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Techniques and Innovation

Managing dysfunctions and reinterventions in endoscopic ultrasound-guided choledochoduodenostomy with lumen apposing metal stents: Illustrated technical review (with videos)

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Endoscopic ultrasound-guided choledochoduodenostomy (EUS-CDS) with lumen apposing metal stent is emerging both as a rescue strategy and a primary treatment for distal malignant biliary obstruction. The large-scale diffusion of the procedure and improved overall survival of patients with pancreatobiliary neoplasms is resulting in a growing population of long-term EUS-CDS lumen apposing metal stent carriers. Recent studies have reported a need for reintervention during follow-up as high as 55%, and the Leuven-Amsterdam-Milan Study Group classification has been developed, identifying five mechanisms of stent dysfunction and 11 possible rescue strategies aimed at restoring biliary drainage. This illustrated technical review aims to further dissect the recent classification through a comprehensive analysis of nine illustrative cases, offering insights into the pathophysiology underlying dysfunction and clinical reasoning behind rescue interventions, as well as technical considerations and practical tips and tricks. By exploring mechanisms of dysfunction, this review also assists clinicians in selecting the ideal candidates for EUS-CDS while identifying patients deemed high risk for dysfunction or clinical failure.

Key words: drainage, endoscopy, ERCP, EUS, stent

INTRODUCTION

ENDOSCOPIC ULTRASOUND-GUIDED CHOLEDOCHODUODENOSTOMY (EUS-CDS) is an established strategy for addressing distal malignant biliary obstruction whenever endoscopic retrograde cholangiopancreatography (ERCP) fails[1–3] or as an upfront drainage approach, corroborated by recent randomized data.[4,5]

EUS-CDS with electrocautery-enhanced lumen apposing metal stents (LAMS), allowing single-step free-hand access and stent release, has demonstrated excellent technical (93.3–97.8%) and clinical success (91.2–96.2%) with an acceptable safety profile (5.2–27.4%).[4–6] However, long-term outcomes have been underreported. Recent evidence[4–8] has focused on LAMS dysfunctions, reporting a heterogeneous prevalence (8.9–55%). Our Leuven-Amsterdam-Milan Study (L.A.M.S.) Group recently reported a dysfunction rate of 31.8% and duodenal invasion as the only independent risk factor (hazard ratio 2.7 [95% confidence interval 1.1–6.8]).[6] Subsequently, the L.A.M.S. classification of dysfunctions and reinterventions was proposed.[6]

Although most pancreatobiliary endoscopists are well-versed in managing traditional self-expandable metal stent (SEMS) dysfunction, there is a less comprehensive understanding of the newer LAMS dysfunctions. This technical review aims to provide a detailed examination and illustration of each event within the L.A.M.S. classification and to delve into the technical nuances of these specific rescue maneuvers.

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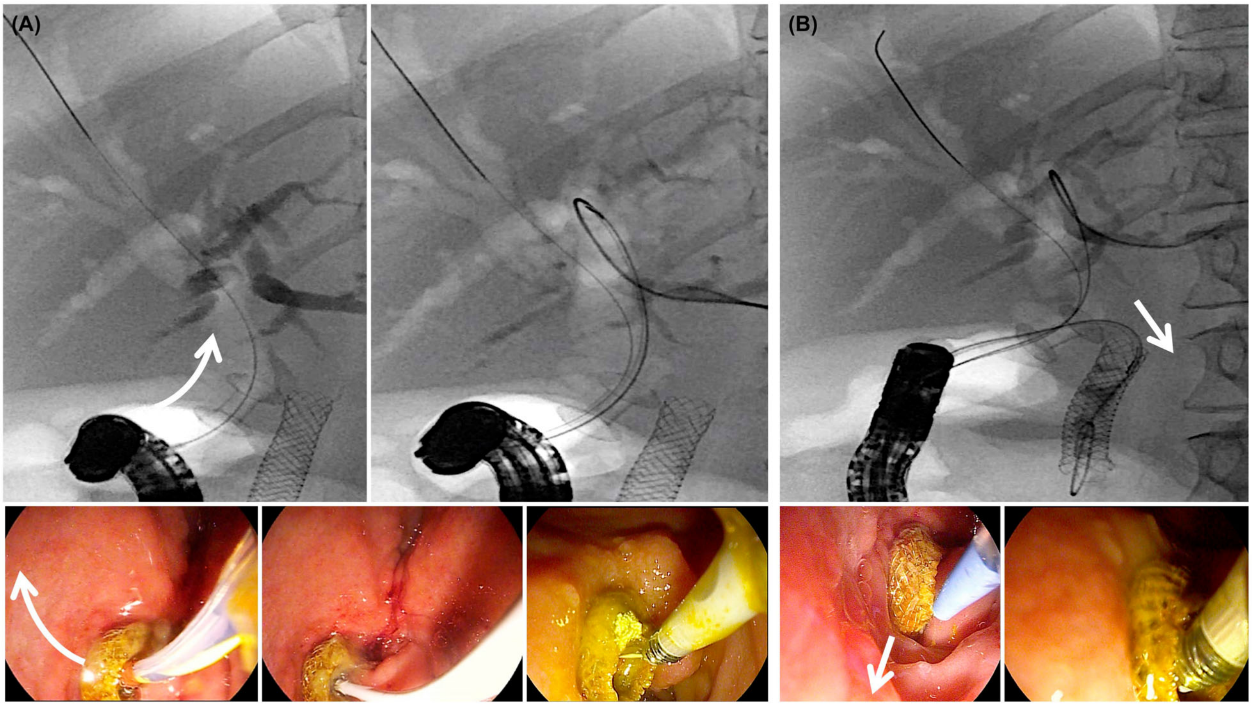

