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Preferred techniques for endoscopic ultrasound-guided gastroenterostomy: a survey of expert endosonographers

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ABSTRACT

Background and study aims Endoscopic ultrasound-guided gastroenterostomy (EUS-GE) is an emerging procedure that lacks technical standardization with limited adoption beyond expert centers. We surveyed high-volume endosonographers about the technical aspects of EUS-GE to describe how the procedure is currently performed at expert centers and identify targets for standardization.

Methods Invitations to complete an electronic survey were distributed to 21 expert EUS practitioners at 19 U.S. centers. Respondents were surveyed about technical aspects of EUS-GE, indications, efficacy, safety, and attitudes toward the procedure.

Results All 21 (100%) invited expert endoscopists completed the survey. Nine (42.9%) reported performing >10 EUS-GEs in the last 12 months. About half (47.6%, 10/21) puncture the target loop prior to lumen-apposing metal stent (LAMS) introduction, most often to confirm the loop is jejunum. No respondents reported guidewire placement prior to LAMS introduction. Most (71.4%, 15/21) do not use a guidewire at any time, while 28.6% (6/21) reported wire placement after distal flange deployment to secure the tract during apposition. Eight (38.1%, 8/21) reported at least one major adverse event, most commonly intraperitoneal LAMS deployment (87.5%, 7/8). Factors most often reported as advantageous for EUS-GE over enteral stenting included lack of papilla interference (33.3%, 7/21) and decreased occlusion risk (23.8%, 5/21).

Conclusions Significant variation in performance technique for EUS-GE exists among expert US endoscopists, which may hinder widespread adoption and contribute to inconsistencies in reported patient outcomes. The granularity provided by these survey results may identify areas to focus standardization efforts and guide future studies on developing an ideal EUS-GE protocol.

Introduction

Endoscopic ultrasound-guided gastroenterostomy (EUS-GE) is an emerging therapeutic option for the treatment of enteral and gastric outlet obstruction (GOO) due to its minimally invasive nature and versatility in treating both benign and malignant etiologies of obstruction [1,2]. With numerous studies reporting high clinical success rates and acceptable safety profiles, EUS-GE offers a promising alternative to existing endoscopic and surgical management strategies [3,4]. The novel procedure generally involves endosonographic access to the jejunum beyond the obstruction site from the stomach and the placement of a biflanged lumen-apposing metal stent (LAMS) to secure a newly formed gastrojejunal fistula tract [1,5,6]. However, EUS-GE is a challenging procedure requiring a high degree of expertise in therapeutic EUS and fluoroscopy. In addition, numerous variations in technique have been previously described [7,8], but the ideal approach has yet to be identified. As such, high procedure difficulty and the absence of a standardized protocol serve as major barriers to entry that limit widespread adoption outside of expert centers and contribute to inconsistencies in patient outcomes.

While previous studies have outlined steps of various EUS-GE techniques, data are lacking looking at the most commonly employed procedural steps, decision-making, and accessories at a granular level. In addition, variations in technical preferences and practice patterns in the performance of EUS-GE among endoscopists with differing years of experience and reported safety outcomes have not been described. In this study, we surveyed high-volume expert endosonographers about the technical aspects of EUS-GE to describe how the procedure is currently performed and identify targets for standardization and dissemination.

Methods

Survey design

This was a cross-sectional survey study in which a 35-item online questionnaire hosted on the Qualtrics platform (Provo, Utah, United States) was developed in the fall of 2022 (**Supplemental Material 1**). An extensive literature review was conducted to design the survey framework with content validity supervised by four advanced endoscopists with expertise in therapeutic EUS and experienced in EUS-GE. Multiple iterations of the survey were tested by a panel of advanced endoscopists and an advanced fellow prior to distribution of the final version.

This study received an exemption from the Institutional Review Board at Weill Cornell Medicine. Survey completion was voluntary with consent to participate in the study inferred from response to the survey. All authors had access to the study data and reviewed and approved the final survey and manuscript.

Survey population and administration

We identified 21 expert EUS practitioners at 19 centers around the United States. Selection of potential respondents was determined by a multifactorial approach including the quality and quantity of publications relevant to EUS-GE, prominence and reputation in the field of therapeutic EUS, and balanced considerations regarding their experience and procedural volume. The surveys were distributed to expert endoscopists via email on November 7, 2022 and were returned over the following 3 weeks until survey closure on November 28, 2022. A single follow-up email was sent to all non-responders on November 14, 2022. The survey collected information regarding demographics, experience, technical aspects of EUS-GE, indications, efficacy, safety, and attitudes toward the procedure.

Statistical analysis

Basic descriptive statistics generated by the Qualtrics platform were used to summarize responses. Results were expressed as counts and percentages or mean and standard deviation (SD). We assessed for differences in EUS-GE techniques, pre- and post-procedure practices, patient outcomes, and endoscopist attitudes based on years of attending practice (physicians with <10 years of experience after gastroenterology fellowship versus >10 years), procedure volume (≤10 EUS-GE performed in the last 12 months versus >10), reported safety outcomes (experience of at least one major adverse event (AE) related to EUS-GE versus no major AEs), and comfort level (completely comfortable performing EUS-GE versus not completely comfortable) using chi-squared tests or Fisher's exact tests as appropriate. P <0.05 was considered significant. Statistical calculations were performed using Stata Statistical Software: Release 17 (StataCorp, College Station, Texas, United States).

