



EUS-guided gallbladder drainage and subsequent peroral endoscopic cholecystolithotomy: A tool to reduce chemotherapy discontinuation in neoplastic patients?

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Background and Aims: EUS-guided gallbladder drainage (EUS-GBD) is emerging as a valuable treatment for acute cholecystitis (AC) in patients unfit for surgery. When lumen-apposing metal stents are used, large-caliber access to the gallbladder allows for subsequent direct peroral endoscopic cholecystoscopy (POEC) and eventual cholecystolithotomy (CL), offering a potentially “curative” solution for frailer patients. The aim of this series was to evaluate the outcome of these procedures in oncologic patients experiencing AC, with a specific focus on chemotherapy continuity.

Methods: A prospective registry of all consecutive therapeutic EUS procedures performed in the San Raffaele Institute between December 2020 and April 2021 was searched for EUS-GBD + POEC-CL performed in chemotherapy candidates. Clinical and technical variables were prospectively registered, as were days of chemotherapy delay and postprocedural outcomes.

Results: Three consecutive patients with a diagnosis of a malignancy (2 pancreatic cancers and 1 severe myeloproliferative disease with skeletal lesions) experienced AC and were primarily treated by EUS-GBD. After 4 weeks, they were systematically scheduled for POEC-CL and lumen-apposing metal stent exchange for a double-pigtail plastic stent. All procedures and revisions were successful, with rapid clinical improvement. All gallbladders were cleared of food debris and stones between 3 and 15 mm using grasping forceps, polypectomy snares, Dormia baskets, and mechanical lithotripsy. One mild adverse event without any clinical consequence was registered during POEC-CL. Revisions did not interfere with the chemotherapy schedule. Technical variables (eg, gastric vs duodenal drainage or need for coaxial double-pigtail plastic stent) are discussed.

Conclusions: EUS-GBD and subsequent POEC-CL allows a highly effective and minimally invasive solution for AC. These initial experiences promote further evaluation of this approach for all those individuals in whom surgical interventions are undesirable, such as oncologic patients whose prognosis depends on chemotherapy continuity, although further prospective confirmation in this setting should be pursued. (VideoGIE 2022;7:120-7.)

INTRODUCTION

EUS-guided gallbladder drainage (EUS-GBD) is emerging as the preferred alternative for the management of acute cholecystitis (AC) in patients unfit for surgery.¹ The electrocautery-enhanced lumen-apposing metal stents (ec-LAMSs) used in this context have significantly improved the efficacy and safety of EUS-GBD. These large-caliber (10-15 mm) biflanged metal stents allow for subsequent easy access from the GI tract into the gallbladder, facilitating direct visualization of the gallbladder lumen (peroral endoscopic cholecystoscopy [POEC]) and,

if needed, removal of residual stones (cholecystolithotomy [CL]).

These adjunct possibilities are turning EUS-GBD from a palliative procedure into a potentially “curative” option and are therefore expanding the pool of possible candidates to all of those for whom surgery might be undesirable. Among these individuals, patients with cancer are prone to increased procedural morbidity and mortality and are therefore expected to benefit more from minimally invasive strategies, potentially reducing the need for chemotherapy discontinuation. This study seeks to examine whether EUS-GBD plus POEC-CL can become a tool to reduce the impact of AC in this setting.

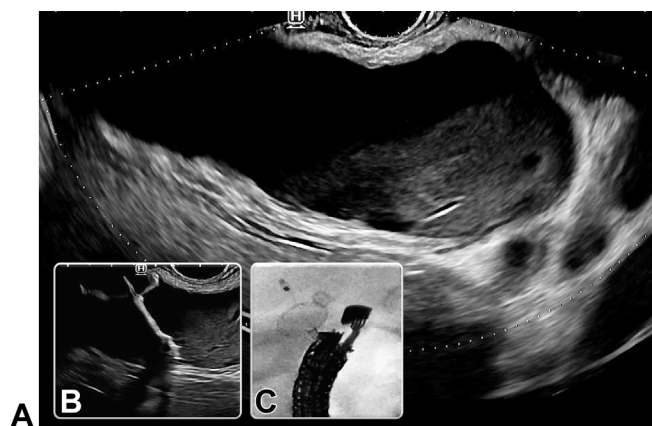


Figure 1. Case 2. **A**, EUS appearance of acute cholecystitis, with a distended gallbladder with thickened walls and inner sludge. **B, C**, EUS-guided gallbladder drainage with an electrocautery-enhanced lumen-apposing metal stent. **B**, Endosonographic view of the released distal flange. **C**, Corresponding radioscopic view.

