REVIEW ARTICLE

The Lambda stenting technique: a new approach to address EUS-guided biliary drainage–associated adverse events

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Background and Aims: EUS-guided biliary drainage (EUS-BD) has been performed increasingly worldwide, especially in patients with malignant tumors in which ERCP is difficult, patients with surgically altered GI tracts, and older patients who are at high risk for surgery. EUS-BD requires high-level skills and has limited options for managing adverse events, particularly when stent migration and cholangitis occur. Adverse events, such as persistent bile leakage from the fistula and continuous reflux from the GI tract, are believed to always have a risk of severe exacerbation that could threaten the patient's life.

Methods: We encountered 2 cases of stent migrations and 1 case with repeated cholangitis in patients with malignant tumors among the patients who underwent EUS-BD. The migrated stent was visualized under EUS in 2 patients with stent migration, and an EUS-guided FNA needle was used to puncture the mesh of the stent. The cannulation catheter was directly inserted into the mesh of the stent in 1 case with repeated retrograde cholangitis, while the stent was visualized with an endoscope. Subsequently, a guidewire was inserted through the puncture site, and a second metal stent was deployed between the meshes of the first stent, bridging the GI wall again (Lambda stenting technique). All procedures were performed with the patient under general anesthesia, and the patients safely completed the intervention.

Results: Patients' conditions significantly improved after the second stent insertion, allowing for chemotherapy resumption while maintaining their activities of daily living. The second stent remained in place without any migration, and the stent successfully prevented further cholangitis.

Conclusions: The Lambda stenting technique is considered highly effective for managing stent migration and repeated cholangitis, which is a major EUS-BD adverse event. This procedure helps avoid more invasive surgeries when stent migration and cholangitis occur and contributes to expanding EUS-BD applicability. (VideoGIE 2024;9:107-14.)

BACKGROUND

EUS-guided biliary drainage (EUS-BD) was first reported as a global biliary drainage technique by Giovanni et al[1] in 2001. Since then, knowledge and understanding of EUS-BD have increased, and various drainage techniques and stents have been reported. Concurrently, EUS-BD–associated adverse events have been reported, and serious adverse events following EUS-BD have been considered difficult to repair endoscopically.[2,3] EUS-BD–associated adverse events are reported in 3% to 30% of cases.[4-6]

Reports on the usefulness of EUS-BD in treating malignant biliary obstruction have been increasing. Conversely, stent migration is one of the major EUS-BD–associated adverse events, especially EUS-guided hepaticogastrostomy (EUS-HGS).[7] Despite efforts to prevent stent migration,[8,9] several cases of stent migration in EUS-BD have been reported.[10] Additionally, the lumen-apposing stent has been applied, particularly in procedures of EUS-guided gallbladder drainage.[11] Although the presence of flanges on both sides of the stent may reduce the risk of migration, cases have been reported in which stent migration occurred.[12] Stent migration poses a high risk of causing bile peritonitis and directly threatens the patient's life. In patients with cholangitis or cholecystitis who undergo EUS-BD, stent migration frequently necessitates an

Abbreviations: EUS-BD, EUS-guided biliary drainage; EUS-FNA/B, EUS-guided FNA/biopsy; EUS-HGS, EUS-guided hepaticogastrostomy; QOL, quality of life.

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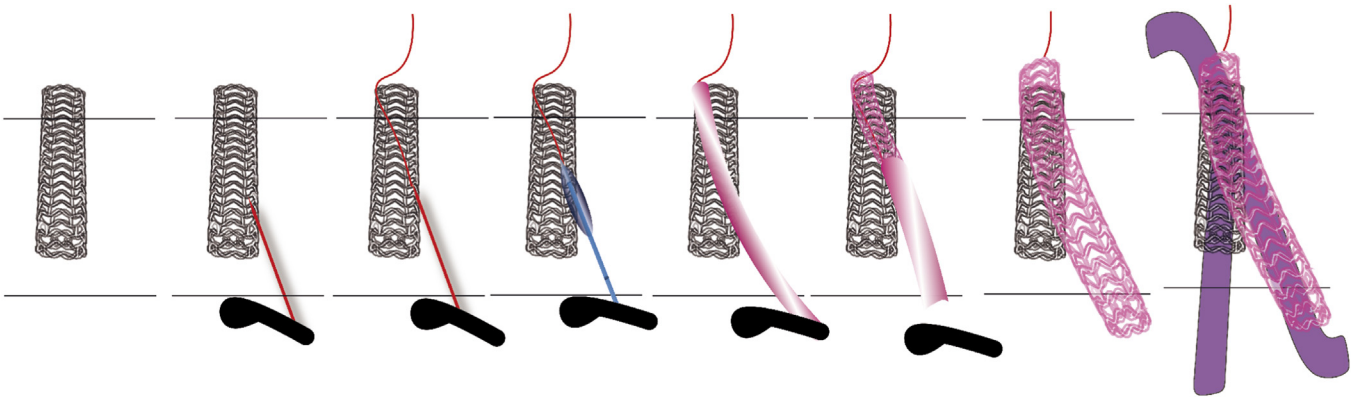

