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Review

Is endoscopic ultrasound-guided gastroenterostomy better than surgical gastrojejunostomy or duodenal stenting?

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Objectives: Gastrojejunostomy is a critical procedure for managing gastric outlet obstruction. While surgical gastrojejunostomy has traditionally been the standard approach, endoscopic ultrasound (EUS)-guided gastroenterostomy has emerged as a promising endoscopic alternative. This comprehensive review aims to explore the development, techniques, outcomes, and comparative effectiveness of EUS-guided gastroenterostomy in comparison to duodenal stenting and surgical gastrojejunostomy.

Methods: A comprehensive literature search was conducted using electronic databases to identify relevant studies published up to April 2024. The search included keywords related to EUS-guided gastrojejunostomy, surgical gastrojejunostomy, and duodenal stenting. Studies reporting on technical success, clinical success, complications, recurrence rates, quality of life, and long-term outcomes were included for analysis.

Results: The development of EUS-guided gastroenterostomy has evolved significantly over the years, driven by device advancements and improved endoscopic techniques. Comparative studies have shown that the technique offers several advantages, including the ability to create an anastomosis without the need for surgery, reduced invasiveness, shorter hospital stays, and potentially improved patient outcomes as compared to duodenal stenting and surgical gastrojejunostomy.

Conclusion: Endoscopic ultrasound-guided gastroenterostomy represents a promising alternative to surgical gastrojejunostomy and duodenal stenting for the management of gastric outlet obstruction. The technique has evolved significantly, offering a less invasive and more effective treatment option.

Key words: endoscopic stenting, EUS-gastroenterostomy, EUS-gastrojejunostomy, gastric outlet obstruction, laparoscopic gastrojejunostomy

INTRODUCTION

MALIGNANT GASTRIC OUTLET obstruction (MGOO) is a debilitating condition that requires prompt intervention to alleviate symptoms, improve nutritional status, and enhance quality of life (QOL). Surgical gastrojejunostomy (GJ) has traditionally been considered the gold standard for the treatment of MGOO.[1] The procedure, however, is invasive and associated with a risk of adverse events (AEs). Hence, endoscopic duodenal stenting (DS) has been developed to overcome the limitations of surgery. In three randomized trials comparing laparoscopic gastrojejunostomy (LGJ) with DS,[2–4] two trials reported more favorable results from enteral stenting, while one study favored LGJ. LGJs have the advantage of reduced risk of tumor ingrowth requiring reinterventions, but AEs such as delayed gastric emptying or anastomotic leak are not uncommon.[5,6] DS has fewer procedural risks but a higher rate of recurrent obstruction due to tumor ingrowth or overgrowth.[2] Thus, in good-risk patients with longer life expectancy, LGJ is preferred, while in frail patients with limited life expectancy, DS is preferred.

Recently, a novel kind of endoscopic treatment has emerged – endoscopic ultrasound-guided gastroenterostomy (EUS-GE).[7–14] The procedure encompasses the advantages of being an endoscopic intervention, while reducing the chance of tumor ingrowth by placing the stent away from the tumor, similar to a surgical GJ. Multiple comparative studies have confirmed superior outcomes of EUS-GE as compared to DS and laparoscopic gastrojejunostomy (LGP). Hence, the procedure is also recommended by the European Society of Gastrointestinal Endoscopy as an alternative to the two traditional procedures in the expert setting.[15] This comprehensive review aims to explore the development, techniques, outcomes, and comparative effectiveness of EUS-GE in comparison to DS and surgical GJ.

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METHODS

A COMPREHENSIVE LITERATURE search was conducted using electronic databases to identify relevant studies published up to April 2024. The search included keywords related to EUS-guided GJ, surgical GJ, and DS. English studies reporting on technical success, clinical success, complications, recurrence rates, QOL, and long-term outcomes were included for analysis.