METHODS

A prospectively maintained Registry of Therapeutic EUS (PROTECT; Clinical Trial Identifier: NCT04813055, Local IRB approval ID: 178/INT/2020) available in San Raffaele Institute from December 2020 was searched for all consecutive oncologic patients undergoing EUS-GBD for acute calculous cholecystitis up to April 2021. All patients provided written informed consent for the individual procedures and specific consent for the registry.

Patients

The PROTECT Registry includes all consecutive adult patients undergoing therapeutic EUS procedures in our institution. Specific inclusion criteria for this study were as follows: (1) established and active diagnosis of any malignancy, (2) definite AC diagnosis according to Tokyo guidelines,² and (3) upfront treatment of AC with EUS-GBD.

Procedures

EUS-guided gallbladder drainage. EUS-GBDs were performed with the patient under general anesthesia, orotracheal intubation, and antibiotic treatment/prophylaxis. The procedures used a linear-array echoendoscope (EG38-J10UT, Pentax Medical, Tokyo, Japan, operative channel 4 mm). An endoscopy suite with fluoroscopy was used, and all EUS-GBDs were performed by endoscopists experienced in therapeutic EUS (P.G.A., G.V.) working in a high-volume academic setting.

In all procedures, a 10- × 10-mm ec-LAMS (Hot Axios, Boston Scientific, Marlborough, Mass, USA) was placed with the free-hand technique. From the gastric antrum or duodenal bulb, the LAMS catheter was advanced using pure cutting current (Cystotome setting, ERBE Electrosurgery Unit, Tübingen, Germany; Fig. 1). Eventual pneumatic balloon dilation (CRE Catheter, Boston Scientific) or placement of coaxial (10F × 3-4 cm) silicone double-

pigtail plastic stents (DPPSS; Solus, Cook Medical, Bloomington, Ind, USA; Figs. 2 and 3) was performed at the endoscopist's discretion.

Peroral endoscopic cholecystoscopy and cholecystolithotomy. In our institution, LAMS revision is scheduled 4 weeks after the index procedure. POEC is performed by accessing the gallbladder through the LAMS using a standard gastroscope (EG29-i10, Pentax Medical, diameter 9.8 mm, operative channel 3.2 mm) (Video 1, available online at www.giejournal.org).

Food debris or stones were removed using the following: (1) foreign body forceps; (2) polypectomy snares; (3) net retrievers; or (4) a Dormia basket (Trapezoid, Boston Scientific), which was eventually used for mechanical lithotripsy for stones exceeding the LAMS diameter (Fig. 4A to F). After clearance of larger debris/stones, the gallbladder was irrigated with sterile saline solution and the microfragments were aspirated. The LAMS was removed and exchanged for a DPPS, providing additional patency of the fistula (Fig. 4G-I).

All procedures were performed with the patient under CO₂ insufflation, antibiotic prophylaxis, and available fluoroscopic guidance.

RESULTS

Between December 2020 and April 2021, 3 consecutive neoplastic patients experiencing AC were treated with EUS-GBD + POEC-CL in San Raffaele Institute, 2 with an established diagnosis of pancreatic ductal adenocarcinoma (PDAC) and the third with myeloproliferative disease with skeletal mass-forming replacement (Table 1).

EUS-GBD with a LAMS was successful in all 3 patients, 2 from the gastric antrum and 1 from the duodenal bulb. There were no EUS-GBD-related adverse events. All patients experienced clinical and biochemical postprocedural improvement.

Four-week POEC-CL was successful in all 3 patients, with extraction of pigmented stones ranging 3 to 15 mm. Mean procedural time was 61 (37-78) minutes. POEC-CL-related AEs without any clinical consequence were registered in 1 patient (Fig. 5). Gallbladder clearance was achieved in all patients, after which LAMSs were replaced for DPPSS. After a median follow-up of 183 (126-245) days, no clinical/radiologic recurrence was detected.

In case 3, EUS-GBD + POEC-CL was performed during the same admission. In the other 2 cases, patients were discharged 3 days after EUS-GBD and electively readmitted for 2 days for POEC-CL without any interruption of chemotherapy schedule.

