Conservative management of malignant gastric outlet obstruction syndrome—evidence based evaluation of endoscopic ultrasound-guided gastroentero-anastomosis

Anna Cominardi, Giacomo Tamanini, Nicole Brighi, Pietro Fusaroli, Andrea Lisotti

ORCID number: Anna Cominardi 0000-0002-7003-2855; Giacomo Tamanini 0000-0001-5795-9851; Nicole Brighi 0000-0002-1187-5481; Pietro Fusaroli 0000-0002-4397-9314; Andrea Lisotti 0000-0002-7724-7402.

Author contributions: Cominardi A and Lisotti A wrote the paper; Cominardi A and Tamanini G performed data collection and a systematic review of the literature; Brighi N and Fusaroli P reviewed the manuscript for pivotal intellectual contents.

Conflict-of-interest statement: Authors declare no conflict of interests for this article.

Open-Access: This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/License s/by-nc/4.0/

Abstract

Gastric outlet obstruction (GOO) is a clinical syndrome characterized by post-prandial vomiting, abdominal pain, bloating and, in advanced cases, by weight loss secondary to inadequate oral intake. This clinical entity may be caused by mechanical obstruction, either benign or malignant, or by motility disorders. In this review we will focus on malignant GOO and on its endoscopic ultrasound (EUS)-guided palliative treatment. The most frequent malignant causes of this syndrome are gastric and locally advanced pancreatic carcinomas; other causes include duodenal or ampullary neoplasms, gastric lymphomas, retroperitoneal lymphadenopathies and, more infrequently, gallbladder and bile duct cancers. Surgery represents the treatment of choice when radical and curative resection is potentially feasible; if the malignant cause is not likely to be completely resected, palliative treatments should be proposed. Palliative treatments for malignant GOO are primarily based on surgical gastro-jejunostomy and endoscopic placement of an enteral self-expanding metal stent. Both treatments are effective; however, endoscopic stent placement is less invasive and is associated with less intervention re-intervention. In the last few years, EUS-guided gastroenterostomy (GE) has been proposed as palliative treatment for malignant GOO. This novel technique consists of the creation of an anastomosis between the gastric lumen and a small bowel loop distal to the malignant obstruction, through the deployment of a lumen-apposing metal stent under EUS-view. EUS-GE has the advantage of being as minimally invasive as enteral stent placement, and of...
guaranteeing long-term results similar to those of surgery.

**Key Words:** Gastric outlet obstruction; Endoscopic ultrasound-guided gastroenterostomy; Endoscopic ultrasound; Enteric anastomosis; Lumen-apposing metal stents

©The Author(s) 2021. Published by Baishideng Publishing Group Inc. All rights reserved.

**Core Tip:** Malignant gastric outlet obstruction is a clinical syndrome affecting patients with advanced pancreatic adenocarcinoma, gastric and duodenal cancer, or retroperitoneal neoplasms. Recently, endoscopic ultrasound-guided gastroenterostomy using a lumen-apposing metal stent has been proposed as a minimally invasive and long-lasting endoscopic palliative treatment for this condition. This technique has not only shown similar technical and clinical success rates to those of surgical gastro-jejunostomy and endoscopic enteral stent placement, but it also results in a lower rate of reintervention, adverse events, and costs.

**INTRODUCTION**

Gastric outlet obstruction (GOO) is a clinical syndrome caused by the presence of any obstacle to gastric emptying. However, the definition “gastric outlet obstruction” is misleading, since this condition is caused not only by intrinsic gastric, but also by duodenal, jejunal or extra-luminal conditions.

**ETIOLOGY**

The two main etiologies of GOO are motility disorders and mechanical obstructions.

**Motility disorders**

The most common motility disorder causing GOO is gastroparesis, usually secondary to long-standing diabetes. Gastroparesis may also be idiopathic or the result of viral infections, chronic use of medications (e.g., opioids, anticholinergics and antidepressants), connective tissue diseases (e.g., scleroderma, Ehlers-Danlos syndrome), or neurological conditions, such as Parkinson’s disease and multiple system atrophy[1].

Some solid and hematologic malignancies may induce gastric and intestinal dysmotility through a paraneoplastic syndrome or a secondary infiltrative process (e.g., amyloidosis or carcinomatosis).

Moreover, thoracic and abdominal surgery may cause vagus nerve injuries, resulting in an alteration of gastric motility; vagus nerve injuries occur more frequently in bariatric surgery, fundoplication, surgery for peptic ulcer disease (PUD) and esophagectomy[1].

