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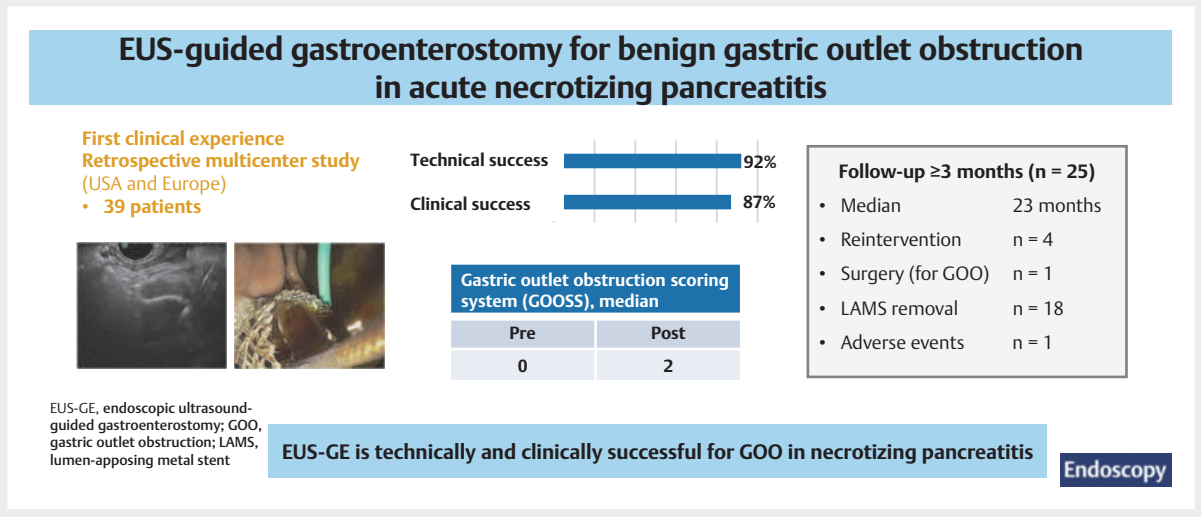
Endoscopic ultrasound-guided gastroenterostomy for the treatment of gastric outlet obstruction secondary to acute pancreatitis

GRAPHICAL ABSTRACT



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ABSTRACT

Background Endoscopic ultrasound-guided gastroenterostomy (EUS-GE) is a minimally invasive technique for treating gastric outlet obstruction (GOO). The aim of this study was to assess the outcomes of EUS-GE in managing benign GOO caused by duodenal stenosis in patients with acute pancreatitis.

Methods This international retrospective study analyzed patients treated with EUS-GE for GOO caused by acute pancreatitis until December 2023, evaluating technical and clinical success, adverse events, and reintervention.

Results 39 patients (median age 55 years, 15 women) were included. There was a 92.3% technical success rate, with only three patients unable to undergo EUS-GE owing to a long distance between the stomach and small bowel or an inadequate window for puncture. Clinical success was observed in 34 patients (87.2%). The median Gastric Outlet Obstruction Scoring System (GOOSS) improved from 0 before EUS-GE to 2 afterward (P<0.001). Follow-up (≥3 months) was available in 25 patients. During a median follow-up of 23 months, four patients required reintervention. It was possible to remove the lumen-apposing metal stent in 18 patients. The only adverse event was a gastrocolic fistula detected incidentally after 3 months.

Conclusion EUS-GE is an effective and safe method for managing benign GOO in the setting of acute pancreatitis.

Introduction

Gastric outlet obstruction (GOO) results from mechanical blockages in the stomach or proximal small intestine, limiting oral intake and causing malnutrition and volume depletion depending on the severity of the stenosis [1]. For malignant GOO, treatment options include enteral stenting, surgical gastrojejunostomy, and more recently, endoscopic ultrasound-guided gastroenterostomy (EUS-GE) with a lumen-apposing metal stent (LAMS) [2]. EUS-GE has become a recognized procedure for palliating malignant GOO [3]. It offers advantages over enteral stenting in terms of lower stent obstruction and reintervention rates [4, 5, 6]. A recent multicenter study indicated that compared with surgical gastrojejunostomy, EUS-GE was associated with fewer adverse events (AEs), shorter hospital stays, and quicker resumption of oral intake and chemotherapy [7].