Case 1

A 64-year-old man was diagnosed with PDAC; biliary obstruction was already palliated by partially covered self-expandable metal stents (SEMSs). The patient was

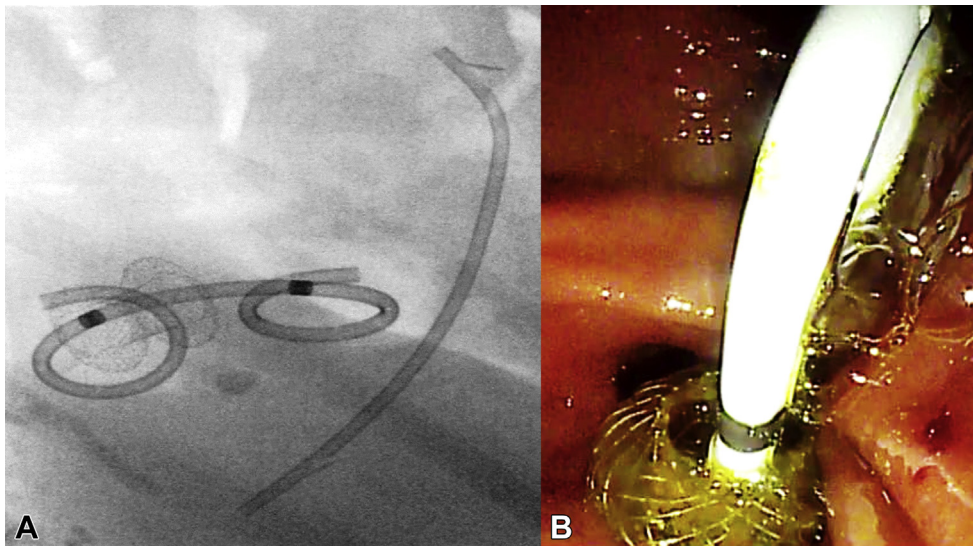


Figure 2. Placement of a coaxial double-pigtail silicon plastic stent inside the lumen-apposing metal stent: radioscopic (A) and endoscopic (B) appearance.

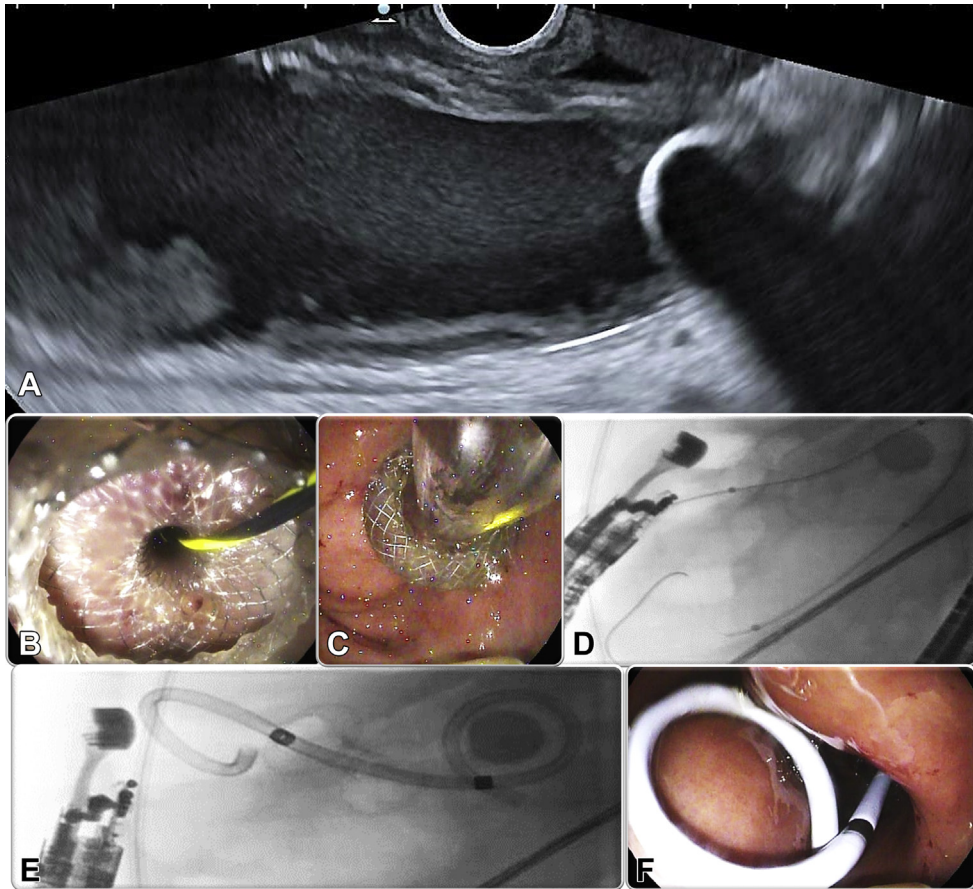


Figure 3. Case 1. **A**, EUS-appearance of acute cholecystitis, with severely thickened gallbladder walls, pericholecystic effusion, and a gallstone measuring 15 mm. **B**, Endoscopic appearance of the lumen-apposing metal stent (LAMS) after placement. **C**, Dilatation of the LAMS. **D-F**, Placement of a coaxial double-pigtail plastic stent (DPPS). **D**, Radioscopic appearance of the guide catheter embedded inside the gallbladder. **E**, Silicon DPPS stent released, with 1 pigtail wrapping the gallstone and the other inside the stomach. **F**, Endoscopic appearance of the proximal pigtail inside the stomach.