**Mechanical obstruction**

Mechanical obstruction may be caused by either benign or malignant causes.

Benign causes are PUD, nonsteroidal anti-inflammatory drug use, *Helicobacter pylori* (*H. pylori*) infection, ingestion of corrosive or caustic agents, abdominal tuberculosis, gastric or duodenal polyps, anastomotic strictures, Crohn’s disease, sarcoidosis, gastric bezoars, gastric antral webs, gastric volvulus, Bouvier syndrome, acute and chronic pancreatitis, pancreatic pseudocyst and annular pancreas.

Malignant mechanical GOO is usually secondary to gastric, duodenal or pancreatic neoplasms. In particular, up to 35% of cases of GOO is caused by distal gastric cancer.
Pancreatic adenocarcinoma is also a common cause of GOO, especially in the presence of gastric and duodenal infiltration. Almost 15%-25% of patients with a diagnosis of pancreatic adenocarcinoma present with GOO[2].

Other causes of malignant GOO are gastric lymphomas (e.g., MALT lymphoma), large neoplasms of the proximal duodenum and ampulla, cystic neoplasms of the pancreas, local extension of advanced gallbladder and bile duct cancer, neuroendocrine neoplasms, retroperitoneal lymphadenopathies (e.g., metastatic tumor, lymphoma), retroperitoneal sarcomas, leiomyosarcomas, gastrointestinal (GI) stromal tumors and metastases (Table 1)[2-7].

**Epidemiology**

A precise estimate of GOO incidence is difficult to extrapolate. Until the late 1970s, PUD was the cause of up to 90% of cases of GOO. However, after the advent of histamine H2-receptor antagonists and proton pump inhibitors and more effective treatment regimens for *H. pylori* infection, less than 5% of cases of GOO are due to PUD. To date, malignancies represent the most common cause of GOO, accounting for almost 50%-80% of cases of GOO[2,3].

**Clinical Manifestations and Diagnosis**

The onset of symptoms of GOO depends on the etiology of the obstruction. Patients with a malignant mechanical obstruction usually show a shorter duration of symptoms than those with benign disease[3-7]. Patients may also present hypokalemia and hypochloremic metabolic alkalosis on laboratory tests, as a consequence of protracted vomiting.

When GOO is suspected, abdominal imaging (abdominal radiography, contrast upper GI studies, or contrast-enhanced computed tomography) and upper endoscopy may confirm luminal obstruction. Additional tests, such as endoscopic ultrasound (EUS) with fine-needle aspiration or full-thickness surgical biopsies, may be useful in patients with suspected malignant GOO with negative endoscopic biopsies obtained during a gastroscopy. Indeed, diffuse-type gastric adenocarcinomas causing *linitis plastica*, gastric lymphomas and gastric metastases (i.e. breast cancer or melanoma), usually growing below the mucosal layer, may be difficult to diagnose with endoscopic biopsies[2-7].

**Management of Malignant GOO**

**Supportive management**

Patients with symptomatic GOO, regardless of its cause, should receive intravenous fluids support and correction of electrolyte alterations. Patients should be fasted and receive *nil per os*; high-dose proton pump inhibitor therapy is suggested to decrease the volume of gastric secretions and associated inflammation. Nasogastric tube placement should be considered[1,8,9].

**Malignant GOO management**

Surgical approach represents the treatment of choice in patients with malignant GOO. However, radical resection (gastrectomy) is often not indicated or feasible, since most underlying malignant conditions present as unresectable (almost 40% of gastric cancers and 80%-90% of periampullary cancers) or even metastatic.

Therefore, most patients require palliative interventions for GOO. Several palliative treatment strategies are available, such as surgery (bypass), endoscopy [endoscopic stenting, decompressive gastroscopy with or without feeding tube placement or EUS-guided gastroenterostomy (EUS-GE)] or radiotherapy (Table 2). Finally, primary curative chemotherapy is usually indicated in patients with gastric lymphomas. However, in this subset of patients, gastrectomy may be indicated in advanced T stages due to the high risk of chemotherapy-induced gastric perforation[10].

