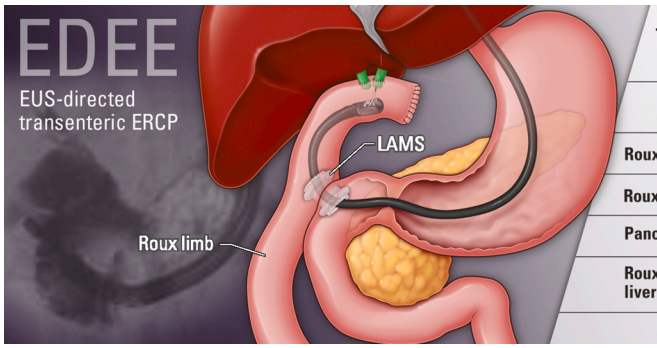
Transenteric endoscopic retrograde cholangiopancreatography via endoscopic ultrasound–guided anastomosis using lumen-apposing metal stents in patients with surgically altered anatomy (with video)

Enrique Pérez-Cuadrado-Robles, MD, PhD,[1,2] Michiel Bronswijk, MD,[3,4] Amy Tyberg, MD,[5] Giuseppe Vanella, MD, PhD,[6] Andrea Anderloni, MD,[7,8] Pieter Hindryckx, MD, PhD,[9] Haroon Shahid, MD,[5] Paolo Giorgio Arcidiacono, MD,[6,10] Jean-Philippe Ratone, MD,[11] Avik Sarkar, MD,[5] Cecilia Binda, MD,[12] Iman Andalib, MD,[5] Wim Laleman, MD, PhD,[3,13] Jan-Werner Poley, MD,[14] Mariano Gonzalez Haba, MD,[15] Fabrice Caillol, MD,[11] Carlo Fabbri, MD,[12] Tom Boeken, MD,[2,16] Aymeric Becq, MD, PhD,[17] Laurent Monino, MD,[18] Christophe Cellier, MD, PhD,[1,2] Michel Kahaleh, MD,[19] Schalk van der Merwe, MD, PhD[3]

Paris, Marseille, Creteil, Montpellier, France; Leuven, Bonheiden, Ghent, Belgium; Hackensack, New Brunswick, New Jersey, USA; Milan, Pavia, Forlì-Cesena, Italy; Munster, Germany; Maastricht, Netherlands; Madrid, Spain

GRAPHICAL ABSTRACT



Technical success of EDEE, clinical success and adverse event rates according to the surgically altered anatomy configuration

	Technical success	Clinical success	LAMS-related AEs	ERCP-related AEs
Roux-en-Y gastrectomy (n, %)	14 (93.3%)	13 (91.86%)	0	3 (20%)
Roux-en-Y and HJ (n, %)	20 (87%)	19 (95%)	4 (17.4%)	3 (13%)
Pancreaticoduodenectomy (n, %)	12 (80%)	11 (91.7%)	0	0
Roux-en-Y after living donor liver transplantation (n, %)	2 (100%)	2 (100%)	1 (50%)	0

Background and Aims: Endoscopic ultrasonography (EUS)-directed transenteric endoscopic retrograde cholangiopancreatography (ERCP) (EUS-directed transenteric ERCP [EDEE]) using a lumen-apposing metal stent (LAMS) is a novel biliary drainage technique for patients with surgically altered anatomy. The study aimed to evaluate the feasibility, safety, and effectiveness of EDEE.

Current affiliations: Department of Gastroenterology, Georges-Pompidou European Hospital, APHP.Centre, Paris, France (1), University of Paris-Cité, Paris, France (2), Department of Gastroenterology and Hepatology, University Hospitals Leuven, Leuven, Belgium (3), Department of Gastroenterology and Hepatology, Imelda General Hospital, Bonheiden, Belgium (4), Hackensack Meridian Health Care System, Hackensack, New Jersey, USA (5), Pancreatobiliary Endoscopy and Endosonography Division, San Raffaele Scientific Institute, Milan, Italy (6), Department of Internal Medicine and Medical Therapeutics, University of Pavia, Pavia, Italy (7), Gastroenterology and Digestive Endoscopy Unit, Fondazione I. R.C.C.S. Policlinico San Matteo, Pavia, Italy (8), Department of Gastroenterology, Ghent University Hospital, Ghent, Belgium (9), Vita Salute San Raffaele University, Milan, Italy (10), Digestive Endoscopy Unit, Paoli-Calmettes Institute, Marseille, France (11), Gastroenterology and Digestive Endoscopy Unit, Forlì-Cesena Hospitals, AUSL Romagna, Forlì-Cesena, Italy (12), Medizinische Klinik B, Universitätsklinikum Münster, Munster, Germany (13), Gastroenterology and Hepatology, Maastricht University Medical Centre, Maastricht, Netherlands (14), Department of Gastroenterology, Hospital Universitario Puerta de Hierro Majadahonda, Madrid, Spain (15), Department of Interventional Radiology, Georges-Pompidou European Hospital, APHP.Centre, Paris, France (16), Department of Gastroenterology, Henri Mondor Hospital, Creteil, France (17), Department of Gastroenterology, University Hospital of Montpellier, Montpellier, France (18), Foundation for Interventional & Therapeutic Endoscopy, New Brunswick, New Jersey, USA (19).

Corresponding author: Enrique Pérez-Cuadrado-Robles, MD, PhD, Department of Gastroenterology, Georges-Pompidou European Hospital, 20 Rue Leblanc, Paris 75015, France. E-mail: enrique.perez.cr@gmail.com.