receiving neoadjuvant treatment with gemcitabine + abraxane + pamrevlumab/placebo in a study protocol, with partial response.

He presented to the emergency department with AC. EUS confirmed a hydropic gallbladder, with diffusely thickened walls, containing a 15-mm gallstone (Fig. 3), which

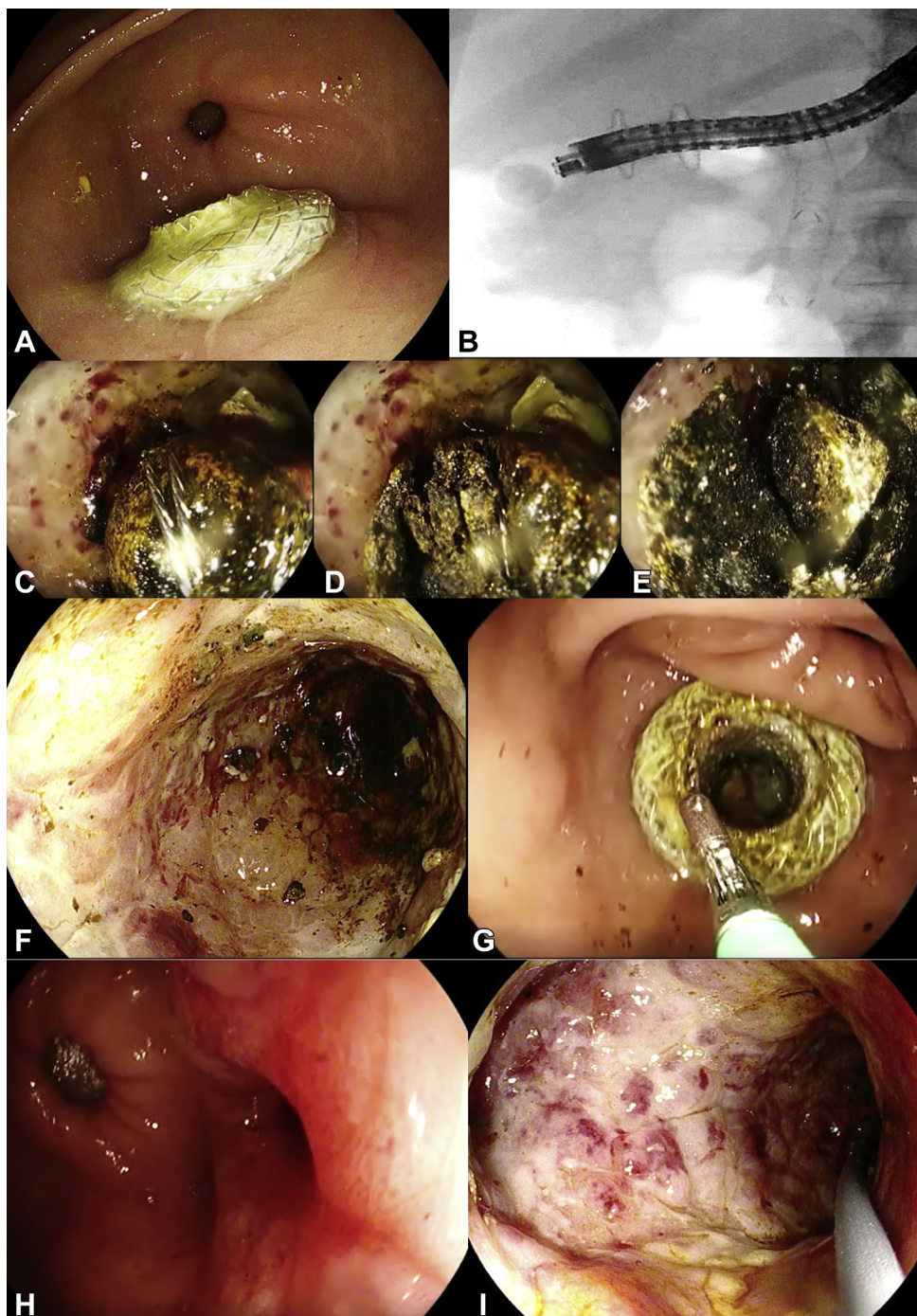


Figure 4. Case 1: peroral endoscopic cholecystoscopy and cholecystolithotomy. **A**, The lumen-apposing metal stent (LAMS) is visible in the antrum and is accessed through a standard gastroscope, which can be followed radioscopically through the LAMS to reach the gallstone (**B**). **C-E**, Mechanical lithotripsy: a 15-mm pigmented stone is grasped through a Dormia basket and, being larger than the LAMS diameter, is mechanically fragmented. **F**, The gallbladder is cleaned of all fragments, and the LAMS stent is removed (**G**). **H**, Endoscopic appearance of a 4-week-matured cholecystogastric fistula, through which a double-pigtail plastic stent (DPPS) is placed (**I**).

was treated by EUS-GBD with a 10-mm LAMS from the gastric antrum and coaxial DPPS. He was discharged on postoperative day 3 and resumed chemotherapy on postoperative day 6.

After 4 weeks, he was electively readmitted for POEC (**Fig. 4**). The coaxial DPPS had spontaneously migrated,

and food debris was seen inside the gallbladder. After removal, a large 15-mm pigmented stone was grasped with a Dormia basket. Because it was larger than the 10-mm LAMS, mechanical lithotripsy was performed (**Fig. 4C-E**), and fragments were removed. The LAMS was exchanged for a DPPS. The patient was discharged

TABLE 1. Characteristics of included patients and technical variables of EUS-GBD + POEC-CL

	Case 1	Case 2	Case 3
Sex	M	F	F
Age, y	64	86	55
Primary disease	Borderline-resectable pancreatic cancer	Myeloproliferative disease with skeletal involvement and extramedullary hematopoiesis	Locally advanced pancreatic cancer
EUS-GBD			
Gallbladder access	Gastric antrum	Gastric antrum	Duodenal bulb
LAMS size, mm	10 × 10	10 × 10	10 × 10
Coaxial DPPS	1 (4 cm)	1 (3 cm)	0
Technical success	1	1	1
