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Systemic Air Embolism During ERCP : A Case Report and Focus on Identification and Management

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1. Abstract

Endoscopic Retrograde Cholangiopancreatography (ERCP) is both a diagnosis and treatment for hepatobiliary and pancreatic diseases. Due to its minimally invasion and fast track, ERCP is one of the most frequently performed procedures in endoscopic operation. Known complications of ERCP including pancreatitis, hemorrhage, acute cholangitis, duodenal perforation, hepatic hematoma and sepsis and cardiopulmonary changes. However, systematic air embolism (SAE) is a rare but fatal complication of ERCP. Here, we concerned a case of SAE happened in a 42-year-old male during ERCP for choledocholithiasis. The patient presented with sudden cardiopulmonary instability and decreased end-tidal carbon dioxide (eTCO2, 12mmHg) during operation. After the patient revived from anesthesia, he presented with neurologic symptoms and marble-like rashes appeared on his back. Then emergent Computed Tomography (CT) scan were performed and showed air bubbles in right ventricle, pulmonary artery trunk and spinal canal. The patient was diagnosed SAE and provided rehydration to maintain circulatory and respiratory stability. The patient was transferred to a superior hospital for Hyperbaric Oxygen Treatment (HBO). Present experience stresses that a close vigilance during ERCP is critical to ensure early identification and timely management.

2. Introduction

Mild venous air embolism can be asymptomatic, but the severe cases can be fatal. Since air embolism is not specifics, and large amounts of air embolism often result in rapid and severe clinical deterioration that can lead to cardiac arrest, respiratory failure, and paraplegia. ERCP is one of the most frequently performed procedures for the diagnosis and treatment of biliary-pancreatic diseases, related complications including pancreatitis, hemorrhage, acute cholangitis, duodenal perforation, hepatic hematoma and sepsis and cardiopulmonary changes. We present a case report about SAE during ERCP in our hospital. In addition, literature review was conducted to summarize the prudent prevention, early identification and timely reasonable treatment management of air embolism in ERCP.

3. Case Report

A 42-year-old male who has repeated upper abdominal pain for 11 days was admitted to our hospital. Laboratory examination showed: white blood cells 42.45x109 / L, neutrophils 95.7%, C reaction protein 104.0mg/L. Alanine aminotransferase(ALT)187U/L, aspartate aminotransferase (AST) 72U/L, total bilirubin 47.14umol/L, amylase 59U / L, lipase 101U / L. Upper abdominal CT scan report indication: (1) consider the lower common bile duct stones with biliary tract inflammation, (2) inflammatory stricture at the end of the common bile duct. (3) multiple cysts in the liver. (4) chronic cholecystitis. The main diagnosis was acute suppurative obstructive cholangitis and common bile duct stones. On the second day of admission, clear diagnose after the exclusion of surgical contraindications, electronic endoscopic retrograde cholangiopancreatography plus electronic endoscopic nasal bile duct drainage (ENBD) for drainage bile. On the 10th day of admission, the ERCP to remove common bile duct stones was taken. The patient underwent systemic intrave-

nous anesthesia and was given anesthesia with propofol, remifentanil hydrochloride, and atrafene benzenesulfonate. During ERCP, the first common bile duct stone was smoothly discharged into the duodenum (Figure 1), but the second stone was large in diameter and could not be taken out directly, then the duodenal papillary balloon was dilated. When the balloon is expanded and ready to pull out the second stone, the patient's vital signs suddenly change. The patient presented with sudden cardiopulmonary instability, including tachycardia (120 beats/min), hypotension (55/22mmHg), hypoxia and decreased end-tidal carbon dioxide (eTCO2, 12mmHg). After administration of vasoactive drugs and increasing concentration of oxygen inhalation, the vital signs gradually returned to normal. The second stone was successfully taken out and one piece of the nasal bile duct was placed and drainage was unobstructed. The patient recovered from anesthesia, with blurred consciousness, poor response, grade 4 muscle strength in the right upper limb, normal muscle tension, grade 2 muscle strength in the left upper limb; grade 0 muscle strength in both lower limbs. Absolutely, a large number of flaky erythema appeared on the back (Figure 2). The emergency brain, chest and abdomen CT scan and enhanced examination immediately were performed. We suspect that patients have air embolism, immediately adjust the patient's position, head low foot high, high flow oxygen, intravenous rehydration, transfer to severe ICU support treatment. Emergent CT scan showed air bubbles in right ventricle, pulmonary artery trunk and spinal canal (Figure 3). The patient was diagnosed with systemic gas embolism, determined by Hyperbaric Oxygen Therapy (HBO) for neurological dysfunction, and immediately transferred to a hyperbaric oxygen hospital for treatment. The patient's current consciousness is clear, the upper limbs have normal muscle strength, and move freely, but there is still weakening of the lower extremity muscles, and the muscle strength is only secondary grade.