Methods: This is a multicenter, retrospective study. We included consecutive patients with altered anatomy who underwent an EDEE. Surgical anatomy configuration, prior biliary drainage, and ERCP indications were collected. The EUS-guided anastomosis technique was assessed. The primary outcome was the technical success of the EDEE. The secondary outcomes were the clinical success and the adverse events (AEs).

Results: Ninety-four ERCPs were performed in 55 patients (60 ± 16.2 years old, 56.4% male). The most frequent surgical anatomy was Roux-en-Y hepaticojejunostomy (n = 23, 41.8%) and a prior biliary drainage was performed in 28 patients (50.9%). Benign strictures were the most frequent indication (58.2%). The most frequent techniques to identify the biliary limb were EUS imaging alone (n = 14, 25.5%) and EUS-guided puncture of the biliary limb with retrograde opacification of the surgical hepaticojejunostomy (n = 14, 25.5%). The procedure was performed using a direct freehand approach (n = 49, 89.1%). Technical and clinical success rates of EDEE were 87.3% and 93.8%, respectively. The overall AE rate was 20% (9.1% LAMS-related). The rate of persistent fistula was 30.6% with a median follow-up period of 3 months.

Conclusions: The EDEE technique offers a new and effective approach for biliary drainage in patients with surgically altered anatomy, particularly in benign indications and/or when several ERCPs are expected. (Gastrointest Endosc 2026;103:994-1002.)

INTRODUCTION

The treatment of biliary diseases in patients with surgically altered anatomy (SAA) represents a challenge and has evolved significantly in the recent years as a consequence of new endoscopic and mini-invasive techniques. Historically, surgery and percutaneous transhepatic biliary drainage were the only treatment options. Nowadays, a more comprehensive approach, based on the anatomy, the indication (benign/malignant), the local expertise, and newly available techniques, is reshaping the therapeutic algorithm. In addition, hybrid modalities such as percutaneous cholangioscopy[1] or laparoscopic-assisted endoscopic procedures have been reported.

Single- and double-balloon enteroscopy-assisted endoscopic retrograde cholangiopancreatography (ERCP) have shown to be safe and effective regardless of the type of SAA.[2-4] Similarly, the use of a pediatric colonoscope has been successfully described in patients with Roux-en-Y anatomy.[5] These approaches, using forward-viewing scopes, could be useful when the length of the biliary limb is expected to be short, particularly in patients with Billroth-II, pancreaticoduodenectomy, or surgical gastrojejunostomy. However, reaching and cannulating the papilla or the hepaticojejunal (HJ) anastomosis is challenging, and dedicated devices for these lengthy scopes are limited.

Recent advancements in endoscopic techniques have improved the management of these challenging scenarios and have integrated the armamentarium of interventional endoscopy. For instance, therapeutic endoscopic ultrasonography (EUS) has emerged as a pivotal tool,[6,7] allowing for the creation of anastomoses and enabling precise interventions in SAA patients,[8] such as EUS-guided hepaticogastrostomy,[9] EUS-guided hepaticojejunostomy,[10] and EUS-guided digestive anastomoses—either to directly drain the bile duct or to access to the biliary limb.

An increasing body of evidence is available regarding the biliary management of patients with a history of pancreaticoduodenectomy, Roux-en-Y gastric bypass (RYGB), one-anastomosis gastric bypass,[11,12] and afferent limb syndrome.[13,14] In patients with prior RYGB, European guidelines suggest EUS-directed transgastric ERCP (EDGE) for benign indications, thereby avoiding invasive laparoscopy-assisted ERCP or of the limited clinical success rates of enteroscopy-assisted ERCP.[15] Moreover, recent data suggest that EUS-guided anastomosis is efficient in most patients for biliary limb decompression and for preventing reflux cholangitis in afferent limb syndrome.[13]

Other SAAs, such as Roux-en-Y gastrectomy, remain particularly challenging. Identification and access to the biliary limb are difficult, and no consensus currently exists on the optimal approach in these patients. Multiple techniques have been described, including surgical, endoscopic, and minimally invasive hybrid strategies. EUS-directed transenteric ERCP (EDEE) via EUS-guided anastomosis has recently emerged as a novel option. Its usefulness has been proposed in cases requiring repeated biliary interventions, when a previous diagnostic EUS through the anastomosis is necessary (eg, suspicion of ampulloma), in benign conditions, or when alternative modalities are not feasible.

The aim of this study was to evaluate the feasibility, safety, and effectiveness of EDEE in patients with SAA.

METHODS

Patients

We conducted a multicenter, retrospective study. All consecutive adult patients with altered anatomy who underwent an EDEE via EUS-guided anastomosis with lumen-apposing metal stents (LAMSs) between August 2019 and

March 2025 were included. The following SAAs were eligible for inclusion: total gastrectomy with Roux-en-Y reconstruction, distal gastrectomy with Roux-en-Y reconstruction, Roux-en-Y hepaticojejunostomy, and Roux-en-Y after living donor liver transplantation and pancreaticoduodenectomy.

Surgical gastrojejunostomy, gastric bypass (1-anastomosis gastric bypass, RYGB), and afferent limb syndrome patients were excluded. Thus, those patients who underwent an EDGE were not considered in this study. Demographic variables (sex, age), type of SAA, presence of a major papilla, presence of ascites, history of biliary drainage, biliary drainage indication, associated acute cholangitis, and intensive care unit admission were collected.

