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INTERVENTIONAL RADIOLOGY

TECHNICAL NOTE

Minimally invasive management of a post-cholecystectomy bile leak using a microvascular plug

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ABSTRACT

Bouveret syndrome is a rare form of gallstone ileus in which a gallstone causes gastric outlet obstruction via a cholecystoenteric fistula. We present the case of an elderly patient who underwent emergency surgery due to clinical signs of gastric outlet obstruction. Intraoperatively, a large gallstone was identified and removed from the duodenum. A subtotal cholecystectomy was performed, during which the identification of the course of the cystic duct was limited due to considerable inflammatory changes. In the early postoperative period, bile-stained output from the surgical drain raised suspicion of a leak from the cystic duct stump. Given the patient's clinical status and the complexity of the local anatomy with severely inflamed and fibrotic tissues in the hepatoduodenal ligament, the decision was made to proceed with percutaneous treatment. A percutaneous transhepatic biliary drainage was established, and contrast extravasation from the cystic duct remnant was confirmed via fluoroscopic cholangiography. Through the same access, a microvascular plug was successfully deployed into the cystic duct, achieving immediate cessation of bile leakage. The patient's clinical condition improved markedly, and no further intervention was required. This case demonstrates the successful off-label use of polytetrafluoroethylene-covered vascular occlusion devices in managing biliary complications.

KEYWORDS

Cystic duct stump, bile leak, cholecystectomy complication, interventional radiology, microvascular plug, biliary embolization, iatrogenic injury

A leak from the cystic duct stump is an uncommon complication following cholecystectomy, with a reported incidence ranging from 0.3% to 2%, varying depending on the surgical context and patient factors.[1] Interventional radiology has played an increasingly major role in managing biliary leaks, particularly when conventional surgical or endoscopic options are limited. Techniques such as percutaneous drainage or embolization have been documented in the literature for controlling bile leaks. However, the use of microvascular plugs (MVPs), devices traditionally employed in vascular interventions, has not yet been explored in the context of biliary tract occlusion.

This note describes a case of cystic duct stump leakage following open cholecystectomy in the context of Bouveret syndrome that was successfully treated with percutaneous embolization using an MVP.

Methods

A 71-year-old Caucasian male patient presented to the emergency department with multiple episodes of vomiting (up to six times daily) and considerable oral intolerance over 3 days. Clinically, a distended abdomen with diffuse tenderness was noted on presentation, without signs of peritonism. Laboratory investigations on admission showed elevated inflammatory and hepatobiliary parameters. Written informed consent was obtained from the patient for publication of this case and accompanying images.

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Contrast-enhanced multiphase multidetector computed tomography of the abdomen (Somatom X.ceed, Siemens Healthineers, Forchheim, Germany) revealed a markedly distended stomach with upstream gastric outlet obstruction. A large, hyperdense intraluminal gallstone measuring approximately 4 cm was visualized in the descending duodenum. Additionally, the gallbladder appeared atrophic, with evidence of a cholecystoduodenal fistula. These findings were consistent with Bouveret syndrome (see Figure 1a, b).

Following radiological suspicion of gastric outlet obstruction due to a gallstone, the patient underwent emergency exploratory laparotomy. Intraoperatively, a large gallstone was identified and extracted from the duodenum. The cholecystoduodenal fistula was closed primarily with sutures and an omental patch, and a subtotal cholecystectomy was performed, leaving the fibrotic back wall of the gallbladder *in situ*, which was coagulated with bipolar forceps. The fragile and fibrotic cystic duct stump was oversewn with a 4/0 polydioxanone suture. At the end of the operation, white gauze was temporarily placed in the gallbladder fossa and on the cystic duct stump, showing no evidence of a bile leak.

However, on the first postoperative day, approximately 300 mL of bile-stained fluid was observed in the intra-abdominal Robinson drain over 24 hours, raising clinical suspicion of a cystic duct stump leak. Therefore, the interventional radiology team was consulted for further evaluation and image-guided treatment. On the following day (postoperative day 2), an ultrasound-guided puncture of the right biliary system was performed with a 22G needle (Neff Percutaneous Access Set™, Cook Medical, Bloomington, IN, USA) under local anesthesia and intravenous sedation using midazolam and piritramide in our angio suite. A 0.018-inch guidewire facilitated the placement of a 6F sheath, followed by biliary system recanalization using a 0.035-inch guidewire (Guide Wire M, Radiofocus™, Terumo Corporation, Tokyo, Japan) and a 4Fr/65 cm angle catheter (Glidecath®, Terumo). A cholangiogram demonstrated contrast extravasation originating from the cystic duct stump, thereby confirming the suspected leak. A 4F RIM catheter (Tempo™, Cordis, Miami Lakes, FL, USA) was positioned at the ostium of the cystic duct. The cystic duct was then accessed with a 2.6F microcatheter (Master Parkway HF, Asahi Intecc Co., Ltd., Aichi, Japan), and a 0.014-inch microwire (Transend™, Boston Scientific, Marlborough, MA, USA). An MVP (MVP-5Q, Medtronic, Minneapolis, MN, USA) designed for a target vessel diameter of 3.0–5.0 mm was successfully advanced and deployed through the microcatheter into the cystic duct to achieve occlusion. The sheath was removed, and the puncture site was dilated for percutaneous transhepatic cholangiodrainage (PTCD) insertion. An 8.5F biliary drainage catheter (ReSolve®, Merit Medical Systems, South Jordan, UT, USA) was positioned into the duodenum, and cholangiography confirmed its correct placement. A follow-up fluoroscopy demonstrated immediate and complete cessation of contrast leakage, confirming the technical success of the intervention (see Figure 2a, b).