Development of EUS-GE

Endoscopic ultrasound-guided gastroenterostomy has evolved significantly since its inception. The technique was first described in 2002 in an animal model.[16] Khashab *et al*. then reported the outcomes of EUS-GE in 10 patients with a technical success of 90%, clinical success of 100%, and no AEs.[8] At around the same period, Itoi *et al*. also reported favorable results of 20 patients who received EUS-GE with the double-balloon occluder.[7] EUS-GE, however, has only gained popularity with the advent of the cautery-enhanced lumen-apposing metal stent (LAMS), allowing the creation of EUS-GE with ease and safety.[1,9,12,13,17] LAMS allow the exertion of a lumen-apposing force to appose the lumens of the two organs where the stent is placed together.[17,18] This is possible, as the flanges of the LAMS are designed to be much larger than the diameter, allowing anchorage of the stent to the gastrointestinal tract. Furthermore, the presence of a cautery-enhanced delivery system allows for single-step deployment of the stent.[8,19–22] This significantly improves safety and ease of placement of the stents for EUS-GE. Several cautery-enhanced LAMS are now commercially available, and they include the Hot AXIOS (Boston Scientific Medical, Marlborough, MA, USA), the Hot SPAXUS (Niti-S SPAXUS; Taewoong Medical, South Korea), and the ZEUS-IT stent (Hanarostent Z-EUS IT; MI Tech, Gyeonggi-do, South Korea). The stents can be further divided into physician-controlled deployment (the AXIOS and ZEUS-IT stent) vs. the traditional assistant-controlled deployment (SPAXUS stent) systems. In principle, physician-controlled deployment allows for better control of stent deployment, while assistant-controlled deployment requires experienced assistants for coordinated deployment of the stents. Nevertheless, no studies have compared the outcomes of the different deployment systems.

Endoscopic ultrasound-guided gastroenterostomy is currently indicated for a few conditions, including MGOO, afferent limb obstruction, EUS-guided transgastric endoscopic retrograde cholangiopancreatography (ERCP), and EUS-guided transenteric ERCP.[23–25] Recently, the technique has also been used in patients suffering from benign GOO.[26,27] For the purpose of this review, we will focus on the use of EUS-GE for treatment of MGOO.

Techniques of EUS-GE

Several techniques of creating EUS-GE have been described.[1,9,28] All methods aim to create an EUS-guided bypass by inserting a LAMS between the gastric lumen to the small bowel (duodenum or proximal jejunum) distal to the obstruction. The techniques can be broadly classified into device-assisted and the freehand method. For the device-assisted methods, a device is required to be inserted perorally to occlude and distend a segment of the duodenum/jejunum for puncture.[7,28] For the freehand method, an oroduodenal tube is inserted to distend the small bowel with saline, distal to the stenosis for targeting under EUS.[9–11,14] Both techniques seem to be comparable in success and AE rates, but the procedure time may be shorter with the direct technique. For those just beginning to learn the procedure, device-assisted methods will provide a more stable and distended jejunum of puncture. Regardless of the technique, a prerequisite for successful EUS-GE is that the jejunum should be closed to the stomach.[29] According to one study, EUS-GE may be difficult to perform in up to 25% of patients, as the small bowel may be far from the stomach.[30]

For device-assisted methods, two systems have been described. The first system utilizes a double-balloon occluder (open-tip type 16F ileus tube, 16DBR-3000T0 [800-001-1889]; Tokyo Medical University type, Create Medic, Yokohama, Japan) to perform EUS-guided double-balloon-occluded gastrojejunostomy bypass (EPASS).[7] The stricture is first cannulated. The double-balloon occluder is then inserted over the guidewire beyond the duodenal-jejunal (DJ) flexure using an overtube (ST-SB1S; Olympus Medical, Tokyo, Japan) (Fig. 1).[7] The two balloons of the occluder are positioned beyond the stricture around the DJ flexure and inflated with 30–40 mL normal saline and contrast. The occluded segment of the proximal small bowel between the two balloons is distended with around a 350–400 mL mixture of normal saline, contrast, and indigo carmine injected through the dedicated channel of the occluder. A linear echoendoscope is then inserted into the stomach and the distended small bowel is located from the posterior wall of the body of the stomach. The small bowel is then punctured directly by the cautery-enhanced delivery system of a LAMS. The second system utilizes a through-the-scope dual-balloon exchangeable enteroclysis catheter to facilitate EUS-GE (DUBX, Naja; Chess Medical, Montreal, Canada) (Fig. 2).[28] After cannulating the stricture, the