Procedures

EDEE consists of 2 steps, namely, the creation of the EUS-guided anastomosis and the ERCP. These 2 steps can be performed in a single session or 2 separate sessions.

Regarding the EUS-guided procedure, a linear-array echoendoscope with an oblique viewing was used and a HotAxios (Boston Scientific, Marlborough, Mass, USA) or HotSpaxus (Taewoong Medical, Gyeonggi-do, South Korea) LAMS was placed, creating an anastomosis between the proximal digestive lumen (duodenum, gastric pouch, or jejunum) and the biliary limb (duodenum or jejunum). The technical success of the EUS-guided anastomosis was retained when the LAMS was placed within the 2 desired lumens. The EUS-guided anastomotic technique (direct, wire-guided), LAMS diameter, and route were left at the discretion of the endoscopist. Location choice in biliary limb for the anastomosis and time of intervention were collected. Finally, the fixation of the LAMS was performed at the discretion of the endoscopist.

Regarding the ERCP procedure, the time of procedure, type of endoscope, and the need for LAMS dilation to pass the scope were collected. In case of technical failure, a rescue technique or surgery was considered. Procedure-related mortality was assessed.

Outcomes

The primary outcome was the technical success of the EDEE, defined as the deep cannulation of the bile duct.

The secondary outcomes were the clinical success, the adverse events (AEs), and the mortality. The clinical success was defined as the decrease of 50% of bilirubin and/or symptomatic relief at 1 week. The overall AE rate was calculated, with a subgroup analysis of LAMS-related and ERCP-related AEs according to the AGREE classification.[16] Severe AEs (>AGREE II) were collected.

Follow-up

The number of transenteric ERCPs before LAMS extraction, time to LAMS extraction, and fistula closure were collected.

Statistical analysis

Categorical variables were expressed in numbers (%) and compared using χ^2 or Fisher exact tests. Normally and nonnormally distributed continuous variables were presented as mean (SD) or median (range) and analyzed by *t* test and Mann-Whitney *U* test. A 2-sided *P* value <.05 was considered statistically significant. SPSS, version 24, was used (IBM Corp, Armonk, NY, USA).

TABLE 1. Characteristics of 55 patients who underwent a transenteric ERCP through an EUS-guided anastomosis using a lumen-apposing metal stent

Characteristic	*n* (%)
Type of surgery	
Roux-en-Y total gastrectomy	5 (9.1)
Roux-en-Y distal gastrectomy	10 (18.2)
Roux-en-Y and hepaticojejunostomy	23 (41.8)
Pancreaticoduodenectomy	15 (27.3)
Roux-en-Y after living donor liver transplantation	2 (3.6)
Presence of major papilla	15 (27.3)
Previous drainage	28 (50.9)
Indication	
Benign biliary stricture	32 (58.2)
Biliary stones	14 (25.5)
Malignant biliary stricture	7 (12.7)
Ampulloma	1 (1.8)
Biliary leak	1 (1.8)
Acute cholangitis	29 (52.7)
Ascites	4 (7.3)
Intensive care unit admission	1 (1.8)

RESULTS

Patients

Fifty-five patients (60 ± 16.2 years old, 56.4% male) were included. A major papilla was present in 27.3%. The most frequent surgical presentation was Roux-en-Y hepaticojejunostomy ($n = 23$, 41.8%) (Table 1).

A prior biliary drainage had been performed or attempted in 28 patients (50.9%), by single ($n = 22$, 78.6%) or multiple approaches ($n = 6$, 21.4%). A prior percutaneous drainage ($n = 19$, 34.5%), enteroscopy-assisted ERCP ($n = 10$, 18.2%), or EUS-guided anterograde drainage ($n = 5$, 9.1%) had been previously performed. In patients with prior enteroscopy-assisted ERCP or EUS-guided antegrade drainage, EDEE was chosen because of technical or clinical failure of these approaches. In cases with previous percutaneous drainage, EDEE was performed either as part of a 2-step strategy ($n = 11$) or following clinical failure of this technique ($n = 8$).

Most indications were benign ($n = 48$, 87.3%). The most common indication of patients with Roux-en-Y hepaticojejunostomy and pancreaticoduodenectomy was a benign biliary stricture of the HJ anastomosis ($n = 16$, 69.6%, and $n = 11$, 73.3%, respectively). The most common indication in

TABLE 2. The technique to identify the afferent limb and create an EUS-guided anastomosis according to the surgically altered anatomy configuration in patients who underwent a transenteric ERCP

	Roux-en-Y gastrectomy, *n* (*n* = 15)	Roux-en-Y and HJ, *n* (*n* = 23)	Pancreaticoduodenectomy, *n* (*n* = 15)	Roux-en-Y after living donor liver transplantation, *n* (*n* = 2)
Opacification of the HJ through the biliary limb (*n* = 14, 25.5%)	0	9	4	1
Only EUS imaging (*n* = 14; 25.5%)	6	4	4	0
Opacification of the biliary limb through the EUS-guided puncture of the IHBD or CBD (*n* = 10, 18.2%)	4	1	4	1
EUS rendezvous with transhepatic guidewire (*n* = 1, 1.8%)	1	0	0	0
Placement of a jejunal catheter in biliary limb (*n* = 5, 9.1%)	0	2	3	0
Percutaneous assisted procedure (*n* = 11, 20%)	4	7	0	0

CBD, Common bile duct; *HJ*, hepaticojejunostomy; *IHBD*, intrahepatic bile duct.