Results

The clinical course was favorable, with complete cessation of bile leakage via the Robinson drain the following day and normalization of liver and cholestatic enzymes, so that on postoperative day 3, the Robinson drain was removed. On day 11, the PTCD was exchanged for an 8F Münchner drain (PerkuBil®, Peter Pflugbeil GmbH, Zorneding, Germany).

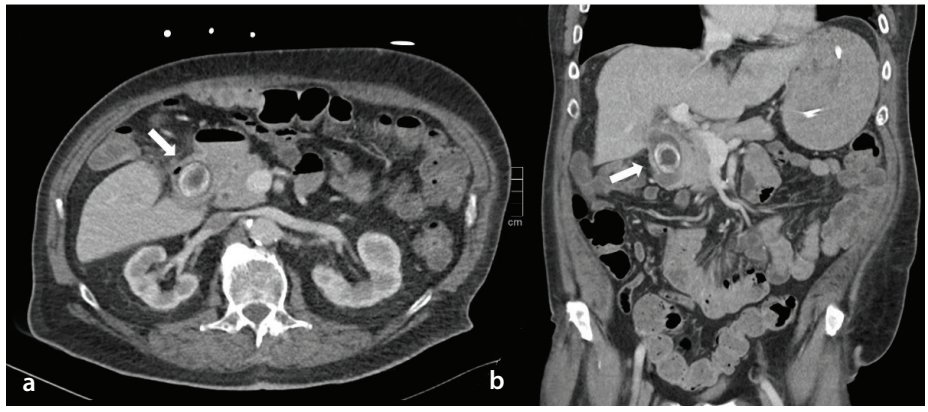

Figure 1. Axial **(a)** and coronal **(b)** contrast-enhanced computed tomography images show a markedly distended stomach due to gastric outlet obstruction. A large hyperdense gallstone is identified in the descending duodenum (Bouveret syndrome, white arrow). The gallbladder appears atrophic, with surrounding inflammatory changes suggesting chronic cholecystitis and a possible cholecystoenteric fistula.

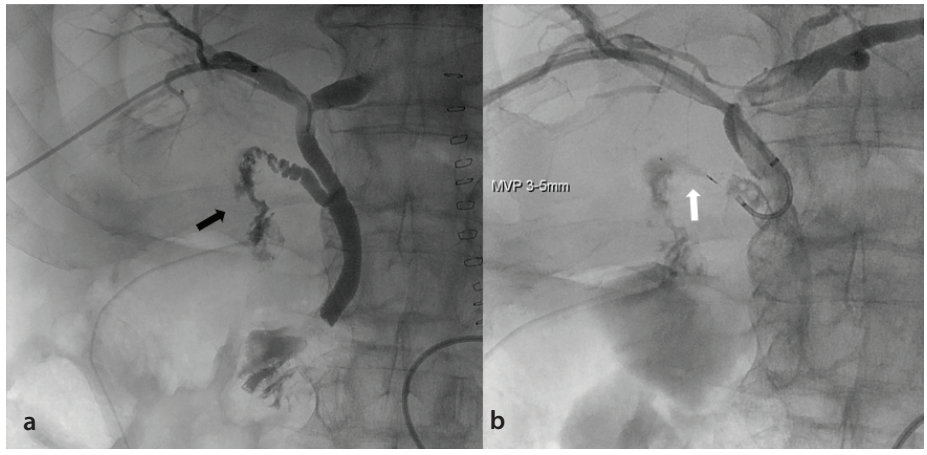

Figure 2. Percutaneous transhepatic cholangiography before **(a)** and after **(b)** deployment of the microvascular plug (MVP) into the cystic duct.

a. Contrast extravasation from the cystic duct stump confirms active bile leakage (black arrow). **b.** Successful placement of the MVP with immediate cessation of contrast leakage, indicating complete occlusion (white arrow).

Main points

- Cystic duct stump leakage is a challenging postoperative complication, particularly after a difficult cholecystectomy with severe inflammation.
- A partially polytetrafluoroethylene-covered microvascular plug can achieve immediate and complete occlusion without relying on thrombus formation.
- This minimally invasive approach offers a safe and effective alternative when standard endoscopic or surgical treatments are not feasible.

Cholangiography performed during the second intervention showed no evidence of persistent bile leakage. The patient tolerated a gradual reintroduction of oral intake and was discharged in a stable condition on postoperative day 19. At the time of discharge, inflammatory and cholestatic parameters had substantially improved. Cholangiography performed on postoperative day 31 still showed sufficient occlusion of the cystic duct, and the Münchner drain was removed (see Figure 3). No further bile leakage or postoperative complications were observed.