Figure 1 Lumen apposing metal stent (LAMS) cannulation. (A) For proximal/hilar cannulation, we suggest cannulating the LAMS with the sphincterotome/catheter, to act as a fulcrum, and then to change the direction of the catheter by the elevator and by moving the tip of the endoscope with the right wheel under fluoroscopic guidance; a certain amount of bending of the sphincterotome might be required to achieve deep cannulation. (B) For distal cannulation, we suggest the scope be placed in parallel to the duodenal wall and to access the LAMS with a straight catheter (or nonbended sphincterotome).

PROCEDURES AND TECHNIQUES

WE REVIEWED ALL cases of EUS-CDS with LAMS dysfunction registered in three tertiary, academic centers between 2017 and 2023 to identify one exemplary case for each item of the L.A.M.S. classification.[6] The retrospective evaluation was approved at the coordinating center (ID: 178/INT/2020) and at each location, and all patients provided informed consent as previously reported.[6] Technical details of EUS-CDS creation were previously detailed.[6]

All reinterventions were performed in a fluoroscopy room, under deep sedation, with either a therapeutic gastroscope or a duodenoscope and CO_2 insufflation.

LAMS cannulation

Because EUS-CDS is a side-to-side anastomosis, LAMS is directed at the lateral wall of the common bile duct (CBD). Therefore, following the introduction of a catheter, two possible directions exist for guidewire cannulation (Fig. 1), either proximally (toward the hilum) or distally (toward the papilla). If the aim is to access the proximal biliary tree for additional stent placement or stone extraction (Fig. 1A), we suggest cannulating and using the LAMS as a fulcrum, and then to change the direction of the catheter by using the elevator and/or by moving the tip of the endoscope with the right wheel under fluoroscopic guidance. A certain degree of sphincterotome bending might be required. If the aim is to access the distal biliary tree for rendezvous or antegrade stenting (Fig. 1B), we suggest placing the scope in parallel to the duodenal wall and accessing the LAMS with a straight catheter (or nonbended sphincterotome).

Balloon swipes through the LAMS

EUS-CDS typically uses LAMS with a 6 mm or 8 mm diameter, smaller than most available extraction balloons. Moreover, recurrent biliary obstruction can dilate the CBD; therefore, we suggest inflating the balloon according to the CBD caliber, and then to retract it toward the LAMS flange, starting gradual balloon deflation while pulling until the balloon has passed the LAMS toward the duodenum. A technique for gradual balloon deflation is the “closed-to-closed” rotation of the stopcock, which involves rapid 180°