Figure 1. Overview of the Lambda stenting technique. EUS was used to visualize the migrated stent, and the spaces between the mesh were punctured with an EUS-guided FNA/biopsy needle. A guidewire is passed through, and a second stent is inserted after expanding the spaces between the mesh.

additional intervention such as surgical intervention for biliary drainage.[13]

Cholangitis is also an important EUS-BD–associated adverse event. Cholangitis may be caused by the interaction of the EUS-BD stent with the GI tract and can mostly be conservatively managed. However, it frequently causes recurrent retrograde cholangitis and may hinder ensuring sufficient patient quality of life (QOL).[14]

EUS-BD remains recommended in cases in which ERCP is difficult to perform because of the advantages and disadvantages of EUS-BD.[15] Therefore, EUS-BD may become an even more beneficial technique for biliary drainage if the issue of adverse events can be overcome.

We successfully managed 2 cases of stent migrations and 1 case of recurrent cholangitis that did not respond to conservative treatment. These cases were successfully managed with the Lambda stenting technique. This method involves visualizing the dislodged stent itself using EUS and then puncturing the stent's mesh with an EUS-guided FNA or EUS-guided FNA/biopsy (EUS-FNA/B) needle. The spaces within the mesh are expanded using a balloon or mechanical dilator after passing a guidewire through it, followed by the stent insertion. The final shape that was achieved was in the form of a Lambda (λ; Fig. 1). This method can be used for stent-related issues in EUS-BD (such as recurrent cholangitis or stent migration) and is applicable without requiring any special equipment. It is also a minimally invasive method for patients experiencing EUS-BD–associated adverse events.

CASE DESCRIPTIONS

We present the cases of 3 patients who underwent EUS-BD. Patient 1 was a 56-year-old woman who underwent gastrojejunostomy for unresectable gastric cancer. The patient had been receiving systemic chemotherapy for 1 year. Subsequently, the lesion invaded the bile duct and caused obstructive jaundice and cholangitis. The scope could not pass through, because the bypassed GI tract was infiltrated by the tumor, although an attempt was made to perform ERCP. The patient was indicated for EUS-HGS.

Figure 2. CT scan images of case 1. Initial CT image of the first case after 24 hours of EUS-guided hepaticogastrostomy. The stent is inserted into the intrahepatic bile duct, but the GI side is dislodged from the wall.

EUS-HGS was performed for the B2 branch with an EUS-FNA/B needle (19-gauge Sonotip Pro Control; Medico's Hirata, Osaka, Japan), and a fully covered metal stent (HANAROSTENT Biliary Full Cover Benefit, 6 mm × 8 cm; M.I. Tech, Pyeongtaek, South Korea) and plastic stent (5F, 10-cm double-pigtail stent; Cook Medical LLC, Bloomington, Ind, USA) were placed. However, the metal stent inwardly migrated from the GI wall 24 hours after the initial EUS-HGS, and the CT scan revealed only the plastic stent still present in the fistula that passed through the GI wall (Fig. 2).