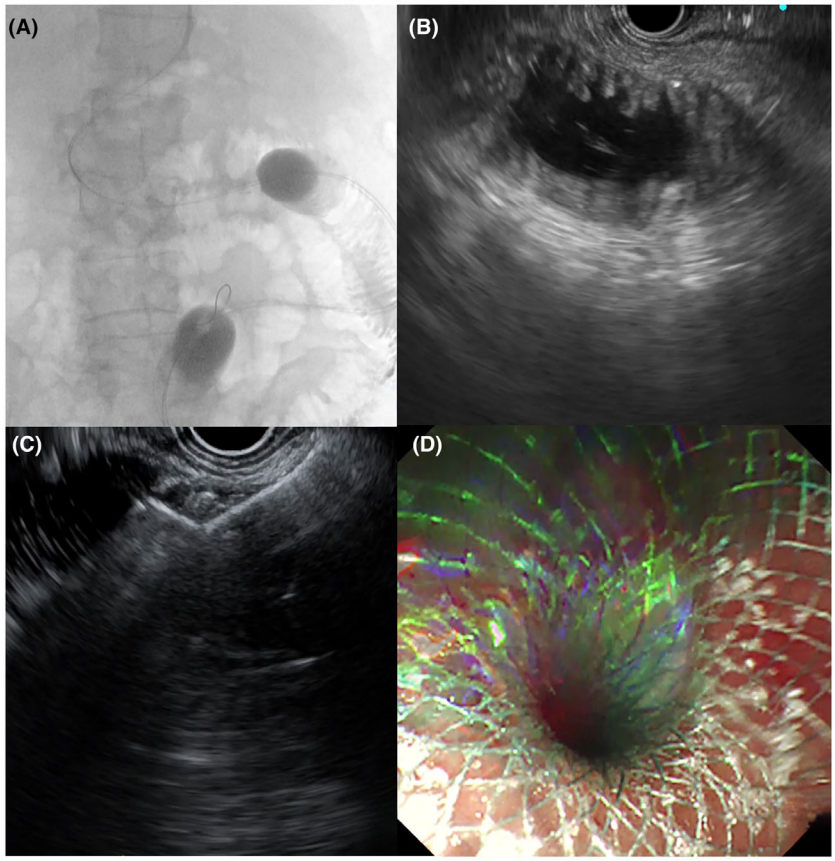

Figure 1 Endoscopic ultrasound (EUS)-guided gastroenterostomy with the EUS-guided double-balloon-occluded gastrojejunostomy bypass technique. (A) Insertion of the double-balloon occluder. (B) Distension of the occluded segment of the small bowel. (C) Opening of the distal flange under EUS guidance. (D) Endoscopic view of the opened proximal flange.

DUBX device is inserted through the channel of the endoscope and positioned at the appropriate segments of the small bowel (Fig. 3). The balloons of the catheter are then injected with air to 40 mm to anchor the balloon catheter. The detachable injection ports of the catheter are then detached from the catheter and the scope removed, while the balloon catheter is exchanged at the same position within the patient. After the endoscope is completely removed, the injection ports are reattached to the catheter and the segment of small bowel distended with around 150 mL normal saline, contrast, and an indigo carmine mixture. A linear echoendoscope is then introduced to identify a segment of small bowel for deployment of the LAMS.

For the freehand technique, the water infusion method is the most popular technique (Fig. 4). The patient is first placed on a left lateral position. A duodenal tube is then inserted distal to the obstruction under endoscopic guidance. The tube is connected to an infusion pump and the small bowel distended with a continuous infusion of normal saline, contrast, and indigo carmine mixture. Antispasmodics are usually given. Thereafter, a linear echoendoscope is inserted into the stomach identifying a duodenal or jejunal loop next to the stomach. EUS-guided transgastric puncture is then performed by the direct method using cautery-enhanced LAMS.