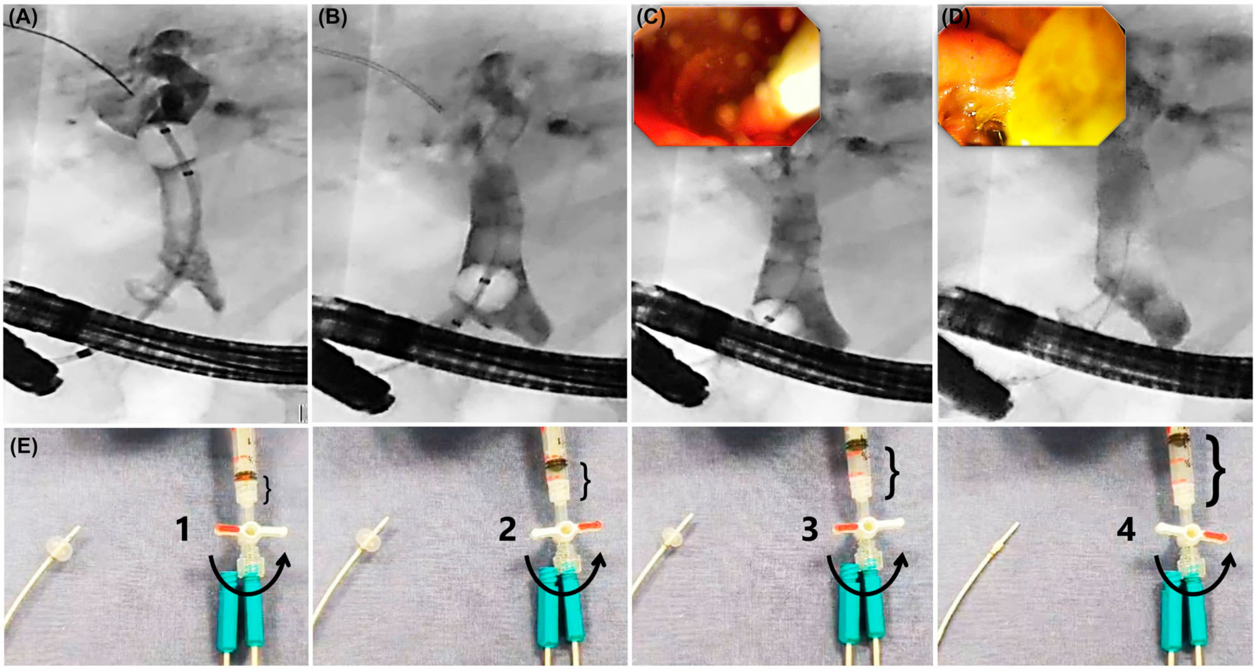

Figure 2 Balloon swipes. Because most balloons are larger than the 6 and 8 mm diameter lumen apposing metal stents (LAMS), we suggest: (A) inflating the balloon according to common bile duct caliber and (B) then retracting it toward the LAMS flange, eventually (C) slowly deflating the balloon by multiple 180° rotations (i.e., “closed-to-closed” position) of the stopcock while (D) pulling until the balloon has passed the LAMS toward the duodenum. (E) Sequential (1–4) “closed-to-closed” rotations of the stopcock result in spontaneous and gradual flow of air from the balloon to the syringe, whereas the open position of the stopcock would have resulted in abrupt complete deflation.

rotations to allow spontaneous and gradual air release from the balloon into the syringe (Fig. 2 and Video S2). In contrast, a fully open stopcock would lead to immediate full deflation.

If clinically possible, swiping of the LAMS should be delayed until a permanent fistula is developed (usually 10–15 days after the initial placement) because of the risk of dislocating the LAMS.[9]

Coaxial double-pigtail plastic stenting

Prophylactic coaxial double-pigtail plastic stenting (DPPS) placement during the index procedure is still debated.[10] Conversely, coaxial DPPS (rescue strategy A)[6] has been extensively used in case of LAMS dysfunction because it can: (i) prevent stent reocclusion, especially by food impaction; (ii) reduce the risk of ascending cholangitis; (iii) redirect the LAMS in case of compression/invasion; and (iv) prevent migration by anchoring the LAMS. Through-the-LAMS DPPS placement can also be considered a bridging emergency procedure before proceeding to more complex definitive solutions. The most prevalent stent in available literature is usually a 7F polyethylene double pigtail stent placed in an upward direction (toward the hilum),[10] with a small caliber preferred to avoid friction during advancement. We have usually preferred a 10F DPPS with multiple side holes (Solus; Cook Medical, Tokyo, Japan) because of the softer, pliable material (Sof-Flex), potentially reducing traumatism on surrounding structures in cases of long-term indwell. Because these stents work as a “bumper,” there is no evidence to suggest a scheduled revision, as is usually the case with plastic stents placed across stenoses.

Clinical Cases

Nine specific cases (Table 1) are hereafter reported. In brackets, the item of the L.A.M.S. classification, ranging 1–5 for dysfunctions (Fig. 3) and A to G for reinterventions (Fig. 4).

Table 1 Characteristics and timing of lumen apposing metal stent (LAMS) dysfunctions and reinterventions, along with technical details

ID and supporting information	LAMS caliber (mm)	Time to recurrence (days)	Dysfunction type[†]	Reintervention type[†]	Post-reintervention dysfunction-free survival (days)	Endoscope	Devices
Patient 1 – Video S1	8	64	3b	A + B	47	Duodenoscope	Extractor balloon (Extractor Pro, Boston Scientific), guidewire (Jagwire, Boston Scientific), double pigtail plastic stent (Solus, Cook Medical)
Patient 2 – Video S2	6	188	1	B	86	Duodenoscope	Extractor balloon (Extractor Pro, Boston Scientific), guidewire (Jagwire, Boston Scientific)
Patient 3 – Figure S1	8	90	3a	C	42	Duodenoscope	Extractor balloon (Extractor Pro, Boston Scientific), guidewire (Jagwire, Boston Scientific), UC-SEMS (Wallflex, Boston Scientific)
Patient 4 – Figure S2	8	213	2a	D1	643	Duodenoscope	Sphincterotome (AUTOtome, Boston Scientific), guidewire (Jagwire, Boston Scientific), PC-SEMS (Wallflex, Boston Scientific), extractor balloon (Extractor Pro, Boston Scientific), Dormia basket
Patient 5 – Video S3	6	15	3b	D2	203	Therapeutic gastroscope, duodenoscope	Sphincterotome (AUTOtome, Boston Scientific), guidewire (Jagwire, Boston Scientific), PC-SEMS (Wallflex, Boston Scientific)
Patient 6 – Video S4	6	5	5	D3	148	Therapeutic gastroscope	Extractor balloon (Extractor Pro, Boston Scientific), guidewire (Jagwire, Boston Scientific), sphincterotome (AUTOtome, Boston Scientific), PC-SEMS (Wallflex, Boston Scientific)

Table 1 (*Continued*)