Figure 1: The first common bile duct stone was smoothly discharged into the duoden.

Figure 2: A large number of flaky erythema appeared on the back.

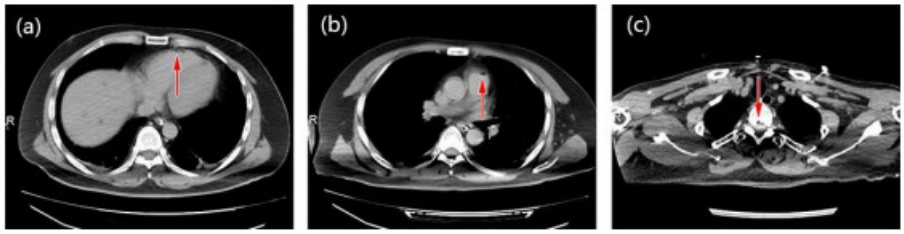


Figure 3: CT shows air bubbles in right ventricle, pulmonary artery trunk and spinal canal.

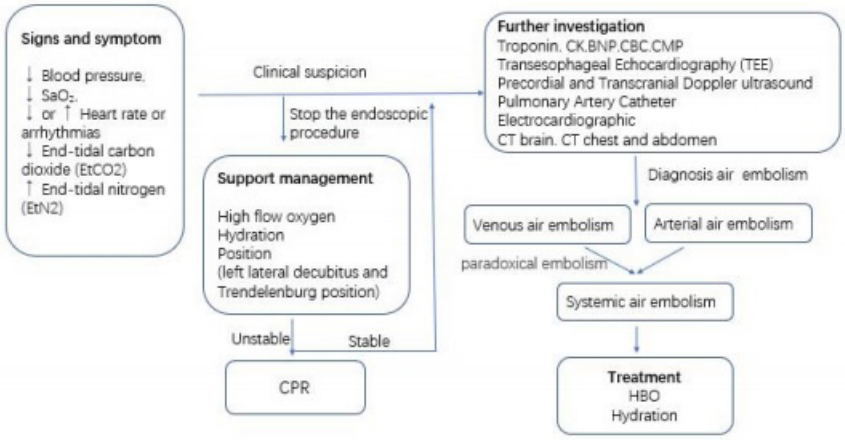
4. Discussion

SAE is a rare but fatal complication, mainly caused by surgery and various invasive procedures. According to the US 1998-2013 National Inpatient Samples, the probability of air embolism complications in all endoscopic procedures in hospital was 0.00057% (13/2, 245291), the probability of air embolism in ERCP operation is 0.0032% [1]. This data also shows that air embolization has the highest incidence of endoscopic procedures.

SAE may happen in three situations: (1) The air bubbles are directly embolized into the pulmonary veins and from there into the systemic

circulation. (2) Gas embolism enters the pulmonary system, followed by incomplete filtration of air bubbles by the pulmonary capillaries. (3) Abnormal embolization through a functional right to left shunt (eg, patent foramen ovale) [2]. In this case, we speculated that the possible cause was the presence of biliary tract fistula based on intraoperative conditions and postoperative adjuvant examination. The most likely explanation is that due to long-term involvement and infection of biliary sandstone secondary to chronic injury of the relevant catheter, the resulting biliary tract spasm causes intermittent gradient pressure air introduced during ERCP to enter the hepatic vein [3].