Clinical success	1	1	1
Procedural time, min	30	15	5
AEs	0	0	0
Postprocedural hospital stay, d	3	65*	3
Time to chemotherapy resumption/initiation, d	6	N.A.*	12†
Delay according to chemotherapy schedule, d	6	N.A.*	0†
POEC-CL			
Time from index procedure, d	28	42	34
DPPS migration	1	0	Not placed
Food impaction	1	0	1
Type and size of stones	Single, pigmented, 15-mm stone	Multiple, pigmented, 3-10 mm	Multiple, pigmented, 3-5 mm
Devices for CL	Grasping forceps, Dormia and mechanical lithotripsy	Dormia and net retriever	Grasping forceps and Dormia
LAMS exchanged for DPPS	1	1	1
Procedural time, min	78	37	68
AEs	0	0	1‡
Technical success	1	1	1
Postprocedural hospital stay, d	2	23*	2
Time to chemotherapy resumption/initiation, d	6	21*	5
Delay according to chemotherapy schedule, d	0	0*	0
Follow-up from EUS-GBD, d	126	245	178
Follow-up from POEC-CL, d	98	203	154
Postprocedural imaging and time	CT (87 d)	N.A.	CT (85 d)
Cholecystitis recurrence	0	0	0
Death	0	0	0

AE, Adverse event; CL, cholecystolithotomy; DPPS, double-pigtail plastic stent; EUS-GBD, EUS-guided gallbladder drainage; LAMS, lumen-apposing metal stent; N.A., not available/applicable; POEC, peroral endoscopic cholecystoscopy.

*EUS-GBD and 4-week POEC with CL were both performed during a prolonged admission for septic shock, cholangitis, cholecystitis, persisting pneumonia, and newly diagnosed hematological malignancy. Hydroxycarbamide was introduced after clarification of the diagnosis and recovery from pneumonia, independently from the 2 procedures, but no discontinuation of hydroxycarbamide would have been recommended by hematologists if the procedure was planned under hydroxycarbamide therapy.

†Chemotherapy was started according to resolution of jaundice.

‡Asymptomatic and self-limiting intraprocedural bleeding and pericholecystic CO₂ diffusion without any clinical or laboratory consequence.

on postoperative day 2 and continued his chemotherapy without any interruption. An 87-day restaging CT scan did not show residual gallstones or AC recurrence (Fig. 6C). The coaxial DPPS had spontaneously migrated.