ID and supporting information	LAMS caliber (mm)	Time to recurrence (days)	Dysfunction type†	Reintervention type†	Post-reintervention dysfunction-free survival (days)	Endoscope	Devices
Patient 7 – described elsewhere‡	6	273	2a–4	E	264	Duodenoscope, linear echoendoscope	Extractor balloon (Extractor Pro, Boston Scientific), guidewire (Jagwire, Boston Scientific), sphincterotome (AUTOtome, Boston Scientific), LAMS (Hot Axios, Boston Scientific)
Patient 8 – Figure S3	6	35	5	F	65	Therapeutic gastroscope, linear echoendoscope	Guidewire (Jagwire, Boston Scientific), sphincterotome, naso-biliary tube 8.5F (Liguory, Cook Medical), saline, indigo carmine, LAMS (Hot Axios, Boston Scientific), dilator balloon (CRE, Boston Scientific)
Patient 9 – Figure S4	6	46	5	G2	76	Linear echoendoscope	19G FNA needle (Cook Medical), guidewire (Jagwire, Boston Scientific), 6F cystotome (Endoflex), partially covered (30% uncovered, 70% covered) dedicated SEMS (GIOBOR, Taewoong Medical)

†According to Leuven-Amsterdam-Milan Study (L.A.M.S.) classification.[6]
‡Described in Vanella *et al*.[9]
FNA, fine needle aspiration; PC-SEMS, partially covered self-expandable metal stent; UC-SEMS, uncovered self-expandable metal stent.

Case 1: LAMS invasion, duodenal side [3b] → balloon swipes [B] and coaxial DPPS placement [A]

A 55-year-old woman with pancreatic cancer (PC) and prior SEMS placement was hospitalized for cholangitis and a type II duodenal stenosis[11] causing gastric outlet obstruction (GOO). She underwent EUS-guided gastroenterostomy (EUS-GE), according to the wireless simplified technique[12] and same-session EUS-CDS above the biliary stent.

Sixty-four days later, she returned with cholangitis. Endoscopically (Video S1), LAMS outflow was hampered by a flap of redundant edematous duodenal mucosa. The LAMS was cannulated; cholangiography showed multiple filling defects that were cleared by balloon swipes. Finally, to prevent the LAMS from repeated occlusions by the mucosal flap a 10F × 3 cm coaxial DPPS was placed. The patient passed away 47 days later from cancer progression without cholangitis recurrence.

Case 2: Sump syndrome [1] → balloon swipes [B]

A 76-year-old woman presented with jaundice from PC. ERCP failed and a 6 mm LAMS EUS-CDS was placed. After 188 days, she returned with cholangitis resulting from biliary stones. Using a duodenoscope (Video S2), LAMS was cannulated by sphincterotome and guidewire. Cholangiography showed mobile and soft filling defects suggestive of aggregated sludge, both above and below (sump syndrome) the LAMS. Balloon swipes were performed in both directions as previously described (Fig. 2).