Discussion

Bouveret syndrome is a challenging variant of gallstone ileus, characterized by gastric outlet obstruction resulting from the impaction of a gallstone in the duodenum via a cholecystoduodenal fistula, contributing to a reported mortality rate ranging from 12% to 30%.[2] The standard surgical approach typically involves removing the obstructing duodenal gallstone, closing the cholecystoduodenal fistula, and cholecystectomy. In cases where severe inflammation or fibrosis makes complete cholecystectomy hazardous, a subtotal cholecystectomy is often chosen to minimize the risk of injury to the common bile duct and surrounding structures. Cystic duct stump insufficiency is a recognized complication following subtotal cholecystectomy, with incidence rates between 0.3% and 2%.[1] Traditionally, endoscopic retrograde cholangiopancreatography (ERCP) with sphincterotomy and stent placement has been the first-line treatment for bile leaks. However, in the early postoperative period, performing ERCP in the context of a recent duodenal repair carries an increased risk of compromising the suture line, as well as a higher risk of perforation and exacerbation of the leak.[3] In such scenarios, PTCD offers a viable alternative. The time required for the resolution of a leak from the cystic duct stump following PTCD treatment varies depending on the extent of the leak and the use of adjunctive embolization techniques. In most cases, minor bile leaks managed with PTCD alone resolve within 7–21 days as biliary pressure is reduced and the fistula tract seals spontaneously.[4] When embolic agents are used to directly occlude the cystic duct remnant, the time to leak resolution may be shortened considerably to a median of 10 days.[5] Embolic materials such as metallic coils and Amplatzer™ vascular plugs (AVPs) have been widely used, favored for their radiopacity, ease of delivery, and mechanical occlusion. However, their effectiveness can be limited in bile or lymphatic leaks, as both rely primarily on thrombus formation to achieve permanent occlusion. In cases with impaired coagulation or high-flow leakage, fluids may continue to pass through the coils. This represents a key advantage of the MVP, which provides immediate and complete mechanical occlusion without depending on the coagulation system.

Figure 3. Follow-up cholangiography on postoperative day 31 demonstrates sustained occlusion of the cystic duct stump after MVP deployment. No contrast extravasation is visible, confirming the long-term technical success of the intervention. MVP, microvascular plug.

In addition to coils, liquid embolic agents such as N-butyl cyanoacrylate (Histoacryl), Onyx, and absorbable gelatin sponges (Gelfoam) have also been used, either alone or in combination with coils, to manage biliary leaks. These agents are valued for their availability, ease of application, and, in the case of Gelfoam, low cost. However, liquid embolic agents carry a risk of non-target embolization, particularly in the biliary system, where unintended occlusion of adjacent ducts may lead to serious complications. Furthermore, temporary agents such as Gelfoam may be absorbed over time, potentially resulting in a recurrent leak.[6] The use of an MVP in this context represents a novel off-label application of a device traditionally employed in vascular embolization procedures. MVPs are self-expanding, detachable devices designed to occlude blood vessels with precision and minimal migration risk (see Figure 4).[7]

A key advantage in the biliary system is that the MVP can be delivered through a 0.027-inch microcatheter, enabling access to small or tortuous segments such as the cystic duct—an area that would be technically challenging to reach with larger devices such as the AVP. Moreover, the partial polytetrafluoroethylene cover of the MVP may offer

Figure 4. The MVP is an embolic device composed of two key components: a proximal PTFE covering (black star) and an electrochemically resorbable detachment point (black arrow) (product image used with the kind permission of Medtronic). PTFE, partial polytetrafluoroethylene; MVP, microvascular plug.

a major advantage, as its occlusive capability does not rely on thrombus formation. Nevertheless, the deployment of an MVP in the biliary system, particularly for sealing cystic duct leaks, scarcely documented in the literature, making this case a pioneering example of such use. The decision to utilize an MVP was influenced by several factors. The cystic duct's size and orientation made it amenable to occlusion with an MVP, which can conform to varying ductal diameters and provide a secure seal. Unlike coil or liquid embolization, which may require multiple coils and carry a risk of coil or glue migration, the MVP's design allows for single-device occlusion with a potentially lower risk profile.[8] In our case, cholangiography after MVP deployment confirmed sufficient occlusion of the cystic duct, indicating immediate technical success. Complete cessation of bile

leakage via the Robinson drain occurred almost immediately after MVP deployment, clearly outperforming the expected timeframe for resolution when using PTCD alone or in combination with other embolic agents. The successful use of an MVP to treat a leak from the cystic duct stump in this case highlights a potential new avenue in the management of this challenging complication.

In conclusion the use of a percutaneous transhepatic approach combined with targeted embolization using an MVP enabled the effective management of a cystic duct stump leak following cholecystectomy.

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Footnotes

Conflict of Interest

The authors declared that they have no conflict of interest.

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