Outcomes of EUS-GE compared with DS and GJ

The potential advantages and disadvantages of the three procedures are shown in Table 1. For MGOO, multiple retrospective studies comparing EUS-GE to DS and surgical GJ have found favorable outcomes associated with EUS-GE. As compared to surgical GJ (open or laparoscopic), technical and clinical success rates were similar, while AEs

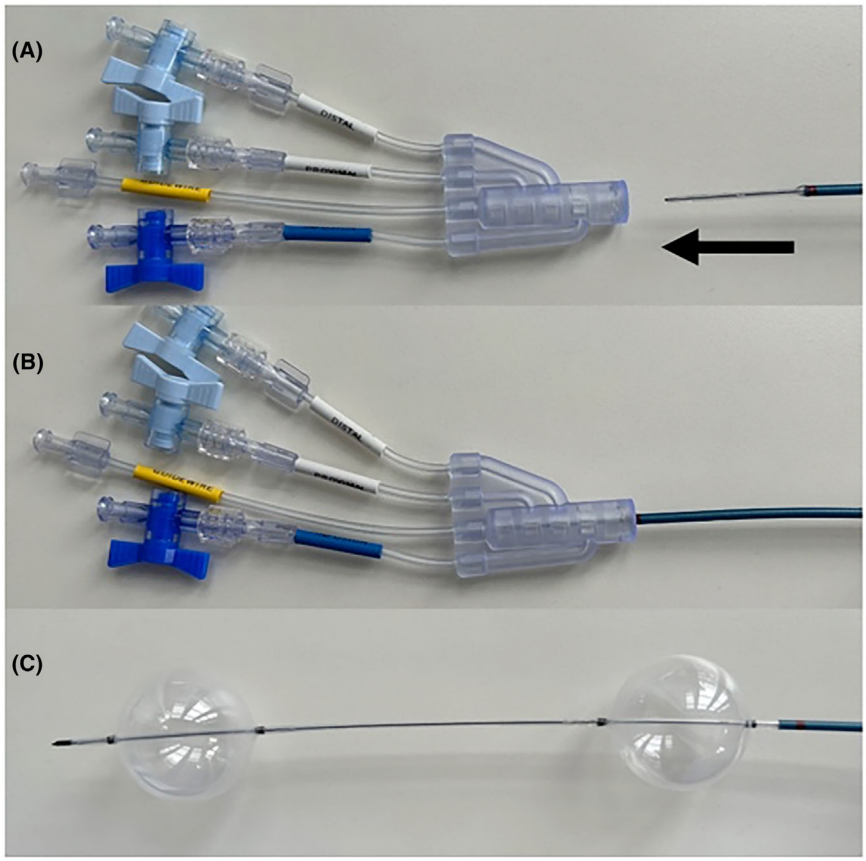

Figure 2 The dual-balloon through-the-scope exchangeable enteroclysis catheter (DUBX, Naja; Chess Medical, Montreal, Canada). (A) Removal of the detachable injection ports from the catheter. (B) The injection ports attached to the catheter. (C) The dual balloons of the catheter.

were lower with EUS-GE.[10,14] In a propensity score analysis, EUS-GE was associated with reduced time to oral intake, shorter median hospital stays, and a lower rate of AEs.[31] In two retrospective studies comparing DS, EUS-GE was associated with less recurrence of GOO and lesser reinterventions in the EUS-GE group.[11] In a three-way study, comparing EUS-GE with DS and LGJ, the EUS-GE group had the shortest hospital stay, lowest rates of recurrent obstruction and reintervention, and the highest 1-month gastric outlet obstruction score (GOOS).[12] In a recent meta-analysis comparing the three procedures, EUS-GE had a lower rate of technical success (95.3%) than DS (99.4%) or surgical GJ (99.9%) (P = 0.0048). For DS vs. EUS-GE vs. surgical GJ, the rates of clinical success (88.9% vs. 89.0% vs. 92.3%, respectively, P = 0.49) were similar. EUS-GE had a lower rate of GOO recurrence (P = 0.0036), while DS had a higher rate of reintervention (P = 0.041). Overall procedural complications were similar (duodenal SEMS 18.7% vs. EUS-GE 21.9% vs. surgical GJ 23.8%, P = 0.32), but the estimated bleeding rate was lowest (P = 0.0048) and the stent occlusion rate was highest (P = 0.0002) for DS.[32]