Air embolism is secretive and critical, and early identification and timely treatment are important. It's vital to build the identification and management of SAE (Figure 4). The operator closely observes the changes in the vital signs of the patients during the operation, makes full use of the auxiliary examination, and recognizes the gas embolism as early as possible, which can reduce the occurrence of adverse events. The warning signs of impending cardiovascular failure may be subtle, but a sudden decrease in end-tidal carbon dioxide, hypoxia, bradycardia, hypotension, and arrhythmia should be used as a warning sign that the patient may have air embolism [4]. If the patient does not wake up after ERCP or if there is a cardiopulmonary problem during the procedure, auscultation, transthoracic echocardiography, acute thoracic CT and brain CT scans should be performed immediately. CAE diagnosis needs a variety of techniques including ultrasound, perioperative monitoring, computed tomography, brain magnetic resonance imaging and other methods [5]. Transesophageal echocardiography is the most sensitive method of detection, but it is invasive. Doppler ultrasound in the anterior region is almost as sensitive and does not pose any risk to the patient. The use of chest Doppler ultrasound (PDU) can help detect VAE during ERCP, especially in high-risk treatments. Monitoring with echocardiography allows direct visualization of the right heart chamber so that air can be detected before the onset of symptoms [3].



HBO, Hyperbaric oxygen therapy; CPR, Cardio-pulmonary resuscitation
CBC, Complete blood count; CMP, Complete metabolic panel; CK, Creatine kinase; BNP, Brain natriuretic peptide; CT, Computed tomography; SaO2, Oxygen saturation

Figure 4: Identification and management of SAE.

4.1. For Treatment

The termination procedure should be the first step in treatment to prevent further gas ingress. Hemodynamics and respiratory stability should be a top priority. CPR should be started as soon as needed. Protect the airway and provide adequate ventilation and oxygenation for endotracheal intubation and carbon dioxide monitoring. In the case of pulmonary embolism, the treatment of venous air embolism by central venous catheter aspiration has been widely established [4].

For venous embolism management, start with a high flow of O2 (which can be 100% O2), increase oxygen saturation, and help dissolve bubbles. Rapid recovery and increased capacity to increase venous pressure to prevent gas from continuing into the venous circulation.6 Hyperbaric oxygen therapy is not a first-line treatment for venous air embolism, but may be a useful adjunct in severe cases. If there is evidence of a neurological change, it should be considered.

For arterial air embolism and systemic air embolism management, immediately give 100% O2 inhalation to protect and sustain life. Patients with arterial embolism should be lying supine in the supine position [7]. Intravenous infusions to maintain blood circulation: blood concentration has been reported in CAE, therefore, infusion in CAE patients is conducive to normal blood volume. For blood dilution, a colloidal solution is preferred because the crystals promote brain edema [5]. HBO is the preferred treatment for patients with stable disease [5-8]. Hyperbaric therapy can reduce the volume of bubbles, increase the diffusion gradient in bubbles, oxygenation of hypoxic tissue, improve brain edema, reduce platelet aggregation, and activate the coagulation cascade due to endothelial damage caused by bubbles Reduces endothelial binding of leukocytes and prevents the release of oxygen free radicals [9]. Hyperbaric oxygen also dissolves large amounts of oxygen in the plasma and increases the extent of oxygen diffusion in the tissue. Improvements in plasma oxygen carrying ca-

pacity and improvements in oxygen delivery to the tissue counteract damage to the microvasculature by embolization [5, 6]. In addition, the use of CO2 instead of air seems to reduce the risk of embolism.

5. Conclusion

SAE is a serious complication of endoscopic surgery with high morbidity and mortality. A close vigilance during ERCP is critical to ensure early identification and timely management. Doppler ultrasound in the anterior region is an almost sensitive and noninvasive identification method. The physiological mode of HBO supports the high-pressure therapy of SAE. And CO2 applied instead of air during ERCP was deemed to reduce the risk of embolism.

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