In addition to the treatment of malignant GOO, EUS-GE has also been used for cases of benign GOO with high technical and clinical success [8], although data on outcomes for GOO from acute pancreatitis are limited. Acute pancreatitis initially causes obstruction because of edema and inflammation, while delayed obstruction is fibrostenotic. Additionally, gastrointestinal motility may be disrupted in acute pancreatitis. A retrospective study of 687 patients with necrotizing pancreatitis found that 29 (4%) developed chronic duodenal stenosis, with over half requiring surgery [9]. Early enteral nutrition is crucial for these patients. Severe GOO can impede per oral intake, worsening outcomes for those who are not nutritionally optimized. Endoscopic options include nasojejunal feeding tubes or gastrostomy tubes with jejunal extension, both of which are limited by dysfunction, discomfort, and impaired eating. EUS-GE provides a therapeutic option to bypass the obstruction, allowing earlier diet resumption without feeding tubes, and its removal once the obstruction has resolved; however, large-scale data are lacking. Therefore, we aimed to investigate EUS-GE outcomes for GOO treatment in patients with acute pancreatitis.

Methods

This international retrospective study involved adult patients undergoing EUS-GE for the management of GOO due to acute pancreatitis between November 2014 and December 2023. Seven academic centers participated (two in Europe, five in the USA). The Institutional Review Board at each center approved the study.

Inclusion criteria were patients over 18 years of age who underwent EUS-GE for GOO due to endoscopically confirmed duodenal stenosis from acute pancreatitis. Exclusion criteria included patients with delayed gastric emptying from gastroparesis and without confirmed duodenal obstruction. Data collected included baseline demographics, endoscopic procedure techniques, outcomes, and AEs.

