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

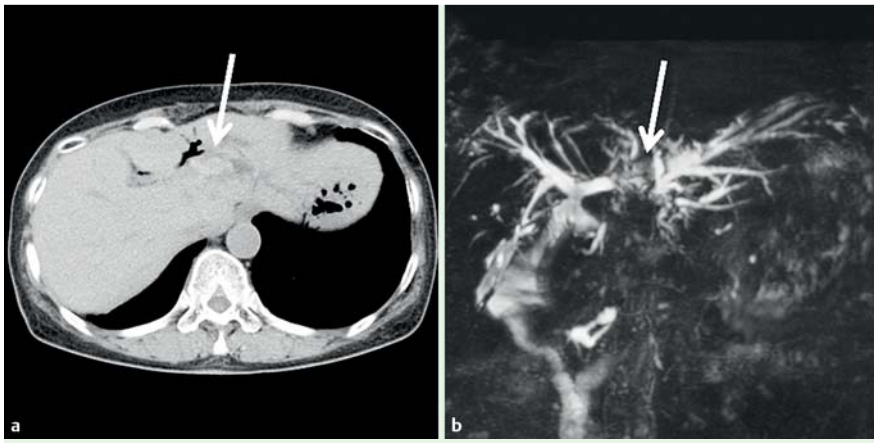

**Fig. 1** Images of a hepatolith (white arrow), 20 mm in diameter, in the left intrahepatic bile duct on: **a** computed tomography (CT) scan; **b** magnetic resonance cholangiopancreatography (MRCP).

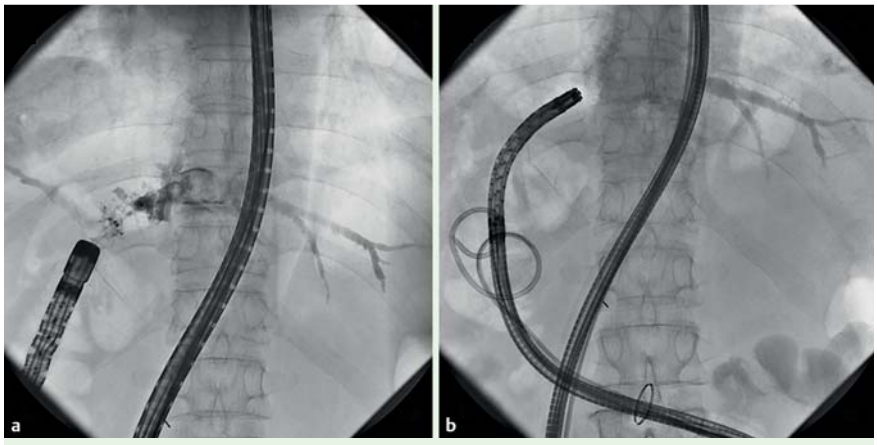

**Fig. 2** Radiographic images showing: **a** an attempt to extract the stones through the double-balloon enteroscope (DBE) from the distal side of the anastomosis; **b** an ultraslim endoscope, which had replaced the DBE, advanced into the bile duct.

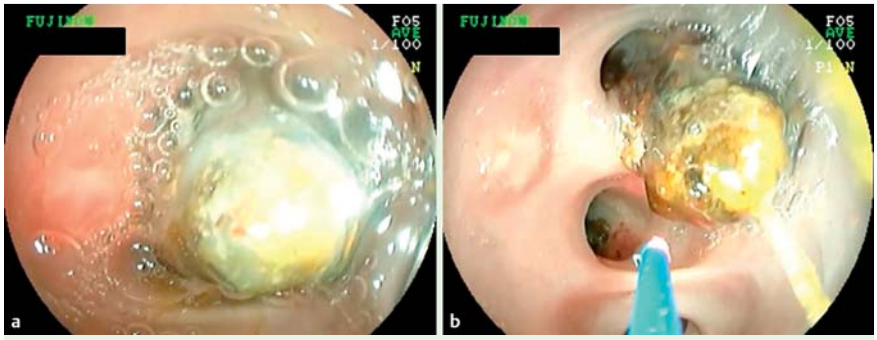

**Fig. 3** Views via the ultraslim endoscope showing: **a** the hepatolith along with pus and mucus in the left intrahepatic bile duct; **b** the proximal bile duct beyond the hepatolith seen at the moment of lithotripsy using a Holmium:YAG laser after mucus and pus had been removed.

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 ($CO_2$) 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 ultraslim endoscope, and an endoscopic $CO_2$ regulator (EC-450BI5, 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 ultraslim 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 cardiomegaly 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 $CO_2$ insufflation. The extent of insufflation should be the absolute minimum required.

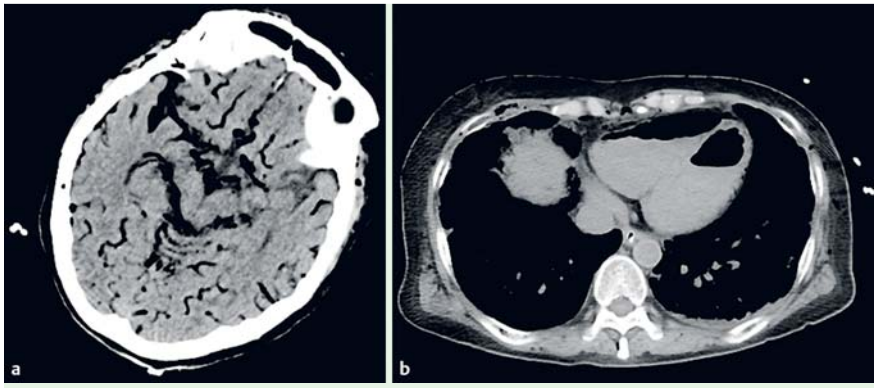


**Fig. 4** Computed tomography (CT) scan during resuscitation showing multiple gas emboli in the systemic arteries and veins of: **a** the brain; **b** the heart.

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**Competing interests:** None

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## Bibliography

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