Results

Demographics

The survey was distributed to 21 selected expert endoscopists, all of whom completed the survey (100% response rate). Demographic characteristics of the responding physicians are summarized in ▶ **Table 1**. A majority of respondents had been practicing for over 10 years (62.0%, 13 of 21). The Northeast was the most heavily represented geographic region (47.6%, 10 of 21) with a varied geographic distribution otherwise (Midwest 23.8%, 5 of 21; South 19.0%, 4 of 21; and West 9.5%, 2 of 21). Most endoscopists reported practicing primarily in an academic hospital (90.5%, 19 of 21) and having completed a fourth-year advanced endoscopy fellowship (95.2%, 20 of 21). The earliest reported use of EUS-GE was in 2013 (range 2013–2021) with a plurality first performing the procedure in 2018 (33%, 7 of 21). Nine of 21 (42.9%) respondents reported performing >10 EUS-GEs in the last 12 months, and most (15 of 21, 71%) reported performing >10 diagnostic and therapeutic EUS procedures each week. Despite four respondents having ≤5 years of experience, all of those endoscopists reported high procedure volumes with ≥ 10 general EUS procedures performed each week and ≥10 EUS-GEs performed in the last 12 months.

EUS-GE procedural techniques

A flowchart featuring the procedure techniques used by the plurality of expert endoscopists is shown in ▶ **Fig. 1** and collated survey responses are shown in ▶ **Table 2**. The most popular pre-

▶ **Table 1** Demographic features of expert endosonographer respondents.

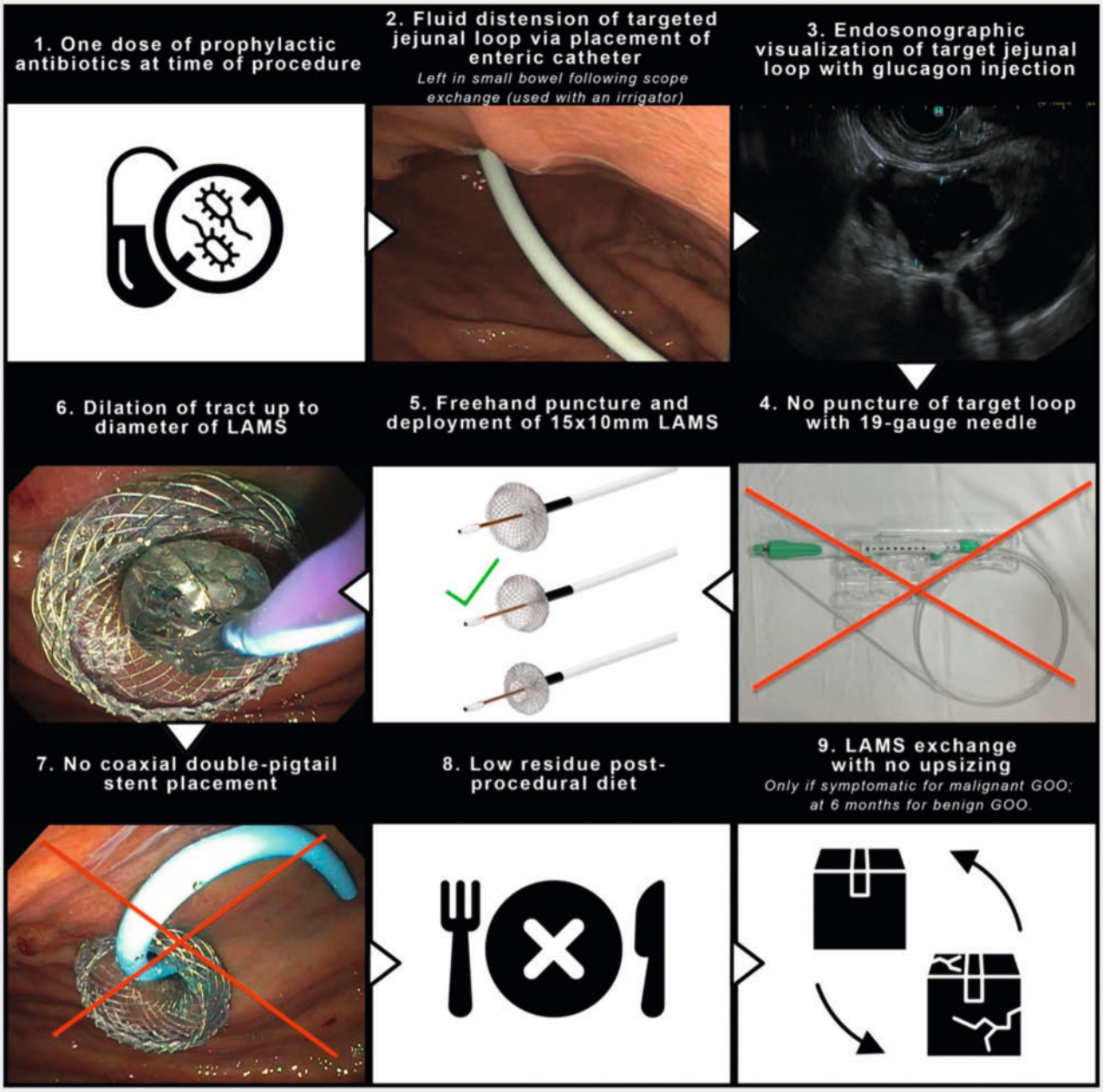
EUS-GE preferred practice patterns	Total endosonographers n = 21
Years since gastroenteroloogy fellowship, n (%)	
0–5 years	4 (19.0)
6–10 years	4 (19.0)
10–20 years	11 (52.5)
>20 years	2 (9.5)
Geographic region, n (%)	
Northeast	10 (47.7)
Midwest	5 (23.8)
South	4 (19.0)
West	2 (9.5)
Primary practice setting, n (%)	
Academic/university hospital	19 (90.5)
Community hospital	2 (9.5)
Completed 4th-year advanced endoscopy fellowship, n (%)	
Yes	20 (95.2)
No	4 (4.8)
Number of EUS (diagnostic and therapeutic) procedures performed each week, n (%)	
0–1	1 (4.8)
2–5	1 (4.8)
6–10	4 (19.0)
>10	15 (71.4)
Year first EUS-GE performed, n (%)	
2013	1 (4.8)
2014	1 (4.8)
2015	6 (28.6)
2016	1 (4.8)
2017	2 (9.5)
2018	7 (33.3)
2019	1 (4.8)
2020	1 (4.8)
2021	1 (4.8)
Number of EUS-GE procedures performed in last 12 months, n (%)	
0–1	0 (0)
2–5	5 (23.8)
6–10	7 (33.3)
11–15	3 (14.3)
>15	6 (28.6)