The aim of this review is to focus on procedural aspects and clinical outcomes of EUS-GE.
Table 1 Causes of malignant gastric outlet obstruction

| Site                      | Pathology                                                                 |
|---------------------------|---------------------------------------------------------------------------|
| Stomach                   | Distal gastric cancer                                                     |
|                           | Gastric lymphoma (e.g., MALT lymphoma)                                    |
|                           | Leiomyosarcoma                                                            |
|                           | Gastrointestinal stromal tumor                                            |
|                           | Gastric neuroendocrine neoplasms                                          |
| Pancreas                  | Pancreatic adenocarcinoma                                                 |
|                           | Cystic neoplasm of the pancreas                                           |
| Duodenum                  | Duodenal cancer                                                           |
|                           | Leiomyosarcoma                                                            |
|                           | Neoplasm of the ampulla                                                   |
|                           | Gastrointestinal stromal tumor                                            |
|                           | Metastasis                                                                |
| Gallbladder and bile duct | Gallbladder and bile duct cancer                                          |
| Other                     | Retroperitoneal lymphadenopathy (e.g., metastatic tumor, lymphoma)        |
|                           | Retroperitoneal sarcoma                                                   |

MALT: Mucosa-associated lymphoid tissue.

Table 2 Treatment of mechanical malignant gastric outlet obstruction

|                      | Curative                          | Palliation                                      |
|----------------------|-----------------------------------|------------------------------------------------|
| Surgery              | Surgery (gastrojejunostomy)       | Surgical bypass                                |
| Endoscopy            | Endoscopic stenting               | EUS-GE                                         |
|                      |                                   | Decompressive gastrostomy with or without feeding tube placement |
| Chemotherapy and radiotherapy | Chemotherapy (especially for GI lymphoma) | Radiotherapy                                    |

GI: Gastrointestinal; EUS-GE: Endoscopic ultrasound-guided gastroenterostomy.

EUS-GE

EUS-GE was initially hypothesized and tested in animal models by Fritscher-Ravens et al[11] in 2002. This technique has progressively evolved; it involves the creation of a bypass between the stomach and a small bowel limb placed distal to the obstruction, through the insertion of a lumen-apposing metal stent (LAMS) under EUS and fluoroscopic guidance.

LAMSs were first designed for the drainage of pancreatic fluid collections and, in the last decade, they have been used for other indications such as EUS-guided biliary drainage, including EUS-guided choledochoduodenostomy and EUS-guided gallbladder drainage. Other off-label indications have been described, such as drainage of post-surgical fluid collections, drainage of pelvic fluid collection, EUS-directed transgastric-endoscopic retrograde cholangiopancreatography (ERCP) and EUS-guided drainage of benign strictures[12-14].

EUS-GE represents a good alternative to surgical bypass in patients with symptomatic advanced malignant GOO regardless of the stenosis size, and it has the advantage to being less invasive than surgery.

This endoscopic technique can be performed in cases with mechanical obstructions occurring in the antro-pyloric region, in the duodenal bulb and in the second or third portion of the duodenum. On the other hand, it is contraindicated for obstructions in
the gastric body, in the fourth portion of the duodenum and in the proximal jejunum, around the ligament of Treitz, as it is considered unsafe or unfeasible. Other absolute contraindications for EUS-GE are the presence of a large amount of ascites interposed between the gastric wall and the target small intestine loop, and the presence of severe portal hypertension with peri-gastric varices[15-18].

Pre-operative management
A careful and complete explanation of the indications, contraindications, techniques and possible adverse events (AEs) of EUS-GE should be offered to all patients, due to the “off-label” nature of this procedure. An informed consent should be signed by all patients undergoing EUS-GE procedures. Patients should be clearly informed regarding the possibility of requiring urgent or emergent surgery in case of procedural complications.

Complete cross-sectional imaging and dynamic contrast radiology scans before the procedure are recommended, in order to evaluate and confirm the close apposition between the gastric wall and duodenum or the target small intestine loop.

No food intake for at least 8 h before the procedure should be recommended; endoscopic removal of gastric residue should be performed before the procedure in the presence of large amounts of ingest. Antibiotic prophylaxis (gram-negative and anaerobe coverage) is suggested, in order to reduce the risk of peritonitis, although no clear evidence is available to date. EUS-GE must be performed under general anesthesia, with airway intubation. Indeed, in patients with presumed gastric stasis and the presence of ingest in gastric lumen, it is mandatory to prevent aspiration. We recommend airway intubation as a basic safety issue in this field. Moreover, we strongly suggest nasogastric tube placement the day before EUS-GE, in case of gastric distension. Carbon dioxide insufflation and a standard gastroscope are required for this procedure; however, sometimes, an enteroscope or a forward-view echoendoscope, especially in the post-surgical anatomy of upper GI tract patients, may be useful[19].