Figure 1. Different techniques to identify the biliary limb prior to performing the EUS-guided anastomosis. Opacification of the hepaticojejunostomy through the afferent limb in patients with Roux-en-Y anatomy and hepaticojejunostomy (**A** and **B**) and pancreaticoduodenectomy (**C**). Opacification of the biliary limb through the EUS-guided puncture of the intrahepatic biliary duct in a patient with pancreaticoduodenectomy (**D**). EUS imaging alone with the identification of the blind end of the biliary limb in a patient with Roux-en-Y gastrectomy (**E**). Placement of a jejunal catheter in the biliary limb connected to a water pump in a patient with pancreaticoduodenectomy (**F**). Percutaneous-assisted EUS-guided anastomosis in patients with Roux-en-Y gastrectomy (**G**) and Roux-en-Y anatomy with hepaticojejunal anastomosis (**H** and **I**).

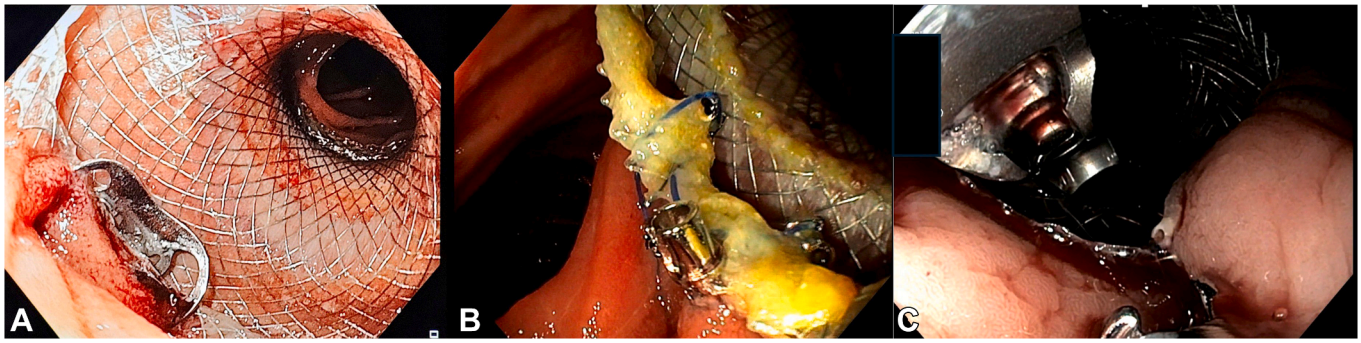


Figure 2. Fixation of a lumen-apposing metal stent in an EUS-guided anastomosis using Stentfix (**A**), X-tack (**B**), and Overstich (**C**).

patients with gastrectomy was biliary stones (n = 9, 60%). The pancreaticoduodenectomy configuration was associated with a higher rate of acute cholangitis compared with other surgical presentations (80% vs 42.5%, P = .013).

EUS-guided anastomosis

The techniques used to identify the biliary limb are described in Table 2 and Figure 1. An EUS-guided puncture of the biliary limb with a 19-gauge needle was used in 33 patients (60%). The most frequent techniques were EUS imaging alone (n = 14, 25.5%) and EUS-guided puncture of the biliary limb with retrograde opacification of the bile duct (n = 14, 25.5%). The latter could only be performed in patients with a permeable HJ anastomosis. Patients with Roux-en-Y total or partial gastrectomy underwent EUS imaging of the excluded duodenum alone (n = 6, 42.9%) as the most frequent approach.

Overall, the technical success of EUS-guided anastomosis was 100% (including 1 case of misdeployment solved intraprocedurally). The procedure was performed using the direct freehand approach in most patients (n = 49, 89.1%). The used routes were gastrojejunal (n = 32, 58.2%), jejunojejunal (n = 16, 29.1%), jejunoduodenal (n = 5, 9.1%), and duodenojejunal (n = 2, 3.6%). All the jejunoduodenal anastomoses were performed in patients with previous Roux-en-Y gastrectomy and an excluded duodenum with a major papilla. The LAMS diameter was 20 mm in 43 patients (78.2%), 16 mm in 1 patient (1.8%), and 15 mm in 11 patients (20%).

LAMS fixation was performed in 16 patients (29.1%) using Stentfix (Ovesco, Tübingen, Germany) (n = 8), Overstich (Boston Scientific) (n = 7), and X-tack (Boston Scientific) (n = 1) as shown in Figure 2. Fixation techniques were mostly performed in the context of single-session procedures (47.1% vs 21.1%, P = .05) with immediate transenteric ERCP. The median EUS-guided anastomosis procedure time was 49 minutes (range: 15-120).

Transenteric ERCP

A total of 94 transenteric ERCPs (median: 1, range: 1-6) were performed (Fig. 3). Gastroscopes (n = 28, 50.9%), duodenoscopes (n = 24, 43.6%), or pediatric colonoscopes (n = 3, 5.5%) were used. Twenty-three patients (41.8%) required more than 1 transenteric ERCP procedure: calibration of a benign stricture (n = 18), stone extraction (n = 3), and postsphincterotomy bleeding (n = 2).

The procedure was achieved in a single session in 17 patients (30.9%) and in a 2-session fashion in 38 patients (69.1%) (Video 1, available online at www.giejournal.org). LAMS dilation at a median of 18 mm (range: 10-20) was warranted in 35 patients (63.6%), being more frequent in patients with a single-session strategy (100% vs 24.2%, P < .001). The median dilation diameter was higher in patients who underwent an ERCP using a duodenoscope compared with that using a gastroscope (19.1 vs 16.2 mm, P = .003).

