to the intensive care unit with diagnosis of gas embolism. He remained intubated and anesthetized for 1 day. On the second day, his condition began to improve and vital signs stabilized. The patient was extubated and was alert, without complaints, and returned to his baseline status.

DISCUSSION

Gas embolism is a rare and catastrophic complication of ERCP, which is difficult to recognize in a timely manner because of its variable presentation.⁴ Because early detection is crucial, gas embolism should be high on the differential diagnoses for cardiac arrest after ERCP, especially in patients with predisposing risk factors. ERCP-associated gas embolism (EAGE) is increasingly reported in the literature, likely because of an increased use of ERCP as an effective and minimally invasive procedure.⁴ A 2013 systematic review identified 26 cases to date, with a mortality rate of 46%.^{5,6} However, a more recent review in 2019 counted 51 cases, indicating a significant increase in the incidence of this life-threatening complication.⁷

EAGE occurs because of high insufflation pressures during ERCP that favor air entry into adjacent vessels. Clinical risk factors include CBD stones, ascending cholangitis, and previous biliary interventions or surgeries, as seen in our patient, as well as any gastrointestinal inflammation, fistulas in the enteric tract, and previous biliary stent, all of which are associated with compromised mucosal

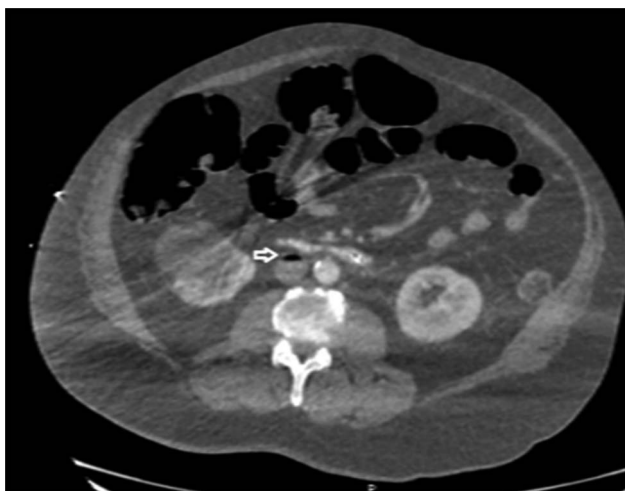


Figure 1. Computed tomography angiography performed after the patient stabilized demonstrated air within the inferior vena cava.

barriers and direct communication with the venous system.^{5,7,8} Therapeutic procedures that carry a higher risk are cholangioscopy, stent removal and replacement, and endoscopic sphincterotomy, which are associated with a greater potential to disrupt the mucosal/vascular barrier.^{5,7,9} No EAGEs have been documented during solely diagnostic procedures or stent removal.⁹

Lanke et al proposed a comprehensive treatment algorithm in 2019: If gas embolism is suspected, stop the procedure immediately, withdraw the endoscope to reduce the pressure gradient, and stop administration of NO₂ if relevant.^{5,7} For all patients, administer hyperbaric O₂ to facilitate gas dissolution and intravenous fluid to increase central venous pressure and prevent further gas entry into circulation.⁴⁻⁸ For suspected venous gas embolism, place the patient in the left lateral position (Durant position) and Trendelenburg position; a central venous catheter can be placed to aspirate excess gas.^{5,7} For pulmonary embolism, anticoagulation is recommended. For suspected arterial embolism, the patient should lie supine and flat as blood flow to the head aggravates cerebral edema. For hemodynamic collapse, proceed with CPR, which additionally breaks up larger bubbles and may reduce right ventricular pressure.^{5,7}

Measures have been suggested to reduce occurrence of EAGE, including use of CO₂ as the insufflation agent because of its greater water solubility and endoscopic setups that allow regulation of gas units insufflated to prevent excessive intraluminal pressures.^{4,5,9,10} Several studies have endorsed increased monitoring during ERCP for earlier detection and better outcomes, by intubation with EtCO₂ monitoring to observe the rapid decrease in EtCO₂ characteristic of EAGE, and by using precordial Doppler ultrasound, which detects air in the heart and pulmonary vasculature.^{5,9}

Younis et al raised the important question of when to abandon endoscopy altogether in patients with complex choledocholithiasis as repeat procedures increase risk of complications, as shown in our patient, who underwent 8 previous ERCPs, the first at the age of 59 years.¹¹ In addition to complications such as pancreatitis, cholangitis, and hemorrhage, repeat ERCP + endoscopic sphincterotomy (ES) procedures are themselves a risk factor of recurrent CBD stones, either through post-ES papillary strictures or duodenobiliary reflux that introduces intestinal tract bacteria into the CBD.^{12,13}

Younis et al proposed re-examining the use of laparoscopic bile duct exploration rather than ERCP + ES, especially in young patients. Our patient had been recommended a hepaticojejunostomy, yet he did not undergo the procedure and instead was treated with repeat ERCPs. In effect, few cases are referred to surgical bilioenteric anastomosis because of loss of expertise among surgeons with bile duct exploration surgeries because ERCP is overwhelmingly the modality of choice.¹¹ However, a study of outcomes in patients who underwent surgical treatment after failed ERCPs and found bilioenteric anastomosis (choledochoduodenostomy, hepaticojejunostomy) to be a highly

safe and effective long-term solution, suggesting that practical skill in this surgical procedure is still needed.¹¹ In addition, ursodeoxycholic acid has been found to reduce the recurrence of CBD stones by a factor of 3 and could provide an alternative treatment to repeat ERCPs and should be further examined.¹⁴

DISCLOSURES

Author contributions: HS Ahmad: patient management, drafting the manuscript. SA Cohen: literature review, drafting the manuscript. R. Tome, H. Zeibak: patient evaluation and management, critical revision. T. Khoury, W. Abboud: patient evaluation and management, critical revision for intellectual content. A. Mari: critical revision for intellectual content and is the article guarantor.

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