EUS-GE, endoscopic ultrasound-guided gastroenterostomy.

ferred approach for fluid distension of the targeted small bowel loop was placement of an enteric catheter left in the small bowel following scope exchange and used with an irrigator (61.9%, 13 of 21; ▶ **Table 2**). Direct injection of fluid via the endoscope channel with syringes or endoscope jet with irrigation pump (28.6%, 6 of 21) or via a catheter through the endoscope channel (9.5%, 2 of 21) was reported less frequently. There was variation in the types of fluids instilled into the target jejunal loop with most respondents reporting incorporating methylene blue, contrast material, and water or saline (66.7%, 14 of 21) but others reporting water or saline plus methylene blue alone (19.0%, 4 of 21) or contrast alone (14.3%, 3 of 21). A majority of endoscopists (81.0%, 17 of 21) reported always using glucagon during EUS-GE; only one reported never using glucagon. Approximately half the expert endosonographers (47.6%, 10 of 21) reported always or sometimes puncturing the target jejunal loop with a 19-gauge needle prior to LAMS introduction. Major reasons cited for pre-LAMS target loop puncture included confirmation of jejunal placement through aspiration of dyed fluid (100.0%, 10 of 10), to inject additional solution to further distend the loop (40.0%, 4 of 10), and to test the angle of puncture and stability of position (20.0%, 2 of 10). Among those surveyed, all freehand punctures were performed directly into the target jejunal loop, and no experts reported using adjunctive devices during puncture.

Interestingly, none of the surveyed endoscopists reported placement of a guidewire prior to LAMS introduction. LAMS placement and deployment was most often accomplished using no guidewire at any point during the procedure (71.4%, 15 of 21). A minority (28.6%, 6 of 21) reported placing a wire after deployment of the distal flange of the LAMS to secure the tract during apposition. Following LAMS placement, tract dilation is performed by 57.1% of the respondents (12 of 21), most commonly up to the diameter of the LAMS (58.3%, 7 of 12). The most common LAMS size was 15 × 10 mm (57.1%, 12 of 21) followed by 20 × 10 mm (38%, 8 of 21). Of those using a 15-mm-diameter stent, 38.5% (5 of 13) reported upsizing the LAMS at a future date. Only 23.8% (5 of 21) place a coaxial DPS through the LAMS to prevent stent occlusion (80.0%, 4 of 5), stent migration (20.0%, 1 of 5), or bleeding or perforation resulting from friction between LAMS flanges and bowel (20.0%, 1 of 5).

When comparing EUS-GE procedure techniques between the higher-volume group of expert endosonographers who performed >10 procedures (42.9%, 9 of 21) in the last 12 months and the lower-volume group who performed ≤10 EUS-GE procedures (57.1%, 12 of 21), no significant differences were observed in any surveyed practices, including guidewire usage ($P = 0.58$), glucagon injection ($P = 0.61$) and tract dilation ($P = 0.90$), as well as instrument and accessory specifications, including LAMS size ($P = 0.58$) and coaxial DPS placement (P = 0.24) (▶ **Table 2**). The higher-volume group tended to always puncture the target jejunal loop with a 19-gauge needle prior to LAMS introduction (44.4% vs. 16.7%, $P = 0.11$) and upsize the LAMS at exchange at higher rates (55.6% vs. 16.7%, $P = 0.16$) than the lower-volume group.