Considering the 32 patients with benign strictures of the HJ anastomosis, they underwent a combined approach of dilation and progressive plastic stenting (n = 18, 56.3%), dilation alone (n = 8, 25%), progressive plastic stenting alone (n = 5, 15.6%), and fully covered metal stents (n = 1, 3.1%).

The median delay between the EUS-guided anastomosis and the ERCP was 15 days (range: 2-70). The median procedure time of transenteric ERCP was 39 minutes (range: 10-190).

Primary outcome

The EDEE was technically successful in 48 patients (87.3%). The procedure failed in 7 patients because of no biliary cannulation (n = 5), duodenal stricture (n = 1), and HJ anastomosis not localized (n = 1). EUS-guided hepaticogastrostomy (n = 5), EUS-guided gallbladder drainage (n = 1), and percutaneous drainage (n = 1) were performed as rescue therapies. No rescue surgery was necessary. Table 3 describes the technical and clinical success depending on the SAA configuration.

Secondary outcomes

Clinical success was achieved in 45 of the 48 patients with EDEE technical success (93.8%). The overall AE rate (EUS-guided anastomosis and transenteric ERCP) was 20%, with a 12.7% rate of severe AEs. Five AEs (9.1%) occurred during the EUS-guided anastomosis (AGREE II [n = 1], IIIA [n = 4]). Four of these AEs occurred during 2-session procedures

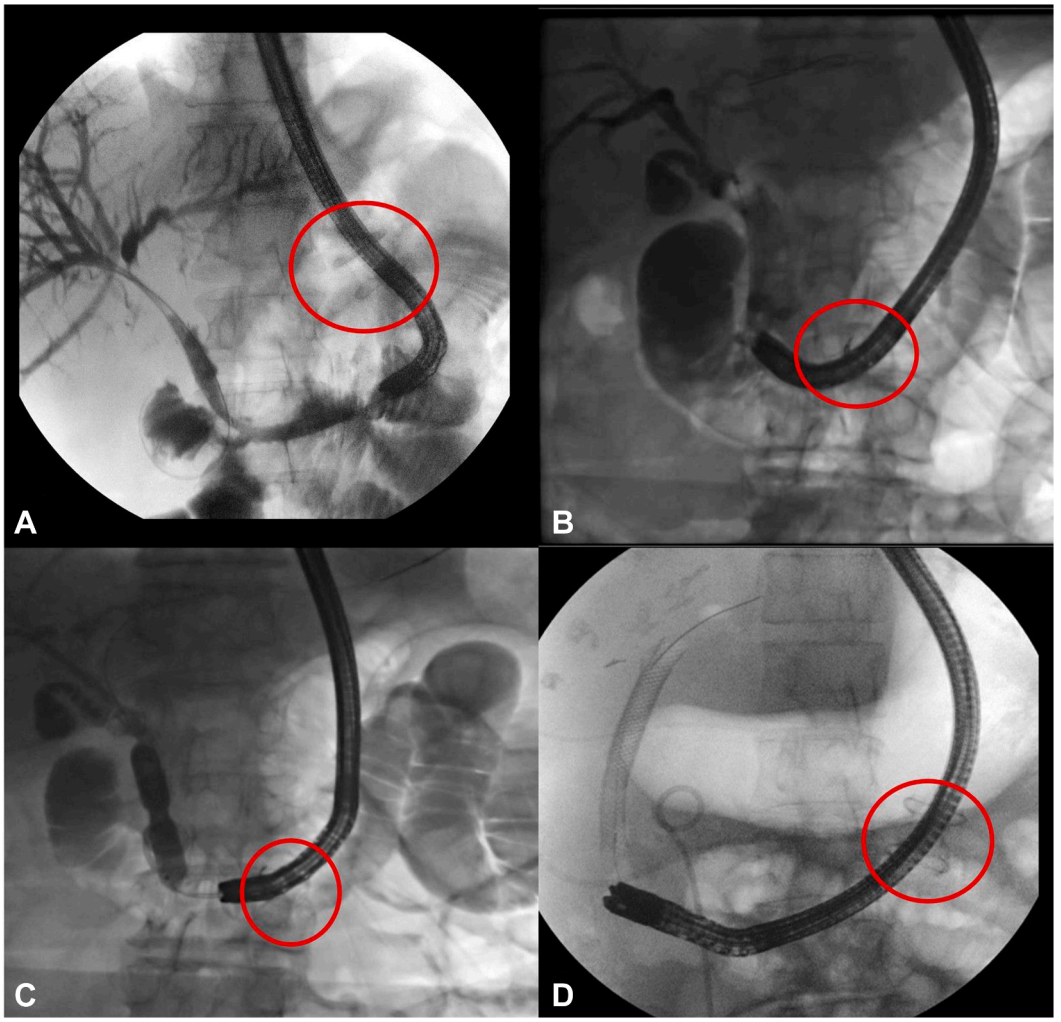


Figure 3. Transenteric ERCP via EUS-guided anastomoses (*red circle*). Percutaneous-assisted ERCP using a forward-viewing therapeutic gastroscope with plastic stenting (**A**), balloon extraction of biliary stones (**B**), and dilation of the hepaticojejunal anastomosis (**C**). Transenteric ERCP using a duodenoscope with fully covered metal stenting in a patient with distal biliary stenosis (**D**).