Endoscopic equipment
A linear echoendoscope and a standard gastroscope are used to perform EUS-GE. The LAMS firstly used for EUS-GE in an animal model by Binmoeller and Shah[20] was the AXIOS stent (Boston Scientific, Natik, Massachusetts, United States). The AXIOS stent is a bi-flanged fully-covered nitinol LAMS[20]. Originally, an AXIOS stent was placed into the newly-generated anastomotic tract after puncture, guidewire placement and tract dilation (Seldinger technique). More recently, two electrocautery-enhanced LAMS delivery systems have been developed and commercialized, namely Hot-AXIOS Stent (Boston Scientific, United States) and Hot-SPAXUS Stent (Taewoong Medical, South Korea), thus allowing the creation of the anastomotic conduit through an electrocautery-enabled access catheter and the subsequent release of a LAMS without guidewire passage and pre-dilatation of the passage.

Techniques
EUS-GE is an EUS technique based on the creation, under linear echoendoscope view, of a communication between the stomach and an adjacent duodenal or jejunal loop.

The first step consists of the choice of a target anastomotic site, as EUS-guided gastroduodenostomy into the third part of the duodenum or EUS-guided gastrojejunoostomy represent the two anatomical options[21]. Moreover, the short length (about 10 mm) of the AXIOS stent has to be considered: The duodenum or jejunum must be in close proximity to the gastric wall in order to prevent LAMS displacement after deployment and to facilitate the formation of a mature anastomosis over time. The different conformation of Taewoong’s Hot-SPAXUS could provide promising innovations in this field.

The target site selection is mainly based on the proximity of the small bowel portion and its axis. Identification of the anastomotic site under EUS view is sometimes difficult; air insufflation and a large amount of ascites can seriously undermine the accuracy of EUS images; moreover, EUS-morphology of the transverse colon may be mistaken for small bowel. In order to overcome these challenges, a controlled-radial expansion balloon or ERCP extraction balloon can be advanced up to the duodenum or jejunum to improve acoustic coupling.

Recently, water-filling luminal techniques, consisting of filling the duodenum or jejunum with water or isotonic saline with or without contrast or tinged with a dye, have been proposed; however, the rapid infusion of a volume of water sufficient to dilate the target small bowel loop may cause serious AEs such as hyponatremia and
cardiovascular volume overload due to fluid absorption[22].

Lately, a novel double-balloon catheter has been developed, in order to enable not only stabilization of the target small bowel loop, but also distension of the lumen between the two balloons with fluid, to provide an easier target[23].

Due to increasing innovations, several techniques for EUS-GE are currently available: direct EUS-GE, anterograde EUS-GE (the “rendezvous” method), anterograde direct method, retrograde EUS-GE, and EUS-guided double-balloon occluded gastrojejunostomy bypass (E-PASS)[21-27].

**Direct EUS-GE-traditional/downstream method**

The stricture is passed using a long stiff guidewire, placed into the proximal jejunum. A dilation balloon catheter (usually 18-20 mm) or a nasal biliary drainage catheter (NBDC) is passed over this wire into the jejunum and inflated with contrast to locate the jejunal loop.

A linear echoendoscope is used to identify the inflated balloon or the dilated target limb. In patients with no previous abdominal surgery, after the identification of the mesenteric vessels, the echoendoscope should be turned (either clockwise or anticlockwise) to find the Treitz area and first proximal jejunal limb. EUS-GE can be performed using a 15 mm × 10 mm or 20 mm × 10 mm Hot-AXIOS delivery system or the recently commercialized Hot-SPAXUS stent (Taewoong Medical, South Korea), with a free-hand technique; in this case, the use of a pure cut setting of the electrosurgical unit with high power is necessary. The procedure could be performed with a previous puncture with a 19-gauge needle and passing a 0.035” guidewire[21-27].

**Antegrade EUS-GE-the “rendezvous” method**

The stricture is passed using a long stiff guidewire, placed into the proximal jejunum. A dilation balloon catheter (usually 18-20 mm) or a NBDC is passed over this wire into the jejunum and inflated with contrast to locate the jejunal loop.

Instead of passing a guidewire downstream into the jejunum, in this technique the guidewire is captured in the duodenum or proximal jejunum and it is pulled back through the obstruction and the mouth in order to secure it. The LAMS is deployed over the fixed guidewire to create the gastroenterostomy[21-27].

**Antegrade direct method**

The small bowel distal to the stenosis is distended with saline solution and contrast, as well as a staining agent (e.g., methylene blue) using a NBDC through the stricture or just flushing the lumen through the scope operative channel. The jejunal limb can be punctured to confirm the correct target, avoiding the transverse colon. Free-hand insertion of the electrocautery-enhanced LAMS is carried out[21-27].