Initially, we removed the pigtail stent and attempted to insert a cannulation catheter and a guidewire directly

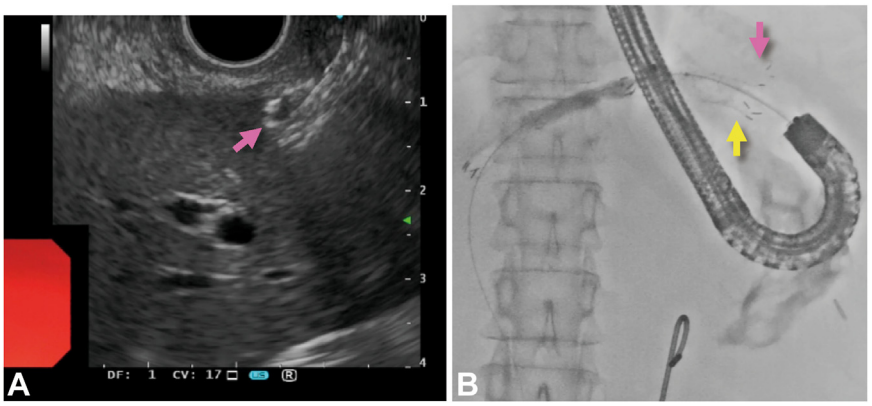

Figure 3. Lambda stenting technique on case 1 (EUS-guided hepaticogastrostomy). **A,** EUS image of puncturing the first inserted stent with an EUS-guided FNA/biopsy needle. **B,** A stent is deployed using the Lambda stenting technique. *Magenta arrow* indicates the first inserted stent (migrated); *yellow arrow* indicates the stent inserted in the Lambda shape (during insertion; **B**).

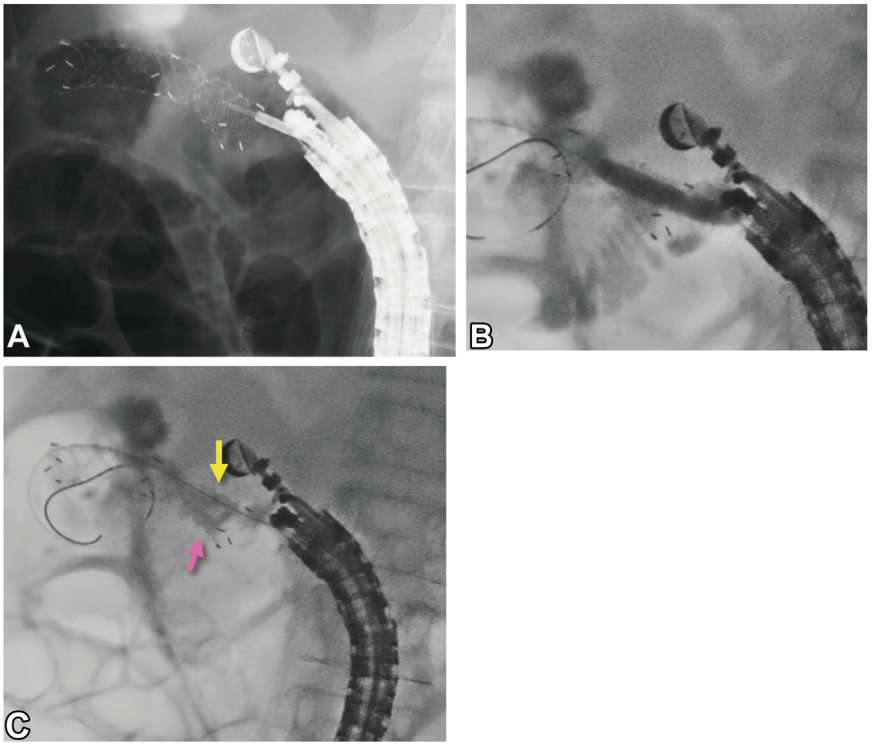

Figure 4. Lambda stenting technique on case 2 (EUS-guided gallbladder drainage). **A,** X-ray image of puncturing the first inserted stent with an EUS-guided FNA/biopsy needle. **B,** Dilation of second puncture site with a 6-mm biliary dilatation balloon. **C,** A stent is deployed using the Lambda stenting technique. *Magenta arrow* indicates the first inserted stent (migrated); *yellow arrow* indicates the stent inserted in the Lambda shape (during insertion; **B**).

through the initially punctured site and then place an additional stent. However, the guidewire bounced off the distal end of the dislodged stent, making stent placement difficult using this technique. Therefore, we punctured the metal stent under EUS observation with an EUS-guided FNA needle (Fig. 3A; 19-gauge EZshot 3 Plus; Olympus Medical Systems, Tokyo, Japan) and successfully inserted a guidewire into the bile duct through the first metal stent. A second fully covered metal stent (HANAROSTENT, 10 mm × 10 cm; M.I. Tech) was placed after the dilation was made with a 7F mechanical catheter dilator (ES dilator; Zeon Medical, Tokyo, Japan). We deployed the second stent through the mesh between the first inserted stent and successfully bridged the gap between the stent and the gastric wall (ie, the cross-sectional view took on a Lambda shape). Therefore, we named this technique the