▶ **Fig. 1** Preferred EUS-guided gastroenterostomy (EUS-GE) procedure steps reported by the plurality of surveyed expert endosonographers.

Attitudes toward EUS-GE

All respondents (100%, 21 of 21; ▶ **Table 3**) reported having performed EUS-GE for the indication of malignant GOO with most also reporting completing the procedure for benign GOO (81.0%, 17 of 21), afferent limb syndrome (85.7%, 18 of 21), and enteral access for transluminal interventions such as endoscopic retrograde cholangiopancreatography (85.7%, 18 of 21). All respondents reported at least sometimes preferring EUS-GE over enteral stenting for patients with malignant GOO (100%, 21 of 21). As summarized in ▶ **Fig. 2**, factors most often reported as advantageous for EUS-GE over enteral stenting included lack of interference with the papilla (33.3%, 7 of 21), decreased risk of occlusion (23.8%, 5 of 21), and faster symptom relief (19.0%, 4 of 21). In contrast, enteral stenting was commonly preferred over EUS-GE in cases of ascites (76.2%. 16 of 21), retained gastric food (47.6%, 10 of 21), and life expectancy shorter than 6 months (42.9%, 9 of 21). Furthermore, most expert endosonographers (66.7%, 14 of 21) reported not being completely comfortable in consistently obtaining successful and reproducible outcomes when performing EUS-GE. Respondent views on the most important limitations preventing widespread adoption of EUS-GE for the treatment of patients with GOO are shown in ▶ **Fig. 3**. The most commonly cited reasons were con-

▶ **Table 2** EUS-guided gastroenterostomy procedural techniques reported by expert endosonographers

Procedure characteristics	Total endosonographers n = 21	≤10 EUS-GEs performed in last 12 months n = 12	>10 EUS-GEs performed in last 12 months n = 9	P value
Fluid distension of target jejunal loop, n (%)				0.17
Placement of enteric catheter left in small bowel following scope exchange and used with irrigator	13 (61.9)	9 (75.0)	4 (44.4)	
Direct injection of fluid via endoscope channel with syringes or via endoscope jet with irrigation pump	6 (28.6)	3 (25.0)	3 (33.3)	
Direct injection of fluid via catheter through endoscope channel	2 (9.5)	0 (0)	2 (22.2)	
Dedicated gastroenterostomy catheter	0 (0)	0 (0)	0 (0)	
Injectate components, n (%)				0.07
Water or saline + methylene blue	4 (19.0)	2 (16.7)	2 (22.2)	
Water or saline + contrast solution	3 (14.3)	0 (0)	3 (33.3)	
Water or saline + methylene blue and contrast solution	14 (66.7)	10 (83.3)	4 (44.4)	
Glucagon usage, n (%)				0.61
Yes, always	17 (81.0)	9 (75.0)	8 (88.9)	
Yes, sometimes	3 (14.3)	2 (16.7)	1 (11.1)	
No	1 (4.7)	1 (8.3)	0 (0)	
Puncture of target jejunal loop using 19-gauge needle prior to LAMS introduction, n (%)				0.11
Yes, always	6 (28.6)	2 (16.7)	4 (44.4)	
Yes, sometimes	4 (19.0)	4 (33.3)	0 (0)	
No	11 (52.4)	6 (50.0)	5 (55.6)	
Guidewire usage during LAMS placement, n (%)				0.58
No guidewire used at any point	15 (71.4)	8 (66.7)	7 (77.8)	
Guidewire preloaded into LAMS prior to freehand puncture, distal flange deployed, then wire advanced into small bowel prior to pulling back and apposing small bowel and gastric walls	6 (28.6)	4 (33.3)	2 (22.2)	
Guidewire placed in target loop, then LAMS advanced over wire into small bowel	0 (0)	0 (0)	0 (0)	
Guidewire preloaded into LAMS prior to freehand puncture, then wire advanced into small bowel prior to deployment of distal flange	0 (0)	0 (0)	0 (0)	
Plan to upsize LAMS at exchange, n (%)				0.16
Yes	6 (28.6)	2 (16.7)	5 (55.6)	
No	15 (71.4)	10 (83.3)	4 (44.4)	
Tract dilation following LAMS deployment, n (%)				0.90
Yes	12 (57.1)	7 (58.3)	5 (55.6)	
No	9 (42.9)	5 (41.7)	4 (44.4)	
Coaxial double-pigtail stent placement, n (%)				0.24
Yes	5 (23.8)	4 (33.3)	1 (11.1)	
No	16 (76.2)	8 (66.7)	8 (88.9)	

▶ **Table 2** (Continuation)