**Retrograde EUS-GE-“enterogastrostomy”**

This technique is a modification of the “rendezvous” method. A long, stiff guidewire is passed through the stricture and the anastomotic tract, punctured with an EUS-fine-needle aspiration needle. A therapeutic gastroscope is advanced, over the wire, through the stricture to the duodenum-jejunal junction. A LAMS is deployed from the small bowel to the stomach (the gastric flange is opened first). However, this technique is not feasible in most cases and the risk of iatrogenic perforation due to the endoscope passing through the stenosis limits its use[21-27].

**EPASS**

Using a double-balloon enteroscope, a guidewire is advanced through the proximal jejunum. The enteroscope is removed, leaving the overtube in place. A dedicated double-balloon enteric tube (Tokyo Medical University type; Create Medic Co., Ltd, Yokohama, Japan) is advanced through the stricture using the overtube to avoid loop formation in the stomach. The device is made with 2 balloons, at a distance of 20 cm. The inflation of these balloons is used to fix the jejenum, which is filled with contrast material and methylene blue. EUS is used to puncture or to directly deploy the LAMS. Unfortunately, to date, this device has not been registered in Europe and the United States for human use[21-27].

**Post-operative management**

On the day of the procedure no food intake is recommended, while clear fluids can be resumed 12 h later if no worrying symptoms are observed. The day after the procedure a liquid diet should be started and it should be converted, if tolerated, into a low residue diet within the next 1-2 d.
Cominardi A et al. EUS-GA for malignant gastric obstruction

The day after the procedure, abdominal radiography or CT may be performed to confirm correct placement of the LAMS, especially if dislodgment or migration or perforation are suspected. Nevertheless, performing imaging the day after EUS-GE is not necessary if the procedure was uneventful and the patient did not develop any symptoms. Systemic antibiotics may be continued for 3 d after the procedure, although no solid evidence is available to date.

Misdeployment
In case of LAMS misdeployment, the use of a preloaded guidewire could provide effective access to the punctured limb. However, in the case of a “proximally misdeployed” stent (with the distal flange in the peritoneum and the proximal flange in the stomach), we suggest removing the stent and restarting the procedure. The site of puncture could be closed with a through-the-scope clip. In our experience, no complications have occurred. In the case of a “distally misdeployed” stent (with the distal flange in the jejunal limb and the proximal flange in the peritoneum), the presence of a preloaded guidewire could be useful for a salvage procedure; on the other hand, peritoneal exploration (either with laparoscopy or with a NOTES procedure) may be required to rescue the EUS-GE.

Long-term EUS-GE management
As no large study reporting EUS-GE long-term outcomes is available, there is no robust evidence in the field. Long-term complications due to LAMS traumatism on the contralateral wall could be hypothesized, based on pancreatic fluid collection drainage experience. The long-term management represents an unsolved issue in EUS-GE. Data on long-term AEs and LAMS management are required in the near future.

Outcomes of EUS-GE for malignant GOO
Patients suffering from malignant GOO can be treated either with surgical gastrojejunostomy (SGJ), endoscopic enteral self-expanding metal stent (SEMS) placement or EUS-GE.10
Since the first description of EUS-GE in a pig model in 2002,12 this technique has also been demonstrated to be feasible in humans with a significant success rate. Previous studies on EUS-GE for malignant GOO are summarized in Table 3.

The technical success rate of EUS-GE for the treatment of malignant GOO, regardless of the technique performed, has been reported to range from 80% to 100%, while clinical success ranges from 73% to 100%. However, the definition of “clinical success” is not univocal in the reported literature, as some authors defined “clinical success” as resumption of solid oral intake, while others as the ability to tolerate at least a full liquid diet.

The rate of AEs varies from 0% to about 27%; the most frequent AEs reported are misdeployment of the LAMS, bleeding, abdominal pain, perforation, pneumoperitoneum and fistula.