Case 2

An 86-year-old woman with heart failure and chronic obstructive pulmonary disease was admitted with septic shock, severe AC, cholangitis, and a COVID-19–negative

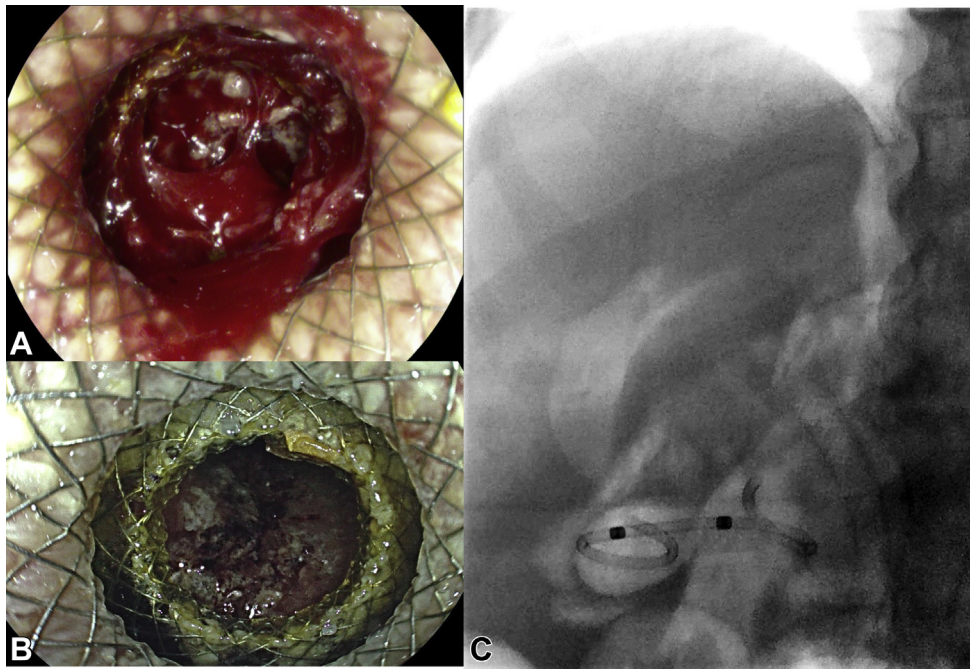


Figure 5. Case 3. Asymptomatic adverse events of peroral endoscopic cholecystoscopy and cholecystolithotomy. **A**, A mild oozing bleeding started from a dystrophic and ulcerated gallbladder wall, opposite to the lumen-apposing metal stent flange, which was self-limiting after flushing the gallbladder with diluted adrenalin **(B)**. **C**, A small sickle-shaped pericholecystic CO₂ diffusion was visible at the end of the procedure, which did not result in any clinical or biochemical abnormality.

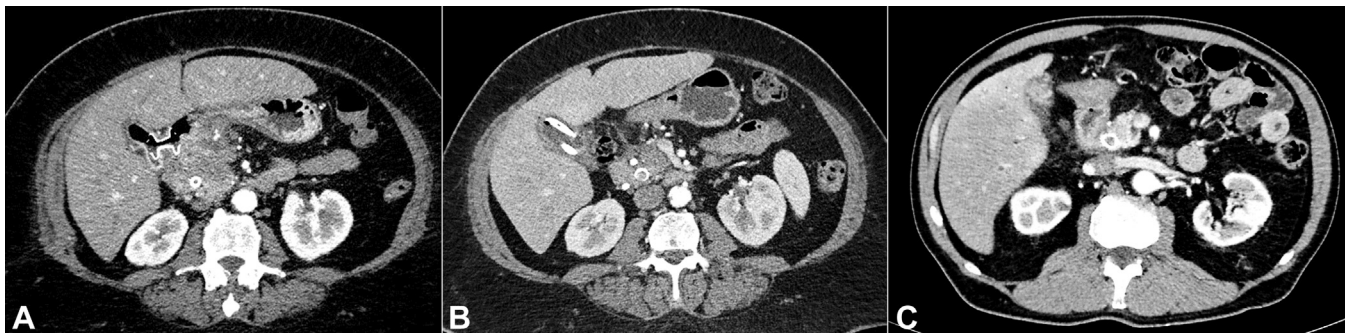


Figure 6. Follow-up CT scans. **A**, Case 3 after EUS-guided gallbladder drainage showing the lumen-apposing metal stent creating a large-caliber communication between the duodenum and the gallbladder, full of air. **B**, The same patient after peroral endoscopic cholecystoscopy and cholecystolithotomy and stent removal during a restaging CT, showing the double-pigtail plastic stent (DPPS) still in place without any sign of recurrence of acute cholecystitis. **C**, Case 1: restaging CT showing spontaneous migration of the DPPS, with a virtual gallbladder without any sign of recurrence.