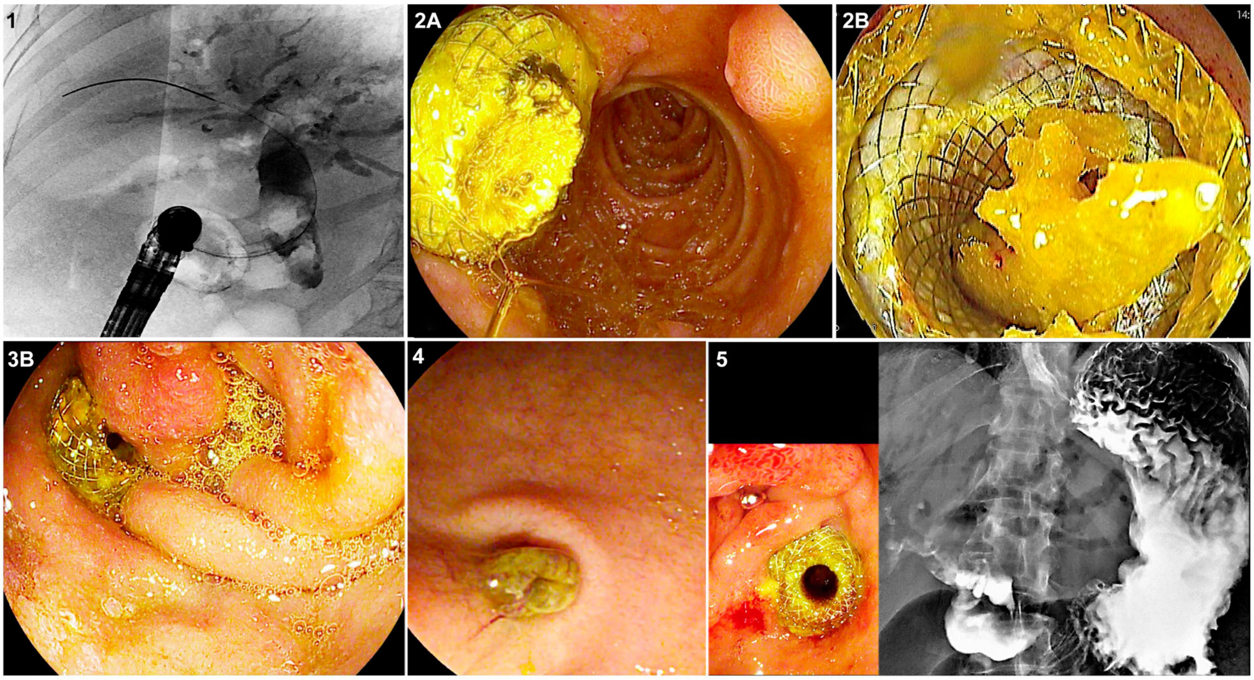

Figure 3 Leuven-Amsterdam-Milan Study (L.A.M.S.) classification of dysfunctions. (1) Stones accumulation, distal to the lumen apposing metal stent (LAMS) (sump syndrome). (2A) LAMS obstruction from stone impaction. (2B) Food impaction. (3B) LAMS invasion/compression on the duodenal side, by neoplastic infiltration. (4) LAMS migration. (5) Gastric outlet obstruction causing ascending cholangitis, as ascertained also by gastrointestinal follow-through showing contrast ascending the biliary tree through the LAMS.

Case 3: LAMS invasion, duodenal side [3b] → through-the-LAMS biliary SEMS [C]

A 56-year-old woman with PC underwent EUS-CDS after ERCP failed because of a duodenal stenosis. Three months later, jaundice recurred and endoscopic evaluation revealed malignant invasion of the LAMS. She also developed symptomatic GOO for which EUS-GE was performed. Though other solutions could also have restored biliary flow (e.g., a coaxial DPPS placement), a 6 cm covered SEMS was placed coaxial to the LAMS (Fig. S1) with the distal end inside the bile duct, whereas the proximal end above the duodenal stenosis allowed bile drainage toward the stomach. Jaundice subsided, but the patient passed away from disease progression 6 weeks later.

Case 4: LAMS obstruction by stone [2a] → transpapillary SEMS by retrograde cannulation [D1]

A 73-year-old woman with PC underwent primary EUS-CDS inside a clinical study. After 213 days, she was hospitalized for cholangitis. Magnetic resonance cholangiopancreatography showed extensive biliary dilatation with multiple stones (up to 20 mm). Given the complex lithiasis, a retrograde SEMS placement was decided on (Fig. S2). A standard ERCP with placement of a partially covered-SEMS was performed, followed by mechanical lithotripsy using an over-the-wire basket. This decision was based on the larger diameter of SEMS compared with LAMS, the more stable position the duodenoscope can achieve in front of the papilla, and the potential angulation challenges maneuvering the basket through the LAMS. After 643 days, the patient remained free of recurrent cholangitis.

Case 5: LAMS invasion, duodenal side (3B) → transpapillary SEMS by through-the-LAMS rendezvous [D2]

An 82-year-old man was admitted for jaundice from PC. After failed ERCP, a same-session EUS-CDS was performed. However, the patient suffered from persistent jaundice and biliary dilation seen on transabdominal ultrasound. After 15 days, endoscopic re-evaluation (Video S3) revealed early duodenal neoplastic infiltration leading to episodes of