The rate of GOO recurrence or the need for reintervention is reported to be 0%-15%. In 2015, Khashab et al.28 reported the technical and clinical success of EUS-GE in their retrospective cohort of 10 patients (among them, 3 presented with malignant GOO), as 90% and 100%, respectively. During follow-up no AEs or recurrences occurred.28

Tyberg et al.29 showed similar results in 2016 by retrospectively evaluating 26 patients, of which 17 presented with malignant GOO. EUS-GE had a technical success of 92% in the entire population and a clinical success of 88% in patients affected by malignant GOO. However, this study reported an AEs rate of 11.5%.29

Although in this study different EUS-GE techniques were performed, in the same year Itô et al.30 reported their experience on performing EPASS in 20 patients with malignant GOO, and showed a technical and clinical success of 90% with AEs in 10% of cases. In addition, no stent occlusion or migration occurred during a median follow-up of 100 d.30

Studies enrolling a greater number of patients date back to 2017; in this year Perez-Miranda et al.32, Khashab et al.33 and Chen et al.34 reported their retrospective multicenter experience of EUS-GE for palliation of malignant GOO using several techniques. These studies showed a similar technical success rate of 88%, 87% and 86.7%, respectively, and a comparable clinical success rate (84%, 87% and 83.3%). AEs occurred in 12% to 16.7% of the procedures and in 4.3% of cases, GOO recurrence or need for reintervention were described.31-34

In 2018, Chen et al.35 compared the safety and efficacy of the antegrade direct technique with the “traditional” balloon-assisted technique in a cohort of 77 patients
Table 3 Summary of reports in the literature on endoscopic ultrasound-guided gastroenterostomy for malignant gastric outlet obstruction

| Ref.                  | Nation                  | Study design                  | Population (n) | Techniques                                                                 | Technical success (%) | Clinical success (%) | Adverse events (%) | Follow-up (wk) | GOO recurrence (%) |
|-----------------------|-------------------------|-------------------------------|-----------------|----------------------------------------------------------------------------|-----------------------|---------------------|------------------|-----------------|-------------------|
| Khashab et al [30], 2015 | United States           | Retrospective multicenter     | 25 (9 with malignant GOO) | Direct (n = 1), Balloon-assisted (n = 9)                                   | 90                    | 100                 | 0                | 21              | 0                 |
| Tyberg et al [30], 2016 | United States           | Retrospective multicenter     | 26 (17 with malignant GOO) | Direct (n = 3), Balloon-assisted (n = 13), NB catheter assisted (n = 3), Hybrid rendezvous (n = 5) | 92                    | 88                  | 11.5             | 8               | 0                 |
| Itou et al [30], 2016  | Japan                   | Prospective single center     | 20              | EPASS                                                                    | 90                    | 90                  | 10               | 14              | 0                 |
| Breuer Gutierrez et al [31], 2017 | United States | Retrospective multicenter     | 7               | Direct (n = 5), Balloon-assisted (n = 2)                                  | 100                   | 100                 | 0                | 15              | 0                 |
| Perez-Miranda et al [32], 2017 | United States and Europe | Retrospective multicenter     | 25 (17 with malignant GOO) | Direct (n = 6), Balloon-assisted (n = 9), NB catheter assisted (n = 3), Ultraslim-endoscope assisted (n = 7) | 88                    | 84                  | 12               | 8               | 0                 |
| Khashab et al [33], 2017 | United States and Japan  | Retrospective multicenter     | 30              | Direct (n = 2), Balloon-assisted (n = 6), EPASS (n = 22)                  | 87                    | 87                  | 16               | 22              | 3                 |
| Chen et al [34], 2017   | United States and Japan  | Retrospective multicenter     | 30              | Direct (n = 2), Balloon-assisted (n = 6), EPASS (n = 22)                  | 86.7                  | 83.3                | 16.7             | 14              | 4.3               |
| Chen et al [35], 2018   | United States and Europe | Retrospective multicenter     | 77 (52 with malignant GOO) | Direct (n = 52), Balloon-assisted (n = 22)                                | 94.2                  | 92.3                | 6.8              | 17              | 7                 |
| Urrehman et al [36], 2018 | Singapore               | Prospective single center     | 5               | Balloon-assisted EUS-GE                                                  | 100                   | 80                  | 0               | -               | -                 |
| Ge et al [37], 2019     | United States           | Prospective single center     | 22              | Direct EUS-GE                                                            | 100                   | 95.8                | 20.8             | 24              | 4.5               |
| Kerdísrichiarat et al [38], 2019 | United States | Retrospective multicenter     | 57 (34 with malignant GOO) | Direct EUS-GE                                                            | 93                    | 89.5                | 3.5              | 28              | 15.1              |
| Xu et al [39], 2020     | China                   | Retrospective single center   | 36              | Double balloon-assisted EUS-GE                                          | 100                   | 94.4                | 25               | 13              | 2.7               |
| Hu et al [40], 2020     | China                   | Prospective single center     | 9               | RPAT-assisted EUS-GE                                                      | 100                   | 100                 | -               | -               | -                 |
| Kastelijn et al [41], 2020 | Europe                 | Retrospective multicenter     | 45              | Direct (n = 36), Balloon-assisted (n = 9)                                 | 86.7                  | 73.3                | 26.7             | 10              | 5.1               |
| Wannhoff et al [42], 2020 | Germany                | Retrospective single center   | 35 (33 with malignant GOO) | Direct (n = 22), Others (n = 12)                                        | 80                    | 74.3                | 14.3             | 8               | 10                |

