Development of fatal systemic gas embolism during direct peroral cholangioscopy under carbon dioxide insufflation

Direct peroral cholangioscopy (DPOCS) is a useful and effective technique for diagnosis and therapy of biliary tract disease [1–3]. No instances of a fatal systemic gas embolism developing during DPOCS under carbon dioxide (CO₂) insufflation have yet been reported.

A 68-year-old woman was admitted to our hospital with a complaint of hepatolithiasis (Fig. 1). She had undergone Roux-en-Y hepaticojejunostomy for choledochal cysts 34 years previously. We performed DPOCS using a short-type double-balloon enteroscope (DBE), an ultrasmall endoscope, and an endoscopic CO₂ regulator (EC-450B15, EG-580NW, GW-1, respectively; Fujifilm Corp., Tokyo, Japan) while the patient was kept adequately sedated with midazolam.

We planned to perform lithotripsy of the hepatolith using a Holmium:YAG laser. After we had reached the anastomosis using the DBE, attempts to extract the stones through the DBE using balloon or basket catheters failed (Fig. 2a). We therefore decided to perform DPOCS with an ultrasmall endoscope passed through an overtube using a previously described method (Fig. 2b) [3]. The balloon attached to the overtube remained inflated from the time that we reached the anastomosis until the end of the procedure.

We first confirmed the hepatolith was present (Fig. 3a). We then prepared the Holmium:YAG laser for lithotripsy for 5 minutes, while we aspirated pus and mucus discharged from the peripheral bile duct near the hepatolith. As we fractured the hepatolith with the Holmium:YAG laser (Fig. 3b), the patient suddenly went into shock and had a cardiac arrest. Despite immediate cardiopulmonary resuscitation and injection of flumazenil, she died. A computed tomography (CT) scan performed during resuscitation revealed multiple gas emboli in the systemic arteries and veins (Fig. 4).

Pathological examination later revealed hepatic abscesses, inflammation surrounding the hepatolith, intravascular gas, and systemic gas emboli [4]. There was no evidence of a patent foramen ovale [5]. The cause of death was systemic gas embolism. We believe aspiration of pus and mucus prior to lithotripsy may have opened a pre-existing biliovenous shunt. Endoscopists should take the possibility of fatal gas embolism into consideration during DPOCS even under CO₂ insufflation. The extent of insufflation should be the absolute minimum required.

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**Fig. 1** Images of a hepatolith (white arrow), 20 mm in diameter, in the left intrahepatic bile duct on: a computed tomography (CT) scan; b magnetic resonance cholangiopancreatography (MRCP).

**Fig. 2** Radiographic images showing: a an attempt to extract the stones through the double-balloon enteroscope (DBE) from the distal side of the anastomosis; b an ultrasmall endoscope, which had replaced the DBE, advanced into the bile duct.

**Fig. 3** Views via the ultrasmall endoscope showing: a the hepatolith along with pus and mucus in the left intrahepatic bile duct; b the proximal bile duct beyond the hepatolith seen at the moment of lithotripsy using a Holmium:YAG laser after mucus and pus had been removed.
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Competing interests: None

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Fig. 4  Computed tomography (CT) scan during resuscitation showing multiple gas emboli in the systemic arteries and veins of: a the brain; b the heart.