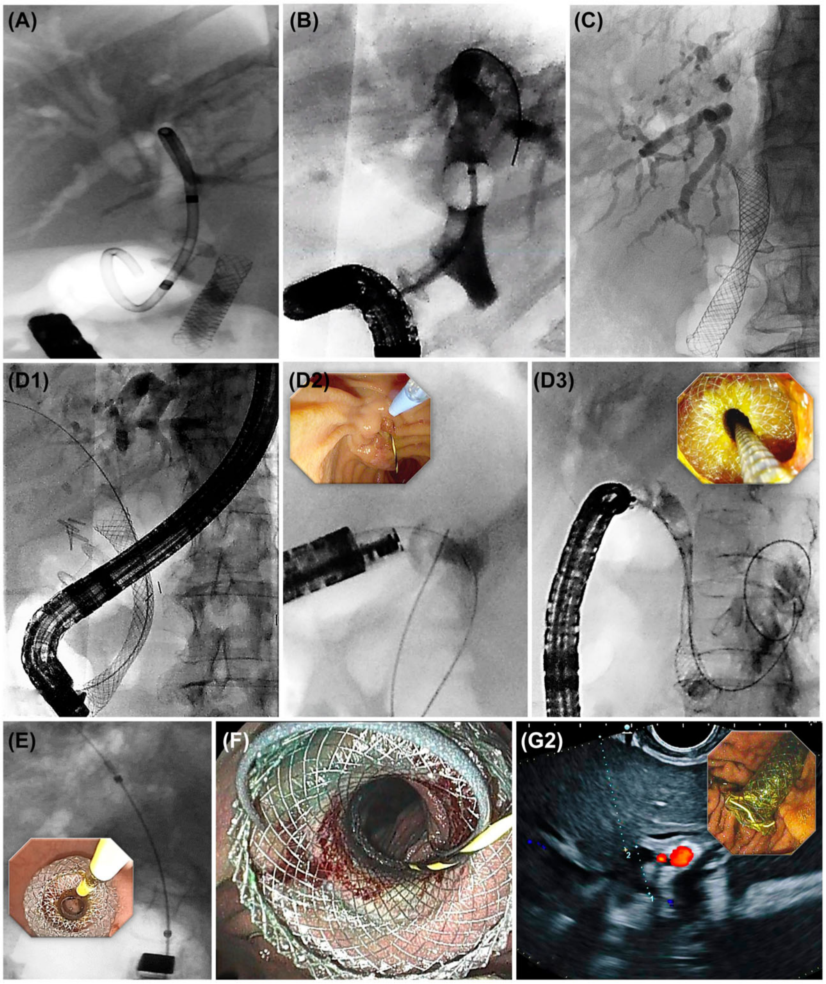

Figure 4 Leuven-Amsterdam-Milan Study (L.A.M.S.) classification of reinterventions. (A) Placement of a double pigtail plastic stent coaxial to the lumen apposing metal stent (LAMS). (B) Balloon swipe. (C) Through-the-LAMS biliary self-expandable metal stent (SEMS). (D1) Transpapillary SEMS placed by standard retrograde cannulation, in cases where endoscopic ultrasound-guided choledochoduodenostomy (EUS-CDS) was used as primary drainage strategy. (D2) The EUS-CDS LAMS is used as a door for advancing a guidewire through the stenosis and the papilla for ERCP rendezvous. (D3) The EUS-CDS LAMS is used as a door for antegrade placement of a transpapillary SEMS. (E) Over-the-wire LAMS exchange in case of LAMS migration. (F) EUS-guided gastroenterostomy for resolution of gastric outlet obstruction. (G2) EUS-guided hepaticogastrostomy as a rescue of EUS-CDS dysfunction.

functional occlusion of the LAMS. Because the papilla was accessible, a through-the-LAMS rendezvous was planned. Using a therapeutic gastroscope, the LAMS was cannulated with a sphincterotome. Contrast injection helped in identifying the stenosis. Sphincterotome bending and guidewire exchanging (e.g., curved tip, hydrophilic, smaller caliber) might be helpful as in any rendezvous. After negotiating the stenosis, the wire was stabilized in the duodenum and the gastroscope exchanged for a duodenoscope. Bile duct was cannulated in parallel to the previously placed wire and a partially covered-SEMS placed. The LAMS was removed with uncomplicated spontaneous fistula closure. A total of 203 days postprocedure, the patient succumbed to cancer progression without jaundice recurrence. Alternatively, a coaxial DPPS could have been used, albeit with higher dislocation risks.

Case 6: Ascending cholangitis resulting from duodenal reservoir in GOO [5] → through-the-LAMS antegrade stenting [D3]

A 61-year-old woman with PC presented with both GOO and malignant biliary obstruction and underwent same-session double EUS-bypass with EUS-GE and

EUS-CDS.[13] Five days later, she developed cholangitis and septic shock. A gastrointestinal follow-through revealed (Video S4) retrograde biliary opacification via the EUS-CDS LAMS despite proper EUS-GE functioning. To avoid ascending cholangitis resulting from food pooling in the bulb, a through-the-LAMS transpapillary antegrade metal stenting was considered.[14] A guidewire preloaded on a sphincterotome was advanced through the LAMS, the CBD, the stenosis, and the papilla, up to the Treitz. An antegrade placement of a 10 mm × 6 cm partially covered-SEMS was performed and the LAMS removed. Contrast injection in the duodenum showed no CBD opacification through the fistula. A total of 148 days postprocedure, no cholangitis recurred. This rescue technique should only be used if there is enough "free" CBD between the stenosis and the LAMS to ensure the SEMS end resides inside the CBD.

Case 7: LAMS migration [4] → over-the-wire LAMS exchange [E]

A 77-year-old man with duodenal cancer and prior enteral SEMS placement was admitted for jaundice and underwent EUS-CDS. Ten months later, he presented with recurring cholangitis. Endoscopy revealed the LAMS lumen fully obstructed by sludge concretions [2a]. Balloon swipe unintentionally dislodged the LAMS. The same fistula was therefore cannulated and used to place a new over-the-wire LAMS as recently described (with video).[9] The LAMS was advanced under endoscopic view, with the distal flange released under fluoroscopy and the proximal flange under endoscopic view. The patient no longer experienced recurrent cholangitis until his death 264 days later.

Case 8: GOO [5] → resolution of GOO [F]

A 68-year-old woman with PC presented with jaundice and GOO (type II stenosis).[11] She underwent enteral stenting and EUS-CDS. Thirty-five days later, she suffered from recurrent cholangitis, nausea, and vomiting. Duodenal stent ingrowth led to accumulation of food particles in the duodenal bulb, blocking the LAMS (Fig. S3). EUS-CDS cannulation revealed no biliary obstruction. An EUS-GE was performed[12,15] to restore the gastric outlet and decrease food retention in the bulb. She remained symptom-free until her passing 65 days after. In cases of duodenal stenting conflicting with the LAMS, without GOO, a potential solution is to insert a coaxial DPPS [A] as a bumper.