Finally, the advantages of the EUS-GE were confirmed by the landmark randomized controlled trial comparing EUS-GE with the EPASS technique vs. DS for MGOO.[13] EUS-GE was associated with significantly lower 6-month reintervention rates (4.2% vs. 29%, P = 0.002, relative risk 0.15 [95% confidence interval (CI) 0.04, 0.61]) and longer mean stent patency (174.2 [70.9] vs. 147.9 [63.6] days, P = 0.013, hazard ratio 0.13 [95% CI 0.08, 0.22]). There were no statistically significant differences in technical success and clinical success, 30-day mortality, 30-day AE, or QOL scores at 1 month. The 1-month GOOS was significantly better in the EUS-GE group (2.41 [0.7] vs. 1.91 [0.9], P = 0.012, r = 0.26) suggesting better eating habits experienced by the patients. The study concluded that EUS-GE should be preferred over DS when the expertise is available.

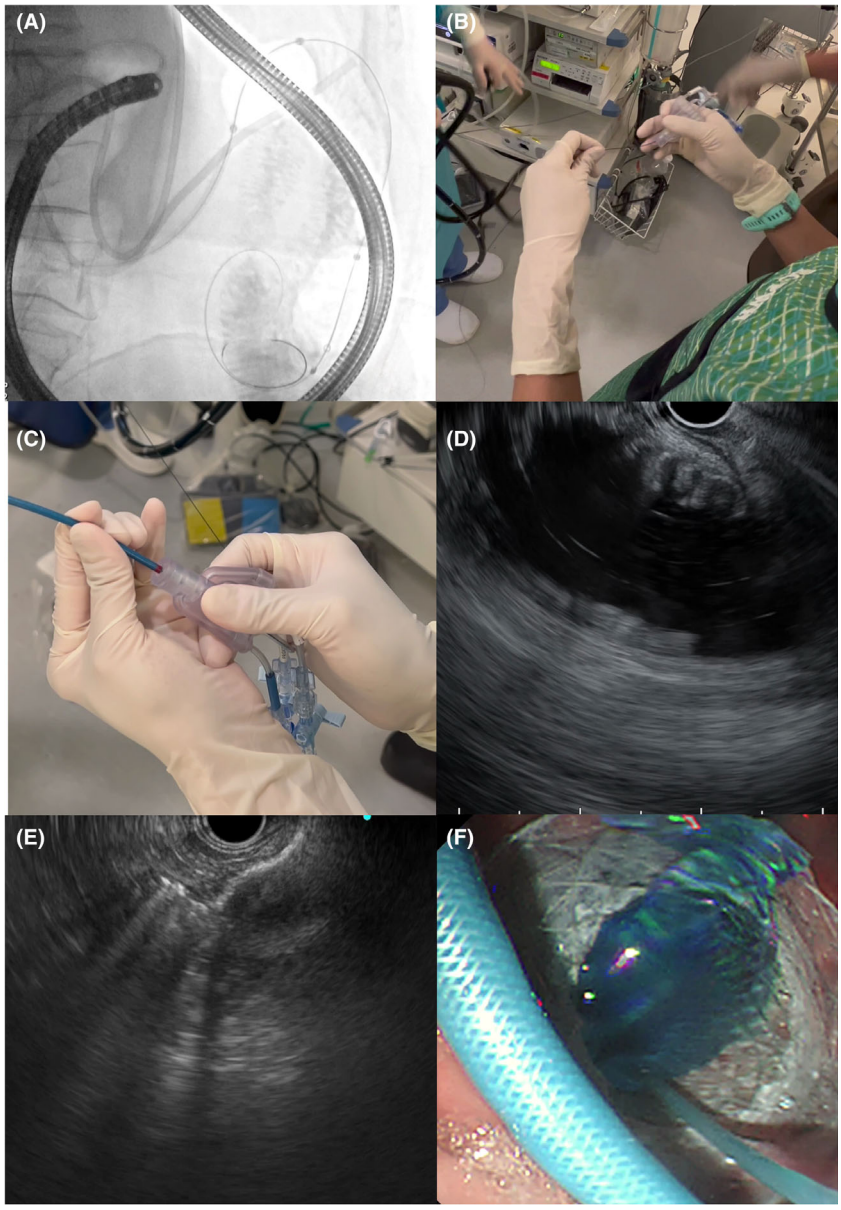

Figure 3 Endoscopic ultrasound (EUS)-guided gastroenterostomy with the DUBX through-the-scope catheter (Chess Medical, Montreal, Canada). (A) Insertion of the through-the-scope DUBX catheter. (B) Reattachment of the detachable injection ports on guidewire to the catheter after scope removal. (C) Attached detachable injection ports to the catheter. (D) Distended occluded segment of small bowel. (E) Distal flange deployed under EUS guidance. (F) Deployed proximal flange as seen endoscopically.