TABLE 3. Technical success of EDEE, clinical success and adverse event rates according to the surgically altered anatomy configuration

	Technical success, *n* (%)	Clinical success*, *n* (%)	LAMS-related AEs, *n* (%)	ERCP-related AEs, *n* (%)
Roux-en-Y gastrectomy	14 (93.3)	13 (91.86)	0	3 (20)
Roux-en-Y and HJ	20 (87)	19 (95)	4 (17.4)	3 (13)
Pancreaticoduodenectomy	12 (80)	11 (91.7)	0	0
Roux-en-Y after living donor liver transplantation	2 (100)	2 (100)	1 (50)	0

AE, Adverse event; *HJ*, hepaticojejunostomy; *LAMS*, lumen-apposing metal stent.
*Clinical success was calculated in patients with previous technical success.

(80%). These AEs consisted in LAMS migration (both 15 mm) ($n = 2$), LAMS misdeployment with intraperitoneal release of the distal flange ($n = 1$), buried stent treated by stent-in-stent technique ($n = 1$), and a small collection next to the LAMS ($n = 1$). The LAMS-related AEs resolved with conservative management ($n = 3$) or endoscopically during the same procedure ($n = 2$). There were no statistically significant differences in the AE rate between patients who underwent LAMS fixation or not (12.5% vs 7.7%, $P = .573$). Six AEs (10.9%) occurred during the transenteric ERCP (AGREE II [n = 3], IIIA [$n = 3$]). These AEs consisted in post-ERCP acute cholangitis ($n = 2$), postsphincterotomy bleeding ($n = 2$), and mild post-ERCP pancreatitis ($n = 2$). No patients died as a result of the procedure.

Follow-up

The median follow-up after the first transenteric ERCP procedure was 3 months (range: 7 days to 26 months). The LAMS was removed in 49 patients (89.1%) after a median delay of 27 days (range: 15-275). The fistula was closed endoscopically in 11 patients (22.5%). A persistent fistula was observed in 15 patients (30.6%), with a lower rate in patients who had undergone a fistula closure (9.1% vs 43.8%, $P = .037$). The LAMS was intentionally left in place for subsequent interventions in 6 patients (10.9%) presenting with benign biliary strictures.

DISCUSSION

In this multicenter retrospective study, 94 transenteric ERCPs were performed in 55 patients with SAA. Most indications were benign ($n = 48$, 87.3%), and different methods were used to identify the biliary limb. The technical success of the EUS anastomosis creation was 100%. The technical and clinical success rates of the transenteric ERCP were 87.3% and 93.8%, with a severe AE rate of 12.7%. The rate of persistent fistula after LAMS removal was 30.6%, with a median follow-up period of 3 months.

This study presents a heterogeneous group of patients with a wide array of surgical anatomies and indications. Understanding the surgical anatomy to properly evaluate all the alternative techniques in a multidisciplinary approach is the cornerstone of the therapeutic algorithm in this setting. In addition, patients with SAA usually underwent several surgeries and/or prior biliary drainage attempts, increasing the complexity of the decision-making strategy.[17]

Notably, all patients with gastric bypass or afferent limb syndrome were excluded given the EUS-guided anastomosis technique has already been described in the European guidelines[15] and published multicenter studies,[18] with satisfactory outcomes. The identification of the excluded stomach or the dilated biliary limb and the creation of the EUS-guided anastomosis in these scenarios is less challenging. Indeed, transgastric ERCP during the EDGE procedure can be done using a duodenoscope in most patients as a standard ERCP. Conversely, identification of the biliary limb in other Roux-en-Y configurations when the bowel is not dilated and to identify the distance to the papilla or to the surgical hepaticojejunostomy is one of the most difficult steps in the EDEE strategy.[19] This is also impacted by the patient's condition and specific surgical presentation.

In our study, the opacification of the HJ anastomosis through the biliary limb was the most common method used in patients with a surgical hepaticojejunostomy, whereas the EUS identification of the limb was mainly chosen in patients with Roux-en-Y gastrectomy and native papilla. The dynamic of the contrast injection should be carefully evaluated to estimate the distance from the puncture site to the HJ anastomosis. Although these patients usually present with a biliary stricture or stones, the biliary anastomosis is usually partially permeable. In some cases, there are 2 side-by-side anastomoses of the left and right biliary ducts, leading to their identification by a reflux of contrast if 1 of them is occluded. Interestingly, although a 19-gauge needle puncture was necessary in most patients to inject contrast, dilate the biliary limb, and drive the strategy, the direct freehand EUS-guided anastomosis with no guidewire was widely preferred. Of note, in patients undergoing EUS-guided anastomosis assisted by a previous percutaneous transhepatic biliary drainage (20% in our series), the previous percutaneous drainage should not always be considered as a failure but the first step in a hybrid 2-step strategy. Indeed, the percutaneous drainage in complex cases is much more accessible in the emergency setting or in centers without the expertise of therapeutic EUS.

The gastrojejunal route should probably be privileged when there is a gastric pouch with an access to the biliary limb, as this is more stable and allows further ERCP procedure maneuvers with a lower risk of LAMS migration. This approach (58.2%), combined with the placement of large LAMSs (78.2%), was chosen in most patients. The jejunogastric approach has been described as a risk factor of difficult ERCP in previous series on EDGE.[11] Furthermore, a small LAMS diameter (15 mm) has been described as an independent risk factor of stent migration in the EDGE technique.[20] Similarly, in our study, LAMS migrations occurred with smaller-sized LAMSs during the transenteric ERCP. The LAMS fixation was not associated with a lower LAMS-related AE rate, but several fixation methods were used. The fixation was only performed in about one-third of patients. The number of sessions and type of scope used can also impact this outcome. Although no reliable conclusion can be made herein given these confounding factors, all LAMS-related AEs resolved with conservative management or endoscopically during the same procedure.