Procedure characteristics	Total endosonographers n = 21	≤10 EUS-GEs performed in last 12 months n = 12	>10 EUS-GEs performed in last 12 months n = 9	P value
LAMS size most often used, n (%)				0.58
10 mm×10 mm	0 (0)	0 (0)	0 (0)	
15 mm×10 mm	12 (57.1)	6 (50.0)	6 (66.7)	
15 mm×15 mm	1 (4.8)	1 (8.3)	0 (0)	
20 mm×10 mm	8 (38.1)	5 (41.7)	3 (33.3)	
Prophylactic antibiotics usage, n (%)				0.61
Yes, one dose at procedure.	17 (81.0)	9 (75.0)	8 (88.9)	
Yes, intra-procedure and post-procedure.	1 (4.7)	1 (8.3)	0 (0)	
No	3 (14.3)	2 (16.7)	1 (11.1)	

EUS-GE, endoscopic ultrasound-guided gastroenterostomy; LAMS, lumen-apposing metal stent.

cerns about procedure safety (85.7%, 18 of 21), lack of a stabilizing device for the jejunal loop (76.2%, 16 of 21), lack of endoscopist training (57.1%, 12 of 21), and lack of procedural standardization (52.4%, 11 of 21).

Attitudes toward EUS-GE were also similar between higher- and lower-volume groups regarding preferences of EUS-GE over enteral stenting for malignant GOO ($P = 0.22$) and recommendations for the LAMS exchange date in benign GOO ($P = 0.63$) (▶ **Table 3**). Earlier recommendations for LAMS exchange in malignant GOO tended to be more common in the higher-volume group than the lower-volume group (44.4% recommending exchange before ≤6 months vs. 16.6%, $P = 0.08$). However, increased experience with EUS-GE was significantly associated with an improved comfort level: 55.6% of respondents (5 of 9) in the higher-volume group versus only 16.7% (2 of 12; $P = 0.04$) in the lower-volume group reported being completely comfortable in consistently obtaining successful and reproducible outcomes in EUS-GE.

EUS-GE safety

Major AEs related to EUS-GE were reported by 38.1% of expert endosonographers (8 of 21) with three of eight (37.5%) reporting an AE that required surgery (▶ **Table 3**). Self-reported AEs included intraperitoneal LAMS deployment (87.5%, 7 of 8); jejunal wall movement requiring LAMS withdrawal, gastrotomy closure, and re-puncture (62.5%, 5 of 8); puncture through the back wall of the jejunal loop (25.0%, 2 of 8); post-procedure bleeding (12.5%, 1 of 8); dislodgement of distal flange (12.5%, 1 of 8); gastro-colonic erosion (12.5%, 1 of 8); and delayed leak (12.5%, 1 of 8). There was no association between rates of major AEs related to EUS-GE and procedure volume, with similar rates reported among endoscopists performing ≤10 EUS-GE procedures in last 12 months (41.7%, 5 of 12) and those performing >10 procedures (33.3%, 3 of 9; $P = 0.70$).

Post-procedure practices

The majority of endoscopists (81.0%, 17 of 21) reported using one dose of prophylactic antibiotic at time of the procedure (▶ **Table 3**). There was variation in the least restrictive post-procedure diet permitted by respondents with the most popular recommendations being a low-residue diet (38.1%, 8 of 21) and mechanical soft diet (23.8%, 5 of 21). The timing of LAMS exchange following the procedure differed between indications with the plurality reporting exchange at 6 months for benign GOO (38.1%, 8 of 21) and only if symptomatic for malignant GOO (38.1%, 8 of 21).

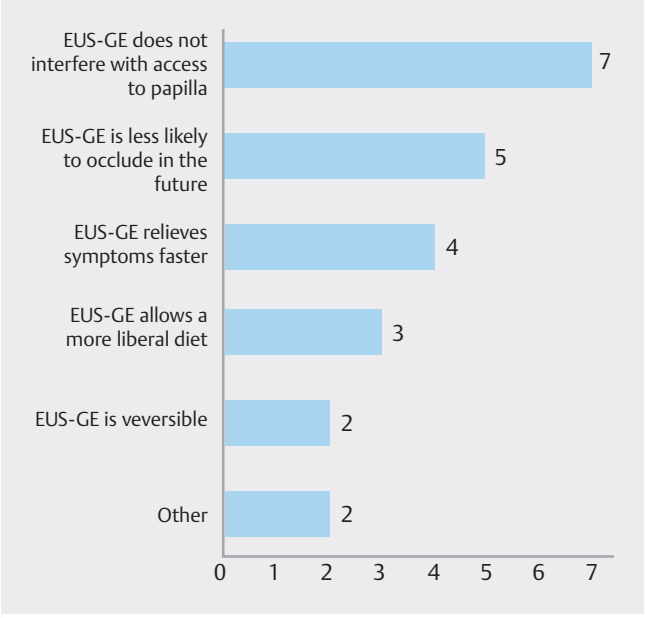
Discussion

This is the first study to assess the preferred techniques and practice patterns of EUS-GE among expert endosonographers in the United States. Our survey demonstrated variability in performance techniques and attitudes toward EUS-GE among leading US endoscopists. In addition, respondents frequently reported experience with serious AEs. A general preference among experts was noted for techniques centered on direct puncture of the jejunal loop without a guidewire. However, several procedure steps demonstrated a lack of uniformity across these expert centers, which may limit the widespread adoption of EUS-GE and contribute to inconsistencies in reported patient outcomes. As such, continued research is needed to assess the impact of differing techniques on EUS-GE efficacy and safety and ultimately develop reliable EUS-GE protocols that maximize technical and clinical success while minimizing intra- and post-procedural risks.