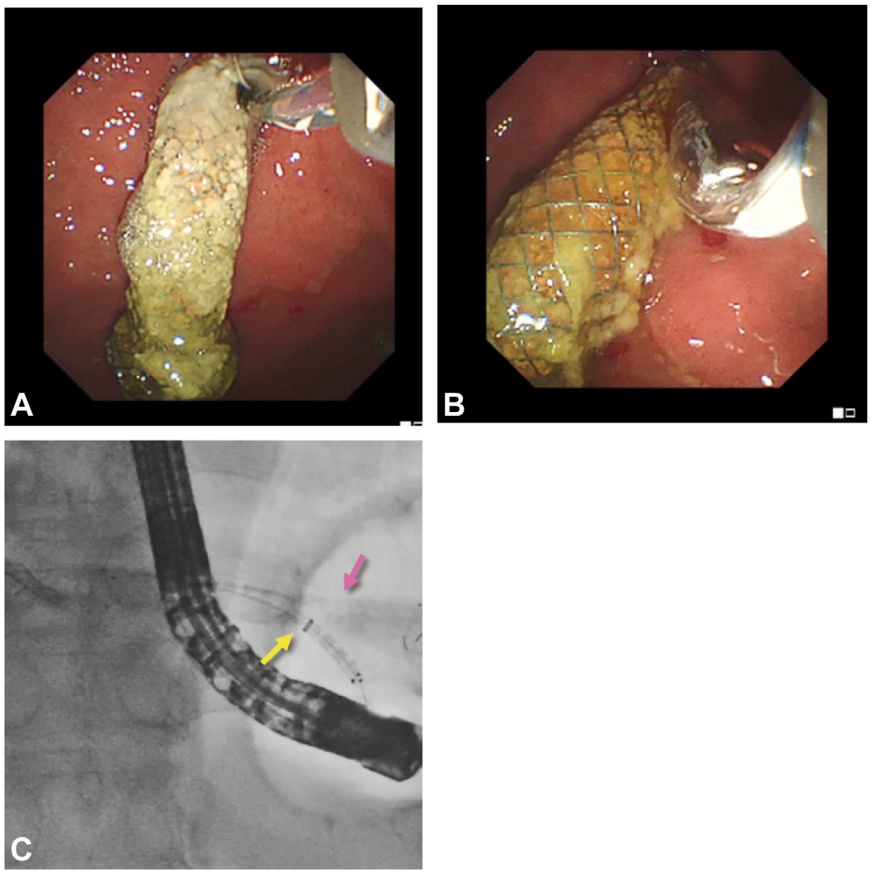

Figure 5. Lambda stenting technique on case 3 (EUS-guided hepaticogastrostomy for recurrent cholangitis). **A,** Direct puncture of the first inserted stent. **B,** Dilation of second puncture site with a 6-mm biliary dilatation balloon. **C,** A stent is deployed using the Lambda stenting technique. *Magenta arrow* indicates the first inserted stent (migrated); *yellow arrow* indicates the stent inserted in the Lambda shape (during insertion; **B**).

Lambda stenting technique (Fig. 3B). The patient did not experience any adverse events and was able to resume chemotherapy.

Patient 2 was a 77-year-old woman who was diagnosed with locally advanced pancreatic head cancer. The patient had duodenal stenosis due to the pancreatic head tumor and received duodenal metallic stent insertion. The patient was hospitalized with severe cholecystitis unrelated to the underlying condition of pancreatic cancer after 2 years of chemotherapy. Subsequently, EUS-guided gallbladder drainage was performed. We performed a gallbladder puncture from the duodenal bulb and placed the 10-mm × 6-cm fully covered metal stent (HANAROSTENT Biliary Full Cover NEO; M.I. Tech) with dilation of a 6-mm biliary dilatation balloon (REN; Kaneka Medics Corporation, Tokyo, Japan). A plastic stent (7F, 10-cm double-pigtail stent) was also placed inside the metal stent. However, the duodenum was narrowed from the second part onward because of pancreatic cancer; thus, space on the GI side (duodenal side) was insufficient. The metal stent was pulled into the gallbladder side after insertion of the first stent, and it became apparent that the stent was not visible on endoscopy. Subsequently, the stent migrated into the gallbladder. We placed the second fully covered stent (HANAROSTENT, 10 mm × 10 cm, M.I Tech) between the meshes on the side with a Lambda technique after removing the pigtail stent, with a dilation of a 6-mm biliary dilatation balloon (Fig. 4A and B). The second stent was successfully delivered and deployed without any further migration (Fig. 4C).