Case 9: LAMS infiltration on duodenal side [3b] → EUS-guided hepaticogastrostomy [G2]

A 67-year-old man with metastatic duodenal adenocarcinoma was treated for jaundice and vomiting through an enteral stent and a same-session EUS-CDS. Twenty-one days later, he returned with recurrent GOO and underwent surgical gastroenterostomy in another hospital. Twenty-five days after, he developed cholangitis (Fig. S4). The LAMS appeared partially embedded in the duodenal wall and was removed. Given the infiltrated duodenal stent, neither rendezvous nor antegrade stenting seemed viable. An EUS-guided hepaticogastrostomy (HGS) was therefore performed as detailed elsewhere.[16,17] He passed away 76 days later with no further cholangitis episodes.

DISCUSSION

ENDOSCOPIC ULTRASOUND-GUIDED CHOLEDOCHODUODENOSTOMY has been gaining popularity in the management of distal malignant biliary obstruction, either as rescue of a failed ERCP or even as upfront drainage strategy.[2] The diffusion of this procedure together with some improvement in overall survival of patients with pancreatobiliary neoplasia is generating a new population of long-term EUS-CDS carriers in whom reinterventions might be required.

Whereas SEMS dysfunction following classic ERCP is a well-known issue, EUS-CDS dysfunction has been underreported. Only recently has increasing evidence focused on this issue.[4,5,7,8] However, despite the prospective nature of these studies, rates of LAMS dysfunction have been inconsistent (8.9–55%). Even though the 1-year dysfunction rate was the primary outcome for two parallel randomized trials of EUS-CDS vs. ERCP,[4,5] risk factors for this event were not thoroughly examined and strategies for reintervention are only sparingly discussed. In a former publication from our group,[6] we attempted a systematic focus on this topic, reporting a need for reinterventions in up to 31.8% of patients, and introducing the L.A.M.S. classification identifying seven subtypes of dysfunctions (Fig. 3) and 11 types of reinterventions (Fig. 4).[6] The aim was to standardize future reporting of these events and to better comprehend the pathophysiology beyond each dysfunction to propose tailored treatment strategies.

For instance, 26% of dysfunctions in our cohort were independent from LAMS invasion/obstruction, but because of a duodenal invasion causing food accumulation in the bulb and ascending cholangitis, as proper gastric outlet is crucial for EUS-CDS efficacy.[18] Duodenal invasion was also identified as an independent predictor of dysfunction. Interestingly, in another series focused on EUS-CDS dysfunctions,[7] these were mostly related to alimentary obstruction, and the presence of a duodenal stent was found to be an independent predictor of dysfunction, together with a CBD diameter <15 mm.[7] These data raise serious concerns about performing EUS-CDS in the setting of GOO and propose this scenario as a relative contraindication to EUS-CDS;[6,18] in those cases, other biliary drainage modalities might be preferred.[16]

Conversely, GOO might follow EUS-CDS and should be therefore acknowledged as a possible cause of ascending cholangitis (Fig. 3, item [5]). Gastrointestinal follow-through (sometimes requiring late sequences and/or position changes) can display contrast accumulating in the bulb and refluxing into the CBD via the LAMS. If biliary opacification is attained, cholangitis likely stems from this mechanism. Addressing type 2 and 3[11] duodenal stenoses following EUS-CDS poses a difficult clinical conundrum. Resolving GOO should be prioritized (Fig. 4, item [F]), possibly favoring EUS-GE to enteral stenting given the recent evidence regarding its short- and long-term benefits.[2,15,19,20] However, ascending cholangitis might persist even after addressing GOO,[16] and this might require replacing the EUS-CDS LAMS with other biliary drainage modalities (EUS-HGS or transpapillary metal stents, regardless of how they are placed).

Managing EUS-CDS dysfunctions requires distinct and specialized maneuvers that differ from conventional SEMS revisions, and this illustrated technical review provides tips and tricks to offer detailed technical insights and practical guidance for endoscopists navigating these challenges.

Cannulation of the bile duct through the LAMS in a prespecified direction (proximal/hilar vs. distal/papillary, Fig. 1) requires a thorough understanding of the objectives and proficiency in wire manipulation.

One of the simpler and most prevalent rescue strategies in dedicated literature[4–8] is coaxial DPPS placement with or without previous CBD clearance, followed by conversion to transpapillary SEMS, either by standard retrograde cannulation or by through-the-LAMS antegrade placement. The need for percutaneous transhepatic biliary drainage in this scenario has been rare.[5,8]

Coaxial DPPS placement ([A]; Fig. 4, Video S1) may be used for several types of dysfunctions. One might therefore ask why DPPS placement at the index procedure has not become standard practice. However, current evidence on this preventive strategy has been controversial, and the results of an ongoing randomized trial are eagerly awaited.[19]

Balloon swipes ([B]; Fig. 4, Video S2) in this setting present additional technical challenges because extraction balloons are usually more oversized than EUS-CDS LAMS and should be therefore gradually deflated (a specific technique has been provided in this paper [Fig. 2, Video S2]).