GOO: Gastric outlet obstruction; NB: Nasobiliary; EUS-GE: Endoscopic ultrasound-guided gastroenterostomy; EPASS: EUS-guided double balloon-occluded gastrojejunostomy bypass; RPAT: Retrievable puncture anchor traction.

(52 affected by malignant GOO). This retrospective multicenter study showed no significant difference between these two methods, in terms of technical success rate (94% for the direct and 91% for balloon-assisted). Moreover, clinical success (defined as the ability to tolerate at least a full liquid diet) of these two methods was similar, (92% and 91%, respectively). Finally, no significant differences were found in the rate of AEs and the need for repeated intervention. Nevertheless, the procedure time for the direct technique was significantly lower than that for the balloon-assisted tech-
nique (35.7 min vs 89.9 min)\cite{35}.

The single center study by Urrehman et al\cite{36}, demonstrated a 100% technical success rate and an 80% clinical success rate. Remarkable technical and clinical success was reported for the double balloon-assisted EUS-GE (100% and 94.4%, respectively) with an AEs rate of 25% and a need for reintervention in almost 3% of cases\cite{36}.

With regard to long-term outcomes of EUS-GE, Kersdirichairat et al\cite{38} reported their retrospective experience of 34 patients with malignant GOO undergoing the direct technique, with a median follow-up of 196 d. In this cohort, technical and clinical success was achieved in 93% and 89.5% of cases, respectively, with AEs occurring in 3.5% of patients\cite{38}.

Different to previous studies, Kastelijn et al\cite{41} and Wannhoff et al\cite{42} recently reported lower technical (86.7% and 80%, respectively) and clinical (73.3% and 74.3%, respectively) success rates for EUS-GE performed with various techniques for palliation of malignant GOO. While Kastelijn et al\cite{41} showed the occurrence of AEs in 26.7% of cases, Wannhoff et al\cite{42} reported reintervention in 10% of cases. Moreover, Wannhoff et al\cite{42} showed that the distance between the two lumina connected with the LAMS was a predictor of success of the procedure\cite{41,42}.

**Comparison of EUS-GE with surgical bypass**

Malignant GOO palliative treatment is fundamental to relieve symptoms, to guarantee an adequate nutritional status and to improve patients’ quality of life.

Traditionally, the palliative therapy proposed for malignant GOO was surgery, either open or laparoscopic SGJ. Over the years, a new mini-invasive endoscopic technique has been developed for the palliation of malignant GOO: Enteral SEMS placement. This endoscopic technique had the advantage of being less invasive than SGJ and resulted in fewer AEs, shorter time to oral intake restart, and shorter hospital stay; however, enteral SEMS placement was associated with a higher rate of reintervention due to stent obstruction. In recent years, the novel EUS technique of EUS-GE has been developed\cite{43,44}.

EUS-GE was first compared to open SGJ in 2017 by Khashab et al\cite{33}; 93 patients with malignant GOO were enrolled: 30 underwent EUS-GE and 63 open SGJ. Open surgery showed a significantly higher technical success rate (100% vs 87%, \( P = 0.009 \)); however, it has to be considered that the EUS-GE group included more patients with carcinomatosis than the SGJ group\cite{43}.

A comparable clinical success (90% for SGJ and 87% for EUS-GE) and a similar mean time to reintervention (88 d and 121 d, respectively) characterized both procedures, although EUS-GE was associated with a lower occurrence of AEs (16% vs 25%).

Recently, a comparison study between EUS-GE and SGJ was performed by Kouanda et al\cite{45}; EUS-GE was associated with a statistically significant faster resumption of oral intake (1.3 d vs 4.7 d, \( P < 0.001 \)) and a significant shorter length of stay (5 d vs 14.5 d, \( P < 0.001 \)). EUS-GE and open SGJ showed similar technical success (92.5% and 100%, respectively) and no significant differences were found for symptoms recurrence, reintervention rate, death within 30 d or 30 d readmission. Moreover, patients treated with EUS-GE could start chemotherapy earlier than those who underwent open SGJ. The cost-analysis of the two procedures showed that EUS-GE had lower overall costs when compared to open SGJ ($49387 vs $124192, \( P < 0.001 \))\cite{45}.