Patient 3 was a 75-year-old man who had been diagnosed with gallbladder carcinoma. The patient had undergone cholecystectomy and bile duct resection (cholangiojejunostomy); however, cancer recurred in the hepatic hilum with repeated cholangitis. Stent placement was performed using double-balloon ERCP. The cholangitis was not manageable because the tumor invaded the multiple intrahepatic bile duct. EUS-HGS was performed in segment B2 for the left lobe bile duct (partially covered stent; Stringstopper, 8 mm × 10 cm; Taewoong Medical Co, Ltd, Gimpo-si, Gyeonggi-do, South Korea), and percutaneous transhepatic biliary drainage was performed for the right lobe bile duct. However, the patient still experienced recurrent cholangitis localized to the left lobe bile duct. The stent inserted via EUS-HGS, which was not an anti-reflux stent, was causing retrograde cholangitis from the GI tract. Therefore, the Lambda stenting technique was adopted.

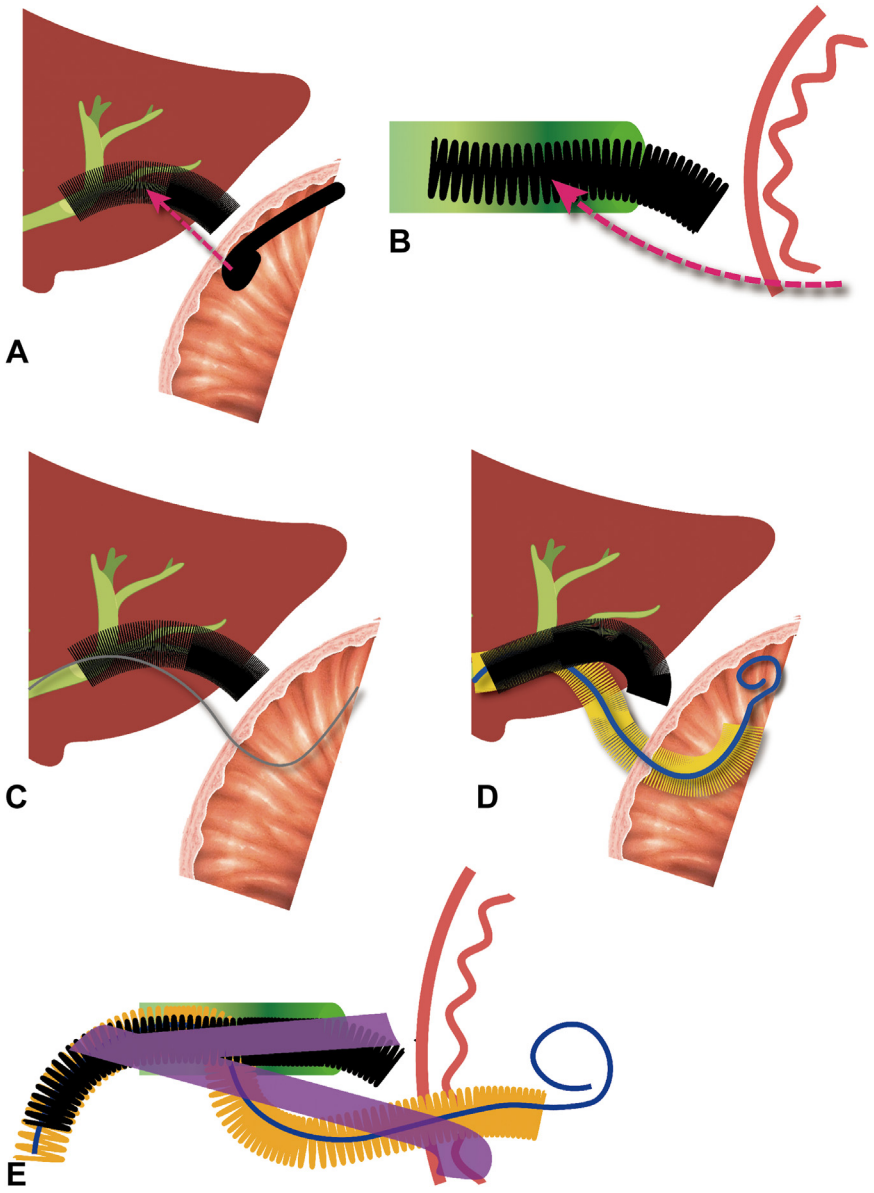

Figure 6. Schematic image of the Lambda stenting technique on EUS-guided hepaticogastrostomy. **A,** The stent is punctured with an EUS-guided FNA/biopsy needle under EUS observation if the stent is dislodged from the gastric wall. **B,** Cross-sectional view of stent puncture. The puncture should be made under clear EUS observation; the needle punctures the intrahepatic bile duct and the first inserted stent. **C,** Inserting the 0.025-inch guide wire through the second puncture site. **D,** Inserting a second stent and pigtail stent that bridge the intrahepatic bile duct and gastric wall. A pigtail stent insertion is optional. **E,** Cross-sectional view of the Lambda stenting technique. The second stent is inserted in a "Lambda shape" together with the first inserted stent.