Thus, based on the above data, there are many advantages of EUS-GE over DS or surgical GJ. Nevertheless, when making the decision for the best treatment of MGOO, one should also take into account several other factors. First, LAMS are expensive and one should take into account the cost effectiveness of EUS-GE. In patients with very limited life expectancy, palliation with DS may be a cheap, safe, and an effective treatment option for the patient. Furthermore, EUS-GE is technically demanding and the expertise may not be readily available in every hospital. Hence, endoscopists just beginning the procedure should seek supervision from endoscopists who are experienced with the procedure. It is estimated that experience with 25 procedures is required to achieve proficiency and 40 procedures required to achieve

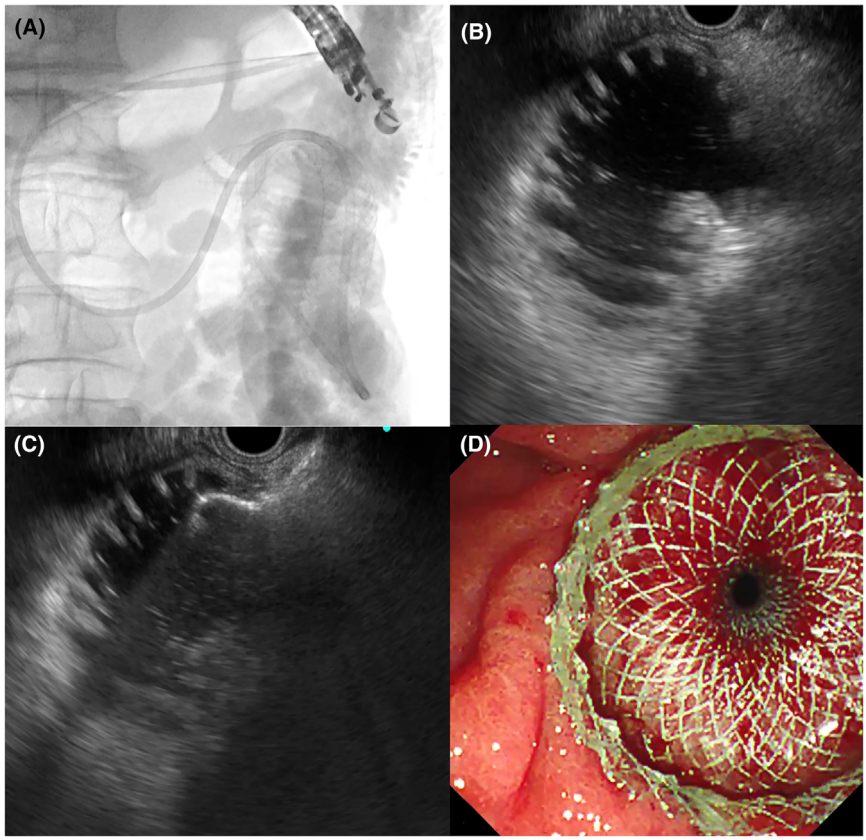

Figure 4 Endoscopic ultrasound (EUS)-guided gastroenterostomy with the freehand water irrigation technique. (A) Insertion of the oroduodenal tube. (B) Distended small bowel after water infusion. (C) Opening of the distal flange under EUS guidance. (D) Endoscopic view of the opened proximal flange.

mastery using the freehand technique.[33] Furthermore, in patients with linitus plastica or those with extensive ascites, EUS-GE maybe contraindicated. Finally, surgical GJ is frequently performed in patients with metastatic disease that is discovered during staging laparoscopy for logistic reasons. Also, in some developing countries, performance of surgical GJ will be much cheaper that EUS-GE. Hence, it is unlikely that EUS-GE will completely replace surgical GJ in the near future.