Outcomes and definitions

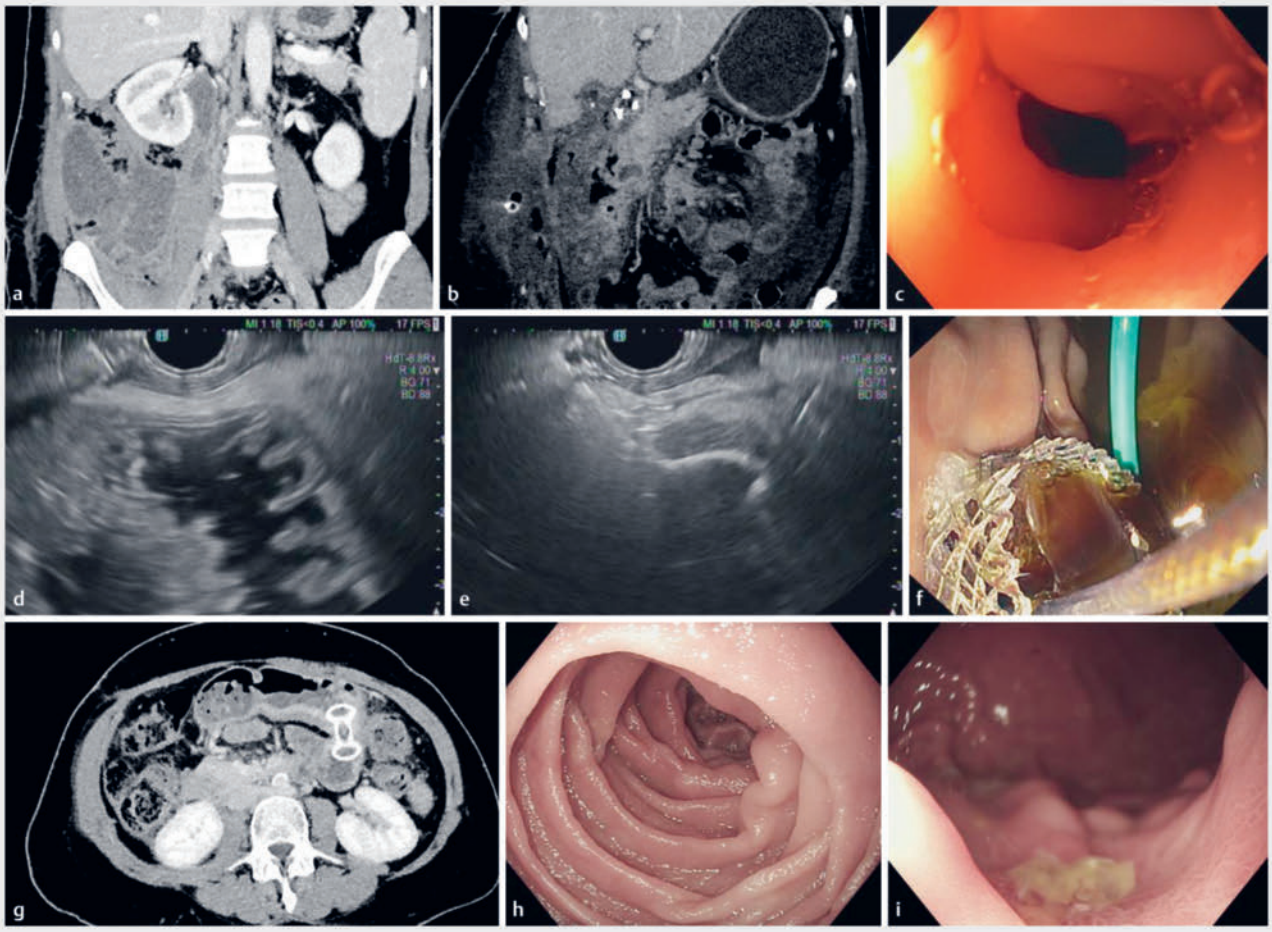
Technical and clinical success were the primary outcomes, with technical success defined as the successful creation of an anastomosis using a LAMS to bypass the obstruction. Clinical success was determined by a ≥1 point improvement in the Gastric Outlet Obstruction Scoring System (GOOSS), which was calculated based on the patient's oral intake tolerance: 3 points for low residue or full diet, 2 points for soft solids, 1 point for liquids only, and 0 points for no oral intake. The baseline GOOSS was assessed prior to EUS-GE and clinical success at day 2 to 7.

GOO recurrence, reintervention rates, and AEs were further outcomes. GOO recurrence was defined as recurrent symptoms (i. e. GOOSS ≤1) after previously achieving clinical success. Patients with early EUS-GE (≤6 weeks from pancreatitis onset) and late EUS-GE (>6 weeks) were analyzed separately.

Only treatment-related AEs were recorded and the AGREE classification was used to assess severity [10]. Pancreatitis severity (mild, moderate, or severe) was based on the revised Atlanta classification, with mild pancreatitis having no organ failure or complications, moderate being defined by transient organ failure and/or local complications, and severe pancreatitis characterized by persistent organ failure (>48 hours) [11].

Procedure techniques

All procedures used either a direct puncture technique or a guidewire-assisted approach under fluoroscopic guidance. The direct technique, also known as wireless EUS-guided gastroenterostomy simplified technique (WEST), involves freehand puncture of the small bowel with a cautery-enhanced LAMS [12]. The small bowel is filled with fluid via a nasoenteric tube, and antispasmodics are administered to reduce bowel movement. This technique is widely adopted owing to its faster procedure times and comparable technical success rates to other methods [1]. The guidewire-assisted approach involves inserting a guidewire into the small bowel after puncture with an EUS needle, followed by LAMS placement over the wire.



▶ **Fig. 1** Images of endoscopic ultrasound-guided gastroenterostomy (EUS-GE) in a patient with acute pancreatitis showing: **a** on computed tomography (CT) scanning, severe necrotizing pancreatitis with a large area of necrosis in the right hemiabdomen; **b,c** fluid retention within the stomach and persistent duodenal stenosis despite drainage of the necroses on CT and endoscopic view; **d–f** successful placement of an EUS-GE; **g** a lumen-apposing metal stent in situ on the CT scan; **h** resolution of the stenosis during follow-up; **i** occlusion of the anastomosis within 1 month after stent removal.