One of the advantages of the EDEE procedure compared to alternative techniques such as percutaneous transhepatic biliary drainage or EUS-guided anterograde treatment is the possibility to easily perform repeat ERCP procedures and better analyze the papilla by transenteric diagnostic EUS, specifically in patients with benign conditions. Moreover, once the access to the biliary limb is performed, biliary cannulation and stent exchanges for biliary strictures are much easier compared with enteroscopy-assisted ERCP. Hereby, in our series, the technical success rate was close to 90%, and 23 patients (41.8%) underwent several ERCPs, mainly for benign biliary stricture calibration. Similarly, a multicenter retrospective study of 18 patients withpancreaticoduodenectomy and Roux-en-Y hepaticojejunostomy reported a technical success of 94.4%.[21] The clinical success in patients with prior technical success was also very high (93.8%) in our series, with most technical failures solved by EUS-guided hepaticogastrostomy as a rescue therapy.

A systematic review and meta-analysis of 470 patients with RYGB who underwent an EDGE procedure showed a pooled AE rate of 17%.[22] Similarly, the overall rate of AEs

was 20% in our study, with a severe LAMS-related AE rate of 7.3%.

Long-term LAMS placement after EDEE may be feasible and safe for direct access to the biliary limb.[23] In our study, the LAMS was removed after a median delay of 27 days, but it was left in place for repeat ERCPs in 6 patients (10.9%). The median follow-up was 3 months after the first transenteric ERCP procedure and can be considered short, but most patients (89.1%) had a LAMS removal and an upper-GI follow-up endoscopy within this period. A lower persistent fistula rate was observed in those patients with previous closure (9.1% vs 43.8%), but the clinical impact of a persistent fistula tract remains unclear in these patients, as weight regain is not an issue, unlike in patients with a gastric bypass.

The main limitations of this study were the heterogeneous population with several postsurgical anatomies, multiple indications, and EUS-guided anastomosis techniques. In addition, we had no access to data from patients with similar conditions who were probably treated with a percutaneous approach during the same period. However, this study represents one of the largest series to date. A comprehensive evaluation of the therapeutic strategy based on the patient's conditions and postsurgical anatomy has been conducted to ensure more effective application of our results in daily practice.

In conclusion, the EDEE technique offers a new and effective approach for patients with SAA, demonstrating an acceptable incidence of severe adverse events. This approach can be proposed in benign indications and/or when several transenteric ERCPs are expected. A multidisciplinary approach, along with a comprehensive therapeutic strategy tailored to the patient's conditions and postsurgical anatomy, seems mandatory.

ETHICAL STATEMENT

The study was approved by the Ethical Committee (s68812) according to the Declaration of Helsinki. No informed consent was required for participation in the study because of the retrospective nature of this protocol.

DISCLOSURE

The following authors disclosed financial relationships: E. Perez-Cuadrado-Robles: Consultant for Boston Scientific. M. Bronswijk: Grants from Boston Scientific and Ovesco/Fides Medical; consultant for Taewoong. A. Tyberg: Consultant for Boston Scientific, Medtronic, Ambu Inc, and Microtech. G. Vanella: Lectures for Boston Scientific and grants from Euromedical. A. Anderloni: Consultant for Boston Scientific and Olympus. P. Hindryckx: Consultant for Boston Scientific. H. Shahid: Consultant for US Endoscopy. P. G. Arcidiacono: Consultant for Boston, Mediglobe, and Pentax; lecturer for Fujifilm; steering committee for Ambu. A. Sarkar: Consultant for US Endoscopy and Obalon Therapeutics. W. Laleman: Consultant for Cook; grant from Boston Scientific. M. Gonzalez Haba: Consultant for Boston Scientific, Medtronic, Micro-Tech, and Olympus. C. Fabbri: Consultant for Boston Scientific. M. Kahaleh: Consultant for Boston Scientific, Steris, Olympus, Creo Medical, AbbVie, Microtech, Medtronic, and ERBE. S. van der Merwe: Chair in interventional endoscopy and consultant for Cook; consultant for Pentax and Olympus. All other authors disclosed no financial relationships.