In this case, the first stent was not dislodged from the GI tract and was visually identifiable. Therefore, we directly punctured the stent under direct visualization using a cannulation catheter (Fig. 5A.) Subsequently, a guidewire was inserted through the catheter, and the mesh was dilated using a 6-mm dilation balloon after we ensured that a sufficient length of the guidewire was inserted into the bile duct (Fig. 5B). Afterward, a covered metal stent (anti-reflux type, 10 mm × 6 cm) was inserted (Fig. 5C). Both stents remained in place without any migration, and the patient was discharged without experiencing any cholangitis after the Lambda stenting technique was performed. He stayed at home and received enteral feeding (Video 1, available online at www.videogie.org).

PROCEDURES

Every patient scheduled for the Lambda stenting technique should be in descent sedative condition and receive

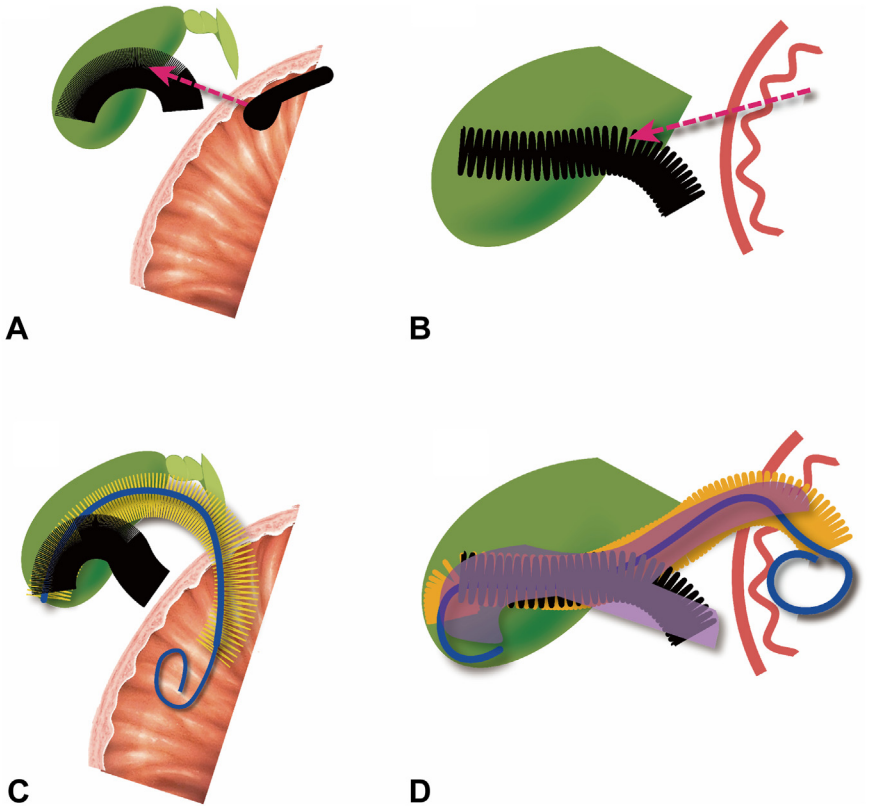

Figure 7. Schematic image of the Lambda stenting technique on EUS-guided gallbladder drainage. **A,** The stent is punctured with an EUS-guided FNA/biopsy needle under EUS observation if the stent is dislodged from the duodenal wall. **B,** Cross-sectional view of the stent puncture. The needle punctures the gallbladder and the first stent is inserted under the EUS observation. **C,** Inserting a second stent and pigtail stent that bridge the gallbladder and duodenal wall. A pigtail stent insertion is optional. **D,** Cross-sectional view of the Lambda stenting technique. The second stent is inserted in a "Lambda shape" together with the first inserted stent.

continuous vital sign monitoring. A convex echoendoscope was used (GF-TYPE-UCT260; Olympus Medical Systems) for the procedure.