Regarding the size of stent to be used for EUS-GE, in a study that included 267 patients, there were no significant differences in technical or clinical success between groups that received EUS-GE with LAMS diameter of 15 and 20 mm.[34] However, a significantly higher proportion of patients in the 20 mm group tolerated a soft solid/complete diet at the end of follow-up (91.2% [84.4–95.7%] vs. 81.2% [73.9–87.2%], $P = 0.04$). Furthermore, the time to oral diet was significantly shorter in the 20 mm group (1 [0.2] vs. 1.2 [0.7] days, $P = 0.004$). Hence, the 20 mm stent should be used for EUS-GE when available.

In general, after placement, the LAMS are placed permanently in patients and do not require replacement, as these patients often have limited life expectancy. However, in patients who have a very good response to chemotherapy and live longer than 1 year, LAMS is required to be exchanged in 1 year, as the silicone coating of the stent may wear off and the stent may become unremovable thereafter.

Adverse events after EUS-GE

The most dreaded AE that can occur during EUS-GE is stent misdeployment. This AE occurred in 9.85% of the patients who can be classified into four types.[35] Type 1 is when the distal flange of the stent is misdeployed in the peritoneum. This occurred in 63.1% of the patients and resulted in a mild AE in 75.9% of the cases. The condition can be managed by complete removal of the stent, closure of any gastric opening, and a reattempt of EUS-GE or DS. Closure of the opening can be achieved with clips, over-the-scope clip, or endoscopic suturing. Type 2 is when the distal flange of the

Table 1 Advantages and disadvantages of endoscopic ultrasound-guided gastroenterostomy (EUS-GE), duodenal stenting (DS), and gastrojejunostomy (GJ)

	EUS-GE	DS	GJ
Technical requirement	Very high	Low	Moderate to high
Technical and clinical success	High	High	High
Short-term adverse event rates	Low	Moderate	Moderate
Risk of recurrent GOO	Low	Moderate	Low
Need for reintervention	Low	Moderate	Low
GOOS after the procedure	High	Moderate	High
Cost	Expensive (similar to surgery or more expensive)	Cheap	Expensive

Abbreviations: GOO, gastric outlet obstruction; GOOS, gastric outlet obstruction score.

stent is misdeployed in the peritoneum with concurrent enterotomy made by the cautery in the target small bowel. This occurred in 30.4% of patients and resulted in mild/moderate AE in 92.9% of the cases. The condition can be managed by complete removal of the stent, closure of any gastric opening, and a reattempt of EUS-GE or DS. The enterotomy made is usually small and may seal off without any intervention. Type 3 is when there is misdeployment of the proximal flange into the peritoneum. This condition is rare, but may be fatal. Treatment will either require a natural orifice transluminal surgery transgastric approach to pull the proximal flange back into the stomach or conversion to surgical GJ. Type 4 is when the colon is misidentified as the small bowel, and gastro-colic stenting performed instead. This condition is again uncommon. Management will require the fistula to become mature first at around 2 weeks, followed by removal of the stent and closure of the stomach opening with either clips or endoscopic suture.

CONCLUSION

ENDOSCOPIC ULTRASOUND-GUIDED GJ represents a promising alternative to surgical GJ and DS for the management of MGOO. The technique has evolved significantly, offering a less invasive and more effective treatment option. Early evidence suggests that EUS-GE may provide a lower risk of AE as compared to surgical GJ and DS. However, further research is needed to establish the cost-effectiveness of EUS-GE and assess its long-term outcomes. Standardization of techniques, improved training, and multidisciplinary collaboration are essential for the safe and successful adoption of EUS-guided GJ in clinical practice.

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NONE.

CONFLICT OF INTEREST

AUTHOR A.Y.B.T. IS an Associate Editor of *Digestive Endoscopy*. He is also a consultant for CMR surgical, Boston Scientific, Cook, Taewoong, Microtech, and MI Tech Medical Corporations. The other authors declare no conflict of interest for this article.

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