In all cases, the Hot AXIOS stent (Boston Scientific Corp., Marlborough, Massachusetts, USA) was used. LAMS sizes ranged from 10 to 20 mm in diameter, at the operator's discretion (▶ **Fig. 1**).

Statistical analysis

Categorical variables were reported as numbers (with frequencies [%] and/or 95%CIs) and were compared using the Fisher's exact test or Pearson's chi-squared test, as appropriate. Continuous variables were reported as medians (with range) and were compared using the Mann–Whitney test. To compare bound samples, specifically the GOOSS results before and after the procedure, the Wilcoxon rank test was employed. All statistical analyses were conducted using SPSS version 28 (IBM Corp., Armonk, New York, USA). A *P* value <0.05 was considered to indicate statistical significance.

Results

Technical and clinical outcomes

Demographics and characteristics of the 39 included patients are detailed in ▶ **Table 1**. Technical success was achieved in 36 patients (92.3%; 95%CI 79.1%–98.4%). Anastomosis creation was not possible because of a long stomach to small bowel distance (>1 cm) in two patients and an inadequate puncture window in one patient. The median time from pancreatitis onset to attempted EUS-GE was 6 weeks (range 0–33). Further procedure-related details are summarized in ▶ **Table 2**. The median procedural time was 58 minutes (range 19–117) for the 11 cases with recording available.

Clinical success was attained in 34 patients, accounting for 87.2% of the total (95%CI 72.6%–95.7%). This translates to a clinical success rate of 94.4% (95%CI 81.3%–99.3%) among the 36 technically successful cases. The median GOOSS improved from 0 (range 0–2) before EUS-GE to 2 (range 0–3) afterward (*P* <0.001). Before EUS-GE, 10 patients (22.7%) were receiving

▶ **Table 1** Demographic and health characteristics of the 39 patients with acute pancreatitis who underwent endoscopic ultrasound-guided gastroenterostomy (EUS-GE).

	n (%), unless otherwise stated
Age, median (range) years	55 (27–76)
Sex, female	15 (38.5)
Etiology of pancreatitis	
▪ Biliary	15 (38.5)
▪ Alcohol-related	13 (33.3)
▪ Post-ERCP	3 (7.7)
▪ Hypertriglyceridemia	3 (7.7)
▪ Other causes	5 (12.8)
Severity of pancreatitis (Atlanta classification)	
▪ Moderate	21 (53.8)
▪ Severe	18 (46.2)
Extent of necrosis	
▪ Pancreatic or peripancreatic	17 (43.6)
▪ Exceeding peripancreatic (e. g. paracolic)	22 (56.4)
Time from pancreatitis to EUS-GE, median (range), weeks	6 (0–33)
Patients per center	
▪ Ludwigsburg, Germany	4 (10.3)
▪ Chapel Hill, USA	13 (33.3)
▪ New York, USA	5 (12.8)
▪ Baltimore, USA	3 (7.7)
▪ Zurich, Switzerland	2 (5.1)
▪ Fort Wayne, USA	1 (2.6)
▪ Seattle, USA	11 (28.2)

ERCP, endoscopic retrograde cholangiopancreatography

tube feeding, seven (15.9%) were receiving parenteral nutrition, and 19 (43.2%) were attempting but failing oral feeding.

Early compared to late EUS-GE

Early EUS-GE was attempted in 20 patients and late EUS-GE in 19. In the early group, technical success was achieved in 19 patients (95.0%; 95%CI 75.1%–99.9%) and clinical success in 18 (90.0%; 95%CI 68.3%–98.8%), compared with 17 patients (89.5%; 95%CI 66.9%–98.7%) and 16 (84.2%; 95%CI 60.4%–96.6%) in the late EUS-GE group, respectively (▶ **Table 2**).

Follow-up

Follow-up of ≥3 months was available in 25 patients (64.1%). Among the remaining 14 patients were three with technical failure, four with a follow-up time <3 months, and seven patients without any follow-up available after discharge. Follow-up for all of the patients (i. e. including those with follow-up of <3 months) is summarized in ▶ **Table 2** and depicted in **Fig. 1s**, see online-only Supplementary material.