The technique for Lambda stenting is as follows. First, puncture the mesh in the first covered metal stent using an EUS-FNA/B needle (19-gauge needle; Figs. 6A and B, 7A and B). The puncture may be made without an EUS-FNA/B needle when the stent is visualized. Next, insert a 0.025-inch guidewire through the needle or catheter into the stent, leading it to the biliary tract (Fig. 6C). The guidewire should be placed sufficiently into the bile duct or gallbladder, creating a loop. Insert a cannulation catheter through the guidewire. Dilation is generally required to expand the mesh. Both mechanical and balloon dilators can be used, but balloon dilators are often preferred because they allow for adjustment of the expansion pressure. A mechanical dilator may be more suitable in cases in which the mesh is rigid.

Insert a second metal stent after the dilation has been made sufficiently. The bile duct or gallbladder-side stent end should be sufficiently inserted into the biliary tract, and the stent should be fully deployed through the mesh. A covered stent is necessary for the second stent to be placed as the Lambda stenting technique, to prevent bile leakage from the first inserted stent. The second stent should be longer than the first chosen (Figs. 6C and D, 7C). Hence, the inserted stent array appears to have a Lambda shape, because the first and second stents appear to intersect when they are inserted (Figs. 6E and 7D). Additionally, anti-reflux stents can be considered for Lambda stenting in cases in which retrograde cholangitis and/or stent occlusion caused by food residue is a concern. A double-pigtail plastic stent may be added to preclude further migration. Enough length should be ensured from the GI wall after deploying the second stent. Finally, inject the contrast reagent into the stent and confirm no leakage of the contrast agent outside of the stents.

Furthermore, because the second stent path completely blocked the first stent, theoretically, bile leakage or potential infection route should have been resolved through the first stent, which may cause bile leaks or contribute to retrograde cholangitis, thereby blocking the backflow of food residue from the first stent. This approach enables us to minimize the risk of further adverse events, such as bile duct injury, even in cases of narrow bile ducts caused by malignant strictures. Additionally, reducing the distance