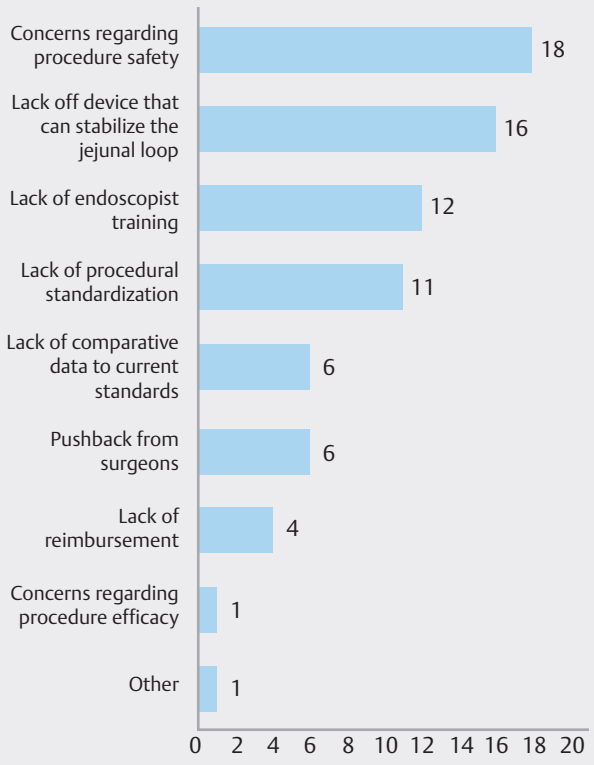
Current studies recognize EUS-GE as a promising but highly challenging therapeutic option for GOO, performance of which should be limited to high-volume expert centers [1, 9]. The procedure consists of several technically demanding steps, including locating the jejunum endosonographically and ensuring

▶ **Table 3** Peri-procedure care reported by expert endosonographers

Peri-procedure characteristics	Total endosonographers n = 21	≤10 EUS-GE performed in last 12 months n = 12	>10 EUS-GE performed in last 12 months n = 9	*P*-value
Indication for EUS-GE, n (%)				
Malignant gastric outlet obstruction (GOO)	21 (100)	12 (100)	9 (100)	NA
Benign GOO	17 (81.0)	9 (75.0)	8 (88.9)	0.42
Afferent limb syndrome	18 (85.7)	9 (75.0)	9 (100)	0.11
Enteral access for translumenal interventions	18 (85.7)	9 (75.0)	9 (100)	0.11
Preference of EUS-GE over enteral stenting for malignant GOO, n (%)				0.22
Always prefer EUS-GE	6 (28.6)	3 (25.0)	3 (33.3)	
Usually prefer EUS-GE	6 (28.6)	2 (16.7)	4 (44.4)	
Sometimes prefer EUS-GE	9 (42.9)	7 (58.3)	2 (22.2)	
Never prefer EUS-GE	0 (0)	0 (0)	0 (0)	
Major adverse event related to EUS-GE, n (%)				0.70
Yes	8 (38.1)	5 (41.7)	3 (33.3)	
No	13 (61.9)	7 (58.3)	6 (66.7)	
Recommended post-procedure diet, n (%)				0.92
Low residue diet	8 (38.1)	3 (25.0)	2 (22.2)	
Mechanical soft diet	5 (23.8)	5 (41.7)	3 (33.3)	
Regular diet	3 (14.3)	2 (16.7)	1 (11.1)	
Stent safe diet	3 (14.3)	1 (8.3)	2 (22.2)	
Puree diet	2 (9.5)	1 (8.3)	1 (11.1)	
Recommended LAMS exchange date for malignant GOO, n (%)				0.08
At 3 months	2 (9.5)	1 (8.3)	1 (11.1)	
At 6 months	4 (19.0)	1 (8.3)	3 (33.3)	
At 12 months	4 (19.0)	4 (33.3)	0 (0)	
Never	3 (14.3)	3 (25.0)	0 (0)	
Only if symptomatic	8 (38.1)	3 (25.0)	5 (55.6)	
Recommended LAMS exchange date for benign GOO, n (%)				0.63
At 3 months	3 (14.3)	2 (16.7)	1 (11.1)	
At 6 months	9 (42.9)	4 (33.3)	5 (55.6)	
At 12 months	4 (19.0)	3 (25.0)	1 (11.1)	
Never	1 (4.8)	1 (8.3)	0 (0)	
Only if symptomatic	4 (19.0)	2 (16.7)	2 (22.2)	
Comfort level in consistently obtaining successful and reproducible outcomes, n (%)				0.04
Completely comfortable	7 (33.3)	2 (16.7)	5 (55.6)	
Very comfortable	9 (42.9)	5 (41.7)	4 (44.4)	
Somewhat comfortable	5 (23.8)	5 (41.7)	0 (0)	
Not very comfortable	0 (0)	0 (0)	0 (0)	



▶ **Fig. 2** Views of 21 expert endosonographer in the United States about reasons to select EUS-guided gastroenterostomy (EUS-GE) over enteral stenting.