pneumonia, requiring vasopressors and mechanical ventilation. CT scan revealed choledochal stones and AC. After hemodynamic stabilization, the patient underwent urgent ERCP and EUS-GBD with a 10-mm LAMS and coaxial DPPS, after which she rapidly improved, with discontinuation of inotropic medications and extubation. The patient remained admitted owing to persisting pneumonia and to clarify the finding of splenomegaly and diffuse skeletal abnormalities suspicious for malignant replacement. Based on a calreticulin mutation, she was diagnosed with a severe form of myeloproliferative disease requiring hydroxycarbamide. Four weeks after EUS-GBD, POEC was performed, with extraction of several subcentimetric stones with net retriever and basket until complete clearance (Fig. 7). The LAMS was

exchanged for a DPPS. The patient was discharged after pneumonia resolution. She did not experience any clinical sign of AC recurrence after 245 days of follow-up.

Case 3

A 55-year-old woman came to the emergency department for fever, jaundice, and abdominal pain due to a pancreatic head mass, with jaundice and AC. The patient underwent EUS for cytologic diagnosis of PDAC, ERCP with partially covered biliary SEMS placement, and EUS-GBD from the duodenal bulb with a 10-mm LAMS. No coaxial DPPS was placed.

On postoperative day 3, the patient was discharged in good clinical condition, and on postoperative day 12 she

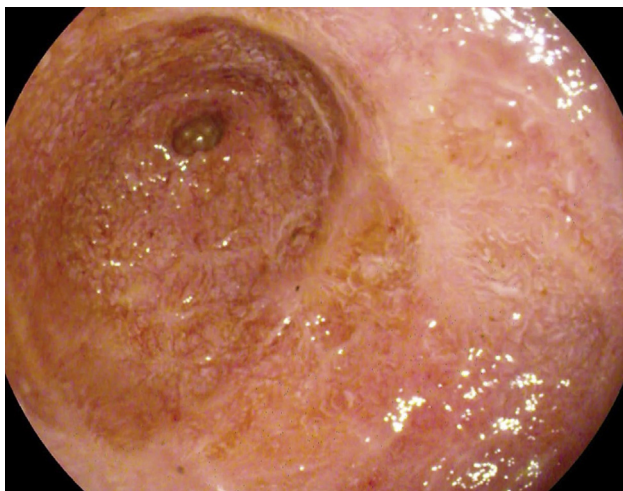


Figure 7. Endoscopic appearance of a gallbladder cleared of all its content after peroral endoscopic cholecystoscopy and cholecystolithotomy. The gallbladder neck and cystic duct orifice are visible.

started treatment with nab-paclitaxel + gemcitabine + capecitabine + cisplatin.³

After 4 weeks, the patient underwent a planned re-intervention with POEC-CL. The stent was blocked by food debris, which was removed by grasping forceps. After clearance, endoscopy showed severely dystrophic and ulcerated gallbladder mucosa, especially close to the internal flange. During lavage and aspiration, minimal oozing bleeding started from the gallbladder wall, rapidly subsiding after flushing of the gallbladder with a small amount of diluted adrenaline (Fig. 5A and B). The LAMS was removed, and a DPPS was placed through the fistula. Fluoroscopy showed evidence of scarce pericholecystic sickle-shaped CO₂ diffusion (Fig. 5C) without any postprocedural clinical events and not requiring imaging or surgical consultation, probably related to a small mucosal defect. The patient was discharged on postoperative day 1 and resumed chemotherapy on postoperative day 4. An 85-day restaging CT scan was negative for cholecystitis recurrence, with the DPPS still in place (Fig. 6A and B).

DISCUSSION

Laparoscopic cholecystectomy is the standard treatment of AC. However, it might be unfeasible in critically ill, unstable patients or elderly patients with severe comorbidities.⁴ In this scenario, guidelines suggest minimally invasive gallbladder drainage, which can be performed either percutaneously or endoscopically.^{1,5,6} A recent randomized controlled trial comparing percutaneous drainage with EUS-GBD using ec-LAMS reported equally high technical success, but a significantly lower 30-day and 1-year risk of adverse events and cholecystitis recurrence.¹

Another unique advantage of EUS-GBD with LAMS is the wide artificial connection between the GI tract and the gallbladder, allowing for subsequent endoscopic access and clearance of the gallbladder to prevent AC recurrence. POEC-CL has been explored in an initial proof-of-concept series of 5 to 25 cases, with a very high rate of technical success (88%-100%) and a low rate of adverse events (0%-3.84%).⁶⁻¹¹ This possibility pushes EUS-GBD beyond AC palliation in patients unfit for surgery, offering a potentially “curative” option in all patients in whom surgery is undesirable.