Although LAMS can migrate spontaneously ([4]; Fig. 3) or during cleaning maneuvers, the mature fistula can be recannulated and a new LAMS (or SEMS) released over-the-wire ([E]; Fig. 4) as previously described.[11] Redo EUS-CDS [G1] or a new EUS-HGS ([G2]; Fig. 4) represents additional possibilities, the latter potentially representing a more suitable solution whenever duodenal infiltration makes the bulb unsuitable for biliary drainage.[16]

Although EUS-HGS or antegrade stenting may be preferrable in some scenarios (e.g., double obstruction), they are sometimes perceived as more complex than EUS-CDS. Yet, opting for EUS-CDS merely for its simplicity might not be advisable when there are anticipated suboptimal outcomes. When an increased risk of cholangitis can be a priori anticipated after EUS-CDS, especially with simultaneous GOO, alternative biliary drainage modalities might be preferred. However, if EUS-CDS was initially chosen, it can serve as an entry point for other interventions, such as coaxial SEMS placement ([C]; Fig. 4), antegrade transpapillary stenting ([D3]), or ERCP rendezvous ([D2]) if the papilla is accessible. A "standard" ERCP with retrograde SEMS placement ([D1]) might be another option if ERCP was not previously attempted.

All of these rescue strategies should be tailored according to the specific circumstances, and we have previously proposed a clinical algorithm to pair each specific dysfunction type with specific rescue strategies.[6]

Percutaneous biliary drainage [G3] may finally represent a widely available solution in the emergency setting, whenever endoscopy fails, which, however, rarely happens in available literature.[6]

While awaiting additional long-term data regarding EUS-CDS with LAMS, this review offers insights into the technical steps and rationale for addressing EUS-CDS dysfunctions and may aid in selecting ideal candidates for this approach, while identifying patients at high risk for clinical failure or dysfunction. Professionals managing pancreatobiliary malignancies should be aware that endoscopic revision of EUS-CDS with LAMS is feasible and effective for experienced endoscopists.

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CONFLICT OF INTEREST

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SUPPORTING INFORMATION

ADDITIONAL SUPPORTING INFORMATION may be found in the online version of this article at the publisher's web site.

Figure S1 Lumen apposing metal stent (LAMS) invasion on duodenal side [3b] treated with through-the-LAMS biliary self-expandable metal stent (SEMS) [C]. Endoscopic ultrasound-guided choledochoduodenostomy dysfunction resulting from malignant invasion of the LAMS treated by placement of a 6 cm SEMS coaxial to the LAMS, with the distal end inside the bile duct and the proximal end in the duodenum allowing bile to drain toward the stomach. (A,B) Endoscopic view. (C) Fluoroscopic view. (D) Postprocedural computed tomography scan.

Figure S2 Lumen apposing metal stent (LAMS) obstruction by stone [2a] treated by transpapillary self-expandable metal stent (SEMS) by retrograde cannulation [D1]. (A) LAMS obstructed by stones. (B) Standard retrograde cannulation and placement of a partially covered SEMS. (C) Mechanical lithotripsy through Dormia basket. (D) Fragment extractions.

Figure S3 Gastric outlet obstruction [5] treated by endoscopic ultrasound (EUS)-guided gastroenterostomy [F]. (A) Gastrointestinal follow-through showing contrast ascending the biliary tree through the lumen apposing metal stent (LAMS) because of obstruction of a previously placed enteral self-expandable metal stent (SEMS). (B) Endoscopic view showing the obstruction of the enteral SEMS and accumulation of food debris inside the bulb. (C) Cleaning of the bile duct through balloon swipes. (D,E) EUS-guided gastroenterostomy performed through the wireless simplified technique involving an orojejunal tube to distend the jejunum and a free-hand placement of a gastrojejunal LAMS.

Figure S4 Lumen apposing metal stent (LAMS) infiltration on duodenal side [3b] treated by endoscopic ultrasound (EUS)-guided hepaticogastrostomy [G2]. (A) Endoscopic view of neoplastic infiltration of the duodenal flange of the EUS-guided choledochoduodenostomy LAMS and of a previously placed enteral self-expandable metal stent (SEMS). (B) Gastrointestinal follow-through showing contrast ascending the biliary tree through the LAMS because of obstruction of a previously placed enteral SEMS. (C) EUS-guided hepaticogastrostomy performed by puncture of an intrahepatic duct of the second segment. (D) Contrast injection showing a dilated biliary tree above the biliary stenosis. (E) Endoscopic view of the epatico-gastric SEMS at the end of the procedure.

Video S1 Lumen apposing metal stent compression on the duodenal side [3b] treated with coaxial double pigtail plastic stent [A].

Video S2 Cholangitis resulting from biliary debris and sump syndrome [1] treated with balloon swipes [B]. A technique for gradual deflation of the balloon, through multiple 180° rotations of the stopcock (closed-to-closed position) is described.

Video S3 Lumen apposing metal stent (LAMS) invasion on the duodenal side [3b] treated with transpapillary self-expandable metal stent by using the LAMS for endoscopic retrograde cholangiopancreatography rendezvous [A].

Video S4 Ascending cholangitis resulting from duodenal reservoir in gastric outlet obstruction [5] treated by using the lumen apposing metal stent for antegrade stenting [D3].