The median follow-up was 23 months (range 3–45) in the 25 patients with follow-up of ≥3 months. Reintervention was necessary in four patients (16.0%; 95%CI 4.5%–36.1%) owing to recurrent GOO symptoms. Three patients were treated endoscopically: two underwent balloon dilation of the LAMS after 17 and 40 months, respectively, and the third had a 15-mm LAMS replaced with a 20-mm stent after 29 months, with all of the treatments being successful in terms of the symptoms of GOO. The fourth patient underwent surgical gastrojejunostomy for persistent duodenal stricture and worsening oral intake after 4 months.

The LAMS was endoscopically removed in 18 patients (72.0%; 95%CI 50.16%–87.9%) after a median of 9 months (range 1–44), with the duodenal stenosis having resolved in all cases. In seven patients, the results of further endoscopies were available and the anastomosis had closed in all patients. In the seven patients without LAMS removal, one underwent surgery for persistent GOO (as detailed previously) and the LAMS was patent in the remaining six, without symptoms of GOO at their last follow-up. Two patients died during follow-up (8.0%; 95%CI 1.0%–26.0%): one due to complications from a subphrenic abscess fistulizing to the lung after 39 months and the other from acute renal failure caused by urinary tract infection after 19 months.

Adverse events

One patient developed a gastrocolic fistula that could be managed endoscopically (AGREE classification grade IIIa), with the fistula being diagnosed 3 months after the EUS-GE when the LAMS was pulled out. A fully-covered esophageal stent (60×20 mm) was placed and the patient's further course was uneventful. In retrospect, the LAMS must have already traversed the colon during placement, but did not cause any symptoms.

Discussion

In this multicenter retrospective study of 39 patients who developed benign GOO from acute pancreatitis, we found that EUS-GE was associated with high technical and clinical success rates of 92.3% and 87.2%, respectively. There was only one AE and four instances of reintervention over a median follow up of 23 months. EUS-GE with a LAMS appears to be a durable and effective management option in this patient population. This is the largest series to date that describes the outcomes pertaining to a single etiology of benign GOO. Our data support the use of EUS-GE to avoid the need for more cumbersome enteral feeding options in patients with GOO from acute pancreatitis as the collections are resolving.

Benign causes of GOO may include peptic ulcer disease, nonsteroidal anti-inflammatory drug use, ingestion of corrosive substances, Crohn's disease, and pancreatitis (acute and chronic), among many others [9, 13]. Historically, these cases have been managed with stepwise endoscopic balloon dilation; how-

▶ **Table 2** Outcomes, further procedures, and follow-up details for all 39 patients (not limited to those with a minimum follow-up of ≥3 months).

	All (n = 39)	Early EUS-GE (n = 20)	Late EUS-GE (n = 19)	*P* value
Success, n (%)[1]				
▪ Technical	36 (92.3)	19 (95.0)	17 (89.5)	0.61
▪ Clinical	34 (87.2)	18 (90.0)	16 (84.2)	0.66
GOOSS, median (range)				
▪ Before EUS-GE	0 (0–2)	0 (0–1)	0 (0–1)	0.76
▪ After EUS-GE	2 (0–3)	2 (0–3)	2 (1–3)	0.64
Symptom recurrence, n (%)[2]	4 (11.1)	2 (10.5)	2 (11.8)	>0.99
▪ Treated endoscopically, n (%)[2]	3 (8.3)	2 (10.5)	1 (5.9)	
▪ Treated surgically, n (%)[2]	1 (2.8)	0	1 (5.9)	
Adverse events, n (%)[2]	1 (2.8)	0	1 (5.9)	>0.99
Puncture technique, n (%)[2]				0.27
▪ Direct puncture technique	26 (72.2)	12 (63.2)	14 (82.4)	
▪ Guidewire-assisted	10 (27.8)	7 (36.8)	3 (17.6)	
LAMS diameter, n (%)[2], mm				0.18
▪ 10	1 (2.8)	1 (5.3)	0	
▪ 15	17 (47.2)	11 (57.9)	6 (35.3)	
▪ 20	18 (50.0)	7 (36.8)	11 (64.7)	
Follow-up				
Follow-up, months	19 (0–45)	23 (1–45)	18 (0–40)	0.83
LAMS removed, n (%)[2]	20 (55.6)	10 (52.6)	10 (58.8)	0.75
Time to removal, months	7.5 (1–44)	3 (1–44)	11 (2–39)	0.10
Death, n (%)[2]	2 (5.6)	0	2 (11.8)	0.22