In this series, we describe 3 neoplastic patients in whom the procedure was effective, was well tolerated, and resulted in a rapid AC resolution. Two of these patients were affected by PDAC. In this scenario, AC might be an expected adverse event of local cancer invasion or palliative procedures (eg, SEMs placement).^{7,8} An eventual surgical treatment can expose these patients to a discontinuation or delay in chemotherapy that could significantly affect their prognosis. In another elderly, frail, and comorbid patient with a severe form of myeloproliferative disease, the procedure resulted in a dramatic improvement of severe septic shock. In all of these patients, after resolution of the acute phase, revision of the drainage was organized to avoid conflict with chemotherapy, and none of the patients experienced AC-related delay of oncologic treatment.

Despite the limit of the small sample size, this series provides an opportunity to discuss some technical variables. First, the risk of food impaction is perceived to be higher when EUS-GBD is performed from the stomach rather than the duodenum.⁹ However, in our series, it happened in the 2 patients in whom the DPPS was not presented through the LAMS, either because it was not placed (in the duodenum) or because it had spontaneously migrated (in the antrum). This suggests that universal coaxial DPPS placement after EUS-GBD might protect against this event. Of note, the DPPS that spontaneously migrated was longer than the one that was retained, raising the question of whether the shorter DPPS should be placed.

Second, when the DPPS was absent, injury of the contralateral wall was detected during POEC and resulted in self-limiting bleeding and CO₂ transperietal diffusion in 1 patient. Therefore, coaxial DPPS might protect against LAMS traumatic injury, a lesson learned from peripancreatic fluid collections drainage.¹⁰

Third, because prolonged stent indwell has been described to increase the rate of stent-related adverse events, early scheduled revision and extraction of the LAMS might be wise. A 4-week interval seems reasonable to mediate among AC resolution, tract maturation, and prevention of adverse events, as already recommended for peripancreatic fluid collections drained with LAMSs.¹¹⁻¹³

Fourth, clearance of gallbladder content theoretically nullifies the risk of cholecystitis recurrence, as suggested

by the null risk in our prospectively followed patients. Whether LAMS removal must be followed by DPPS placement remains unclear. Doing so is suggested from the sole available randomized controlled trial¹ and might have a rationale in avoiding abrupt closure of the fistula to allow drainage of eventual residual secretions, provided that sufficient gallbladder lumen remains.

Fifth, a small series has demonstrated that endoscopic laser lithotripsy through the LAMS might be a solution for giant gallstones. One of our cases suggests that mechanical lithotripsy by the same Dormia basket used for extraction might be sufficient, simpler, less expensive, and less invasive as a first approach.¹³

Although the results are promising, these technical variables should be evaluated in prospective and controlled cohorts.

In conclusion, this series suggests that EUS-GBD plus POEC-CL in neoplastic patients might reduce the time off chemotherapy as a result of (1) fast AC resolution, (2) minimal procedural impact, and (3) reduced recurrence risk.⁶ Indeed, 3 neoplastic patients received EUS-GBD+POEC-CL, resulting in a prompt resolution of AC without need for percutaneous drainage. POEC-CL was planned without any interference in chemotherapy schedule. After an average follow-up of 183 days, there were no clinical or radiologic signs of recurrence.

This first small prospective series promotes larger investigation of this new minimally invasive treatment of AC in a subgroup of frail patients whose prognosis strongly depends on chemotherapy continuity.

DISCLOSURE

Dr Bronswijk is a grant recipient of Taewoong, Takeda, and Prion Medical and has a consultancy agreement with Taewoong and Prion Medical. Dr Van der Merwe is a board member for Cook Medical and Boston Scientific and has a consultancy agreement with Cook Medical. All other authors disclosed no financial relationships.

Abbreviations: AC, acute cholecystitis; CL, cholecystolithotomy; DPPS, double-pigtail plastic stent; ec-LAMS, electrocautery-enhanced lumen apposing metal stent; EUS-GBD, EUS-guided gallbladder drainage; LAMS, lumen-apposing metal stent; PDAC, pancreatic ductal adenocarcinoma; POEC, peroral endoscopic cholecystoscopy; SEMS, self-expandable metal stent.

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