▶ **Fig. 3** Views of 21 expert endosonographers in the United States about the most significant barriers to widespread to the adoption of EUS-guided gastroenterostomy.

proper LAMS deployment and placement, all while overcoming the mobility of the small bowel [10]. This high degree of difficulty has likely contributed to the wide range of previously described techniques on how to perform EUS-GE as endoscopists employ various approaches, each with its own advantages and disadvantages, to overcome these challenges [7, 8].

Our findings provide numerous examples of the discordant nature of these strategies, even among expert endoscopists and at some of the highest-risk steps in the procedure. Instilling fluid into the small bowel is a technique used to distend the lumen and assist in localizing a desired target loop that is often made difficult by artifact from intraluminal air and interposed colon [11, 12]. However, our survey revealed differences among expert endoscopists, not only in the preferred method of fluid distension but also in the components of the injectate solution. Direct injection of fluid via a syringe or catheter through the endoscope channel was preferred by a minority of respondents, possibly due to the limited window of opportunity to complete the ultrasound-guided part of the procedure once through-the-scope instillation of fluid has ended [1, 13]. The preference of expert endoscopists for placement of an enteric catheter left in small bowel following scope exchange and used with irrigator emphasizes this technique's advantage of infusing large quantities of fluid continuously distal to the obstruction, thereby facilitating a more reliable target loop for EUS-guided access without time pressure [1]. One area of strong agreement among expert endosonographers in target loop identification was the administration of glucagon to counteract peristalsis in the small bowel and enable optimal endosonographic windows [14]. Furthermore, prone patient positioning has also been theorized to minimize gastric and intestinal motility, with a recent study reporting lower peri-procedural AEs after implementation of a larger standardized EUS-GE protocol that included placing patients in a semi-prone position [15]. However, the standardization protocol simultaneously incorporated numerous interventions and so the ultimate driving factor and significance of patient positioning remains unclear. There are also no current data demonstrating associations between patient positioning and EUS-GE efficacy or safety. As such, patient positioning was not specifically addressed in our survey instrument but may warrant dedicated analysis in future studies.

Respondents were also divided between the preferred method of target jejunal loop puncture and LAMS deployment, with an approximately even split regarding puncturing the target loop with a 19-gauge needle prior to LAMS introduction. In many other therapeutic endosonography-guided procedures, needle puncture can secure access by enabling the placement of a guidewire over which a stent is introduced [13]. The infrequent reported use of a guide wire prior to LAMS introduction in EUS-GE underscores the special challenges of this procedure that relate to mobility of the small bowel. No respondents reported puncturing the target loop with the intent of introducing a guidewire over which the LAMS would be deployed and a substantial majority reported using no guidewire at all during stent placement. This underscores respondent prioritization of minimizing the ubiquitous risk of jejunal migration away from the gastric wall with subsequent stent misdeployment and per-

foration. Electrocautery-enhanced LAMS enable a one-step approach for target loop puncture, anastomosis dilation, and stent deployment, and for this procedure, their freehand use appears to be most frequent [5,8,1]. Nevertheless, despite several reviews recommending the freehand approach [8, 9, 13], a trend supported by our survey results, a substantial number of surveyed experts continued to puncture the target loop for reasons such as the aspiration of dyed fluid to confirm target loop etiology and the injection of additional fluid for further distension. Given that the most commonly reported EUS-GE-related AE is stent misdeployment likely stemming from the inherently mobile and contractile nature of the small bowel, it is unlikely a single standardized protocol will completely eliminate AEs. However, improved standardization focusing on minimizing technique variability during particularly high-risk and important procedure steps will be essential in improving the safety profile of EUS-GE and underscores the need for comparative studies between techniques.

The scarcity of data comparing these technical variants has prevented the identification of the optimal technique for EUS-GE. One retrospective, multicenter study in 75 patients evaluated the relative efficacy and safety of the direct and balloon-assisted EUS-GE techniques and found significantly lower mean procedure times using the direct technique (35.7 minutes vs. 89.9 minutes) but no differences in technical success, clinical success, or rate of AEs [16]. However, no larger-cohort retrospective studies or any prospective trials have further explored this important question. In addition, existing literature frequently features multiple methodologic variations in EUS-GE protocol, therefore routinely introducing bias in the evaluation of procedure efficacy and safety. Meta-analyses have also demonstrated substantial variability in EUS-GE technique used across studies and have recognized the limitations such a lack of standardization imposes on properly evaluating the procedure [17, 18]. Beyond the inherent difficulty of EUS-GE, the wide range of described approaches and insufficient comparative data create further barriers to entry for less experienced endoscopists and those outside of tertiary institutions.