EUS-GE, endoscopic ultrasound-guided gastroenterostomy; GOOSS, Gastric Outlet Obstruction Scoring System; LAMS, lumen-apposing metal stent.
[1] As a proportion of all patients.
[2] As a proportion of the technically successful cases.

ever, success rates are often variable and dependent on the etiology and length of the stricture. Strictures from severe acute pancreatitis are related either to edema or fluid collections, both of which are typically reversible and not amenable to balloon dilation [14, 15]. Only a small percentage progress to the more chronic situation of fibrostenotic disease, making them difficult to treat, often requiring surgical intervention [9]. In our series, only 1/39 patients eventually required surgery. Because enteral stenting with fully covered self-expandable metal stents is associated with a high migration rate [16] and surgery is invasive and not ideal in this clinical setting, EUS-GE provides a unique opportunity to temporize the obstruction with a minimally invasive approach.

It must be noted that there was a large variation in the timing of stent placement (range 0–33 weeks). The etiology of stenosis is more likely to be edematous in the early phase, while fibrotic stenosis would be more common later. It was not possible to retrospectively distinguish edematous from fibrotic stenosis, but we performed separate analysis for patients who underwent early EUS-GE (≤6 weeks) compared with late EUS-GE (>6 weeks). No difference in technical or clinical success was observed, but time until LAMS removal was shorter in the early EUS-GE group (3 months) compared with the late EUS-GE group (11 months). This difference was not statistically significant but might be indicative of faster resolution of edematous stenosis than fibrotic stenosis. Given the overall high rate of LAMS removal in our study, this may further indicate that duodenal strictures caused by necrotizing pancreatitis are reversible and surgery can be avoided in many cases.

To date, only a handful of studies have focused on EUS-GE for benign GOO [8, 17, 18]. These previous studies have documented a similar technical success rate [8, 17]. In our cohort, we focused on a specific reversible etiology of benign GOO caused by acute pancreatitis and our results expand the current literature on the use of EUS-GE in benign GOO. In all except one case, a stent diameter of 15 mm or 20 mm was used, which is in line

with the majority of published studies [19]. A recent comparative study between 20- and 15-mm LAMSs found that a larger proportion of individuals in the 20-mm group tolerated a soft solid/complete diet (91.2% vs. 81.2%; $P = 0.04$) [20].

Our study was retrospective in design, with inherent limitations. For instance, patient selection and the timing of stent placement and removal was under the discretion of the operator. Long-term clinical success was hindered by patients being lost to follow-up. Furthermore, the procedures were performed by highly experienced endoscopists at tertiary centers, so these results may not be applicable to a community setting.

In conclusion, EUS-GE is an effective and safe method for managing benign GOO in the setting of acute pancreatitis, limiting the need for more cumbersome forms of enteral feeding with nasojejunal and gastroenterostomy tubes. Further prospective studies are needed to determine the optimal timing of EUS-GE and stent removal, as well as to compare the outcomes with patients receiving enteral nutrition support with feeding tubes.

Conflict of Interest

A. Wannhoff received a research grant from Fujifilm Medwork GmbH and OVESCO Endoscopy AG and received lecture fees from OVESCO Endoscopy AG. R.Z. Sharaiha is a consultant for Boston Scientific, Olympus, Cook Medical, and Surgical Intuitive. T.H. Baron is a consultant and speaker for Boston Scientific, W.L.Gore, Cook Endoscopy, and Olympus America. S.S. Irani is a consultant for Boston Scientific and Gore. A. Canakis, F. Fayyaz, C. Schlag, N. Sharma, I. Elsayed, M.A. Khashab, and K. Caca declare that they have no conflict of interest.

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