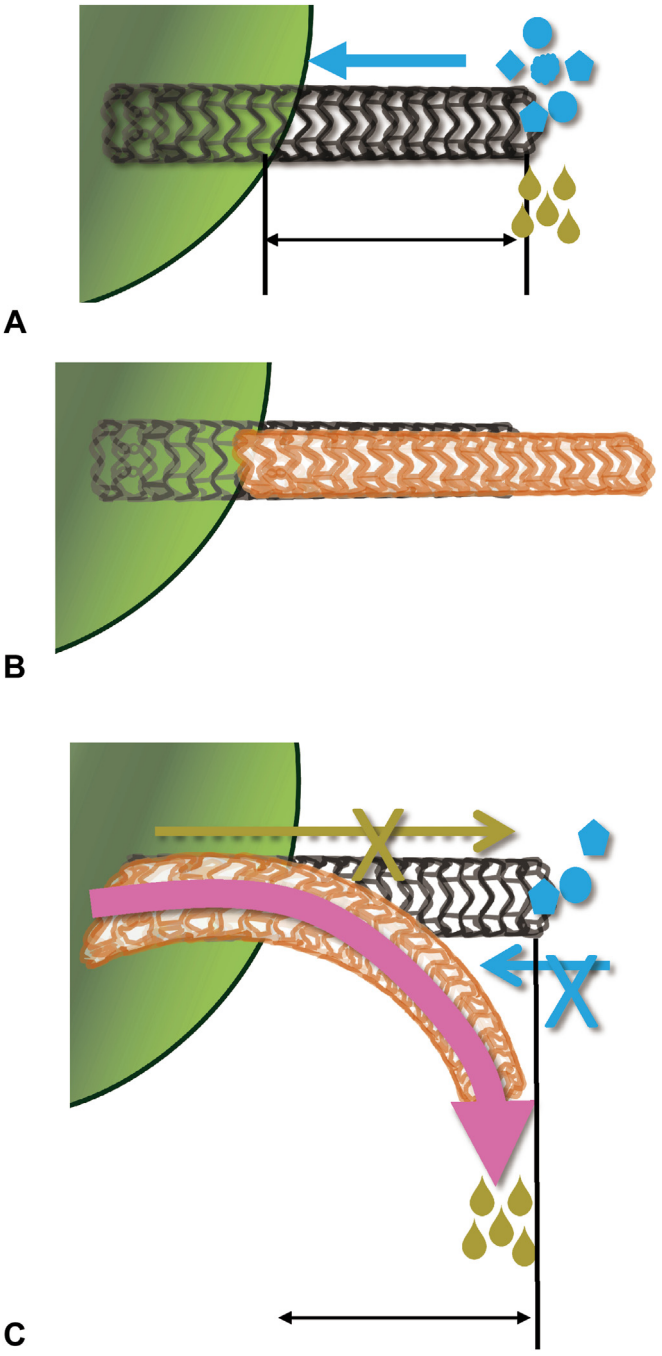

Figure 8. Advantages of the Lambda stenting technique. **A,** Before the Lambda stent technique. Bile flows out along with the dislodged stent and other substances flowing back into the bile duct. **B,** Schematic image of adding a stent at the distal end of the GI tract. The total length of the stent becomes longer, potentially causing GI tract obstructions or damage. **C,** The Lambda stenting technique. The distance to the second stent becomes longer, although the linear distance remains unchanged because of the curve it forms. The use of a covered stent as the second stent may prevent both leakage and backflow from the first stent.

of the stent on the GI side compared with directly adding a stent through the end of the first stent may decrease the risk of issues, such as GI obstruction (Fig. 8).

The method of stent insertion in the Lambda shape has been reported in the fields of cardiovascular surgery and neurosurgery; however, our report represents the first confirmation of its effectiveness in EUS-BD.[16,17]

OUTCOMES

All patients successfully recovered after undergoing the Lambda stenting technique, without experiencing any stent trouble, such as cholangitis or stent remigration (Table 1). Subsequently, they were discharged from the hospital, enabling them to resume rehabilitation, chemotherapy, and eternal feeding. The Lambda stenting technique allows meal resumption and discharge to the home, which has a beneficial effect on maintaining QOL. The patients in the first, second, and third cases survived for 15, 5, and 6 months, respectively, and all patients died as a result of malignant conditions underlying their respective backgrounds.

LIMITATIONS

The Lambda stenting technique is applicable at least when the stent remains on the biliary tract side. It is not applicable when both ends have dislodged and the stent is completely displaced into the abdominal cavity; in cases with bile peritonitis and the puncture position was significantly changed because of a large number of ascites (bile juice); when the distance between the 2 organs exceeds what can be bridged by the stent; and when the dislodged stent is difficult to visualize under EUS. Thus, surgical intervention remains the primary option in such cases.

CONCLUSION

We successfully performed the Lambda stenting technique by inserting a second stent for cases of stent migrations and repeated cholangitis as EUS-BD–associated adverse events. All patients were discharged without surgical intervention, maintaining their QOL. The Lambda stenting technique was proven useful as a salvage procedure for adverse events arising during EUS-BD.

DISCLOSURE

Dr Fujiya receives personal fees from Olympus Co, Ltd, Boston Scientific Corporation, FUJIFILM Corporation, and Otsuka Pharmaceutical Co, Ltd, and grants from Otsuka Pharmaceutical Co, Ltd. The other authors disclosed no financial relationships relevant to this publication.

TABLE 1. Indications, equipment, and long-term outcomes of the Lambda stenting technique

Indication of Lambda stenting technique	Dilator used for the second stent delivery	Second inserted stent	Long-term survival
Stent migration	7F mechanical catheter dilator	Fully covered metal stent (10 mm × 10 cm)	15 months without experiencing any stent trouble
Stent migration	6-mm biliary dilatation balloon	Fully covered metal stent (10 mm × 10 cm)	5 months without experiencing any stent trouble
Repeated retrograde cholangitis	6-mm biliary dilatation balloon	Fully covered metal stent (anti-reflux type, 10 mm × 6 cm)	6 months without experiencing any stent trouble

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