REFERENCES

1. Perez-Cuadrado-Robles E, Phillpotts S, Bronswijk M, et al. PERcutaneous transhepatic CHOLangioscopy using a new single-operator short cholangioscope (PERCHOL): European feasibility study. Dig Endosc 2024;36:719-25.
2. Yokoyama K, Kanno A, Tanaka A, et al. Factors affecting complete stone removal and bile duct stone recurrence in patients with surgically altered anatomy treated by double-balloon endoscopy-assisted endoscopic retrograde cholangiography. Dig Endosc 2024;36:1269-79.
3. Inamdar S, Slattery E, Sejpal DV, et al. Systematic review and meta-analysis of single-balloon enteroscopy-assisted ERCP in patients with surgically altered GI anatomy. Gastrointest Endosc 2015;82:9-19.
4. Anvari S, Lee Y, Patro N, et al. Double-balloon enteroscopy for diagnostic and therapeutic ERCP in patients with surgically altered gastrointestinal anatomy: a systematic review and meta-analysis. Surg Endosc 2021;35:18-36.
5. Wang F, Ge XX, Deng XT, et al. Endoscopic retrograde cholangiopancreatography using a pediatric colonoscope in patients with Roux-en-Y gastrectomy and an intact major duodenal papilla. Exp Ther Med 2024;28:390.
6. Kahaleh M, Artifon ELA, Perez-Miranda M, et al. EUS-guided drainage: summary of therapeutic EUS consortium meeting. Endosc Ultrasound 2019;8:151-60.
7. Vanella G, Dell'Anna G, Bronswijk M, et al. Endoscopic ultrasound-guided biliary drainage and gastrointestinal anastomoses: the journey from promising innovations to standard of care. Ann Gastroenterol 2022;35:441-51.
8. Mangiavillano B, Ramai D, Kahaleh M, et al. Outcomes of lumen apposing metal stent placement in patients with surgically altered anatomy: multicenter international experience. Endosc Int Open 2024;12:E1143-9.
9. Binda C, Dajti E, Giuffrida P, et al. Efficacy and safety of endoscopic ultrasound-guided hepaticogastrostomy: a meta-regression analysis. Endoscopy 2024;56:694-705.
10. Balducci D, Ratone J-P, Schaefer M, et al. EUS-guided hepaticojejunostomy in patients with history of total gastrectomy: a multicenter retrospective feasibility study (with video). Gastrointest Endosc 2025;101:117-22.
11. Perez-Cuadrado-Robles E, Alric H, Queneherve L, et al. Risk factors of anastomosis-related difficult endoscopic retrograde cholangiopancreatography following endoscopic ultrasound-guided gastro-gastrostomy using a standardized protocol (with video). Dig Endosc 2023;35:909-17.
12. Kedia P, Shah-Khan S, Tyberg A, et al. Endoscopic ultrasound-directed transgastric ERCP (EDGE): a multicenter US study on long-term follow-up and fistula closure. Endosc Int Open 2023;11:E529-37.
13. Perez-Cuadrado-Robles E, Bronswijk M, Prat F, et al. Endoscopic ultrasound-guided drainage using lumen-apposing metal stent of malignant afferent limb syndrome in patients with previous

Whipple surgery: multicenter study (with video). Dig Endosc 2022;34:1433-9.
14. De Bie C, Bronswijk M, Vanella G, et al. EUS-guided hepaticogastrostomy for patients with afferent loop syndrome: a comparison with EUS-guided gastroenterostomy or percutaneous drainage. Surg Endosc 2022;36:2393-400.
15. van der Merwe SW, van Wanrooij RLJ, Bronswijk M, et al. Therapeutic endoscopic ultrasound: European Society of Gastrointestinal Endoscopy (ESGE) guideline. Endoscopy 2022;54:185-205.
16. Nass KJ, Zwager LW, van der Vlugt M, et al. Novel classification for adverse events in GI endoscopy: the AGREE classification. Gastrointest Endosc 2022;95:1078-85.e8.
17. Ichkhanian Y, Jovani M. Use of lumen apposing metal stents in patients with altered gastrointestinal anatomy. Curr Opin Gastroenterol 2023;39:348-55.
18. Ghandour B, Shinn B, Dawod QM, et al. EUS-directed transgastric interventions in Roux-en-Y gastric bypass anatomy: a multicenter experience. Gastrointest Endosc 2022;96:630-8.
19. El-Domiaty N, Alric H, Di Gaeta A, et al. Transjejunal ERCP through an endoscopic ultrasound-guided jejuno-duodenal anastomosis in a patient with gastric bypass without excluded stomach. Endoscopy 2023;55:E1027-8.
20. Shinn B, Boortalary T, Raijman I, et al. Maximizing success in single-session EUS-directed transgastric ERCP: a retrospective cohort study to identify predictive factors of stent migration. Gastrointest Endosc 2021;94:727-32.
21. Ichkhanian Y, Yang J, James TW, et al. EUS-directed transenteric ERCP in non-Roux-en-Y gastric bypass surgical anatomy patients (with video). Gastrointest Endosc 2020;91:1188-94.e2.
22. Deliwala SS, Mohan BP, Yarra P, et al. Efficacy & safety of EUS-directed transgastric endoscopic retrograde cholangiopancreatography (EDGE) in Roux-en-Y gastric bypass anatomy: a systematic review & meta-analysis. Surg Endosc 2023;37:4144-58.
23. Donatelli G, Cereatti F, Spota A, et al. Long-term placement of lumen-apposing metal stent after endoscopic ultrasound-guided duodeno- and jejunojejunal anastomosis for direct access to excluded jejunal limb. Endoscopy 2021;53:293-7.

Abbreviations: AE, adverse event; EDEE, EUS-directed transenteric ERCP; EDGE, EUS-directed transgastric ERCP; ERCP, endoscopic retrograde cholangiopancreatography; EUS, endoscopic ultrasonography; HJ, hepaticojejunal; LAMS, lumen-apposing metal stent; RYGB, Roux-en-Y gastric bypass; SAA, surgically altered anatomy.

This video can be viewed directly from the *GIE* website or by using the QR code and your mobile device. Download a free QR code scanner by searching "QR Scanner" in your mobile device's app store.

Use your mobile device to scan this QR code and watch the author interview. Download a free QR code scanner by searching "QR Scanner" in your mobile device's app store.

0016-5107
https://doi.org/10.1016/j.gie.2025.10.005
Received July 19, 2025. Accepted October 2, 2025.