EUS-GE has been shown to possess a significant learning curve even for experienced endoscopists. Our findings of a significant association between increased case volume and endoscopist comfort underscore the importance of exposing endoscopists to EUS-GE procedures via adequate training programs and post-fellowship pathways to improve technical efficiency and minimize procedure times [19, 20]. A previous study demonstrated a threshold of 25 cases to achieve proficiency in EUS-GE while 40 procedures were necessary to attain mastery; however, this was reported for a single operator with extensive experience in interventional EUS, including prior EUS-GE performance [19]. Therefore, the threshold for proficiency and mastery is likely much higher, which is reflected in our survey results showing complete comfort in only one-third of expert endoscopists. In addition, respondents frequently reported at least one serious AE related to EUS-GE (38.1%, 8 of 21) with no significant association between the degree of comfort and AE occurrence. These data reveal individual endoscopist comfort, even among experts, is seemingly insufficient to guarantee increased safety. Future studies will be needed to assess whether total EUS-GE case volumes are associated with AE rates. With concerns regarding procedure safety and lack of endoscopist training encompassing two of the top three limitations of EUS-GE adoption reported in our study, standardization efforts are imperative to formulate training programs and facilitate the development of algorithms in cases of intra- or post-procedure complications to decrease EUS-GE-related morbidity.

The reported attitudes of expert endoscopists in our survey coincide with previous descriptions in previous studies of factors for or against the selection of EUS-GE over conventional alternatives such as endoscopic enteral stenting or surgical gastrojejunostomy. We found respondents most valued the lack of native papilla interference by EUS-GE, which is consistent with theories suggesting that the lack of an overlying stent in EUS-GE allows for improved biliary access for treatment of concomitant biliary obstruction and that EUS-GE provides retrograde access to the papilla for ERCPs [13]. However, limitations of this reasoning include that in cases of early duodenal obstruction requiring an enteral stent or EUS-GE, biliary access is often similarly challenging. The impact of EUS-GE on the ability to perform ERCP via the major papilla also has yet to be studied. Lower risk of occlusion was the second most common reason to select EUS-GE over enteral stenting, which is also consistent with historical data showing enteral stenting is significantly limited by recurrent obstruction and a recent study demonstrating improved stent patency in EUS-GE [21, 22]. On the other hand, the presence of ascites has been found to be a significant predictor of EUS-GE technical failure [23], likely due to increased jejunal mobility, and was also the most common reason for respondents to prefer enteral stenting. By minimizing variability in procedure steps, standardization will decrease bias and improve the generalizability of comparative studies between EUS-GE and other management options. Thus, along with improving safety and efficacy, increased procedure uniformity will allow for the identification of the ideal indications for EUS-GE.

There are several limitations to our study. First, because the goal of our study was to assess the sentiments of endoscopists with extensive experience with and knowledge of EUS-GE, our respondents were limited to expert endosonographers primarily in academic tertiary care centers. As such, the generalizability of our results to other practice settings is uncertain. However, EUS-GE is currently limited to experienced endoscopists in tertiary care centers, and so, our results are likely reflective of the current state of the procedure, especially considering our 100% response rate. Second, all surveyed endoscopists currently practice in American centers, which prevented the evaluation of other EUS-GE variations not currently available in the United States, such as the novel endoscopic ultrasonography-guided double balloon-occluded gastrojejunostomy bypass technique used in Japan. Third, our study aimed to present aggregate, provider-level data on how EUS-GE performed and did not assess patient outcomes, which would require individual, patient-level data. As such, while our data showing no association between rates of major EUS-GE-related AEs and procedure volume may suggest no difference in patient outcomes irre-

spective of case volume, our study was likely underpowered to detect an association between case volume and related AEs. This is especially important considering that even small differences in outcomes can be meaningful given the grave consequences of such AEs. Finally, questions assessing endosonographer comfort and proficiency in endoscopic closure, including suturing and over-the-scope clip devices, were not included in this survey, but would be valuable to assess in future studies, considering the increasing popularity of endoscopic management for intra-procedure AEs.

Conclusions

In conclusion, significant variation exists in performance technique for EUS-GE among expert US endoscopists, which may hinder widespread adoption and contribute to inconsistencies in reported patient outcomes. In addition, endoscopists frequently reported serious AEs. Among surveyed experts, there were no significant differences in preferred EUS-GE techniques or practice patterns based on procedure volume in the last 12 months or the occurrence of major AEs. Enhanced procedure uniformity combined with increased endoscopist exposure to EUS-GE via standardized training programs are imperative to decrease EUS-GE-related morbidity, improve the generalizability of comparative studies, and elucidate EUS-GE utility in the GOO treatment algorithm. The granularity provided by these survey results may identify areas in which to focus standardization efforts and guide future studies on developing an ideal EUS-GE protocol to maximize success.

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Conflict of Interest

Patrick Magahis, Sanjay Salgado, Donevan Westerveld, Enad Dawod, and Kartik Sampath have no conflicts of interest or financial ties to disclose. David Carr-Locke receives royalties from Steris Corporation and consultant fees from Boston Scientific. Reem Sharaiha receives consultant fees from Boston Scientific, Cook Medical, Olympus, and Surgical Intuitive. SriHari Mahadev receives consultant fees from Boston Scientific and Conmed.

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