In conclusion, EUS-GE has been demonstrated to be non-inferior to open SGJ, but the EUS-guided procedure is not only less invasive, but it is also associated with a shorter delay to resumption of oral intake and chemotherapy, a shorter length of stay and reduced hospital costs.

A comparative multicenter retrospective study of EUS-GE and laparoscopic SGJ was performed in 2017 by Perez-Miranda et al\cite{32}; although there was no difference in technical success between the two procedures (100% for laparoscopic SGJ and 88% for EUS-GE), EUS-GE showed a significantly lower rate of AEs (12% vs 41%, \( P = 0.0386 \)). Moreover, the overall cost analysis showed that EUS-GE was less expensive than laparoscopic SGJ ($4515 vs $14778.80, respectively, \( P < 0.00001 \))\cite{45}.

**Comparison of EUS-GE with enteral stenting**

A comparison of EUS-GE and enteral SEMS placement was reported by Chen et al\cite{34} and Ge et al\cite{37}.

Technical and clinical success rates were not significantly different between EUS-GE and enteral SEMS placement according to the comparative multicenter retrospective study by Chen et al\cite{34}: Technical success was 86.7% for EUS-GE and 94.2% for SEMS placement, while clinical success was 83.3% and 67.3%, respectively. The two procedures showed a similar rate and severity of AEs (16.7% for EUS-GE vs 11.5% for
SEMS placement) and a similar post-procedure mean length of hospitalization. However, EUS-GE was associated with a significantly lower reintervention rate and symptom recurrence (4.0% vs 28.6%, \( P = 0.015 \))\(^{[34]}\).

In 2019, the retrospective comparative study by Ge et al\(^{[37]}\) confirmed that EUS-GE and enteral SEMS placement had a similar clinical success rate (100% in both groups), but EUS-GE not only showed a statistically significant better initial clinical success rate (95.8% vs 76.3%, \( P = 0.042 \)) and a lower rate of procedure failure requiring reintervention (32% vs 8.3%, \( P = 0.021 \)), but also a lower incidence of AEs compared to enteral SEMS placement (20.8% vs 40.2%)\(^{[37]}\).

Thus, EUS-GE was confirmed as a valid alternative option to enteral SEMS placement, achieving similar technical and clinical success rates, but with lower costs and a lower rate of AEs and reinterventions.

**CONCLUSION**

Although EUS-GE is a relatively recent technique and available literature is limited, it has been demonstrated to be a safe and effective technique for the palliative treatment of patients with malignant GOO. Moreover, considering the advances in chemotherapy regimens and the subsequent increased survival of these patients, it is essential to dispose of long-term palliative techniques.

EUS-GE has the advantage of being minimally invasive as an endoscopic procedure; weak evidence suggests that EUS-GE could provide long-lasting effects with lower recurrence rates\(^{[10,34]}\). Large high-quality evidence is still required in this field.

Moreover, a recent study suggests that EUS-GE has similar technical and clinical success rates compared to laparoscopic gastro-enterostomy. Interestingly, EUS-intervention seems to reduce the length of stay and incidence of AEs, suggesting possible advantages compared to surgery\(^{[46]}\). Finally, EUS-guided jejuno-jejunal anastomosis provides the opportunity to treat malignant GOO also in patients who have undergone gastrectomy.

The main limitation of EUS-GE is the position of the target small bowel loop; if the latter is too distant from the gastric wall, it may not be punctured under EUS-view. However, the above-described correct identification of the Treitz area from the mesenteric vessels could reduce this issue in patients with non-surgically modified anatomy. Moreover, a safe puncture is not feasible if the target loop is not distended enough; sometimes, despite a large amount of water injected into the small bowel, the target loop collapses due to peristaltic movements pushing water forward. The use of spasmolytic agents could represent a key factor in achieving this goal.

Currently, EUS-GE remains a technically difficult echoendoscopic procedure, whose outcome is strongly influenced by the endoscopist’s skills and LAMS design. For this reason, larger anastomotic tracts with minimal risk of obstruction or stent migration are desirable.

In conclusion, EUS-GE, enteral SEMS placement and SGJ all represent valid options for the palliative treatment of malignant GOO; the appropriate treatment should always be chosen according to the patient’s characteristics and comorbidities, in order to guarantee better prognostic outcomes and technical and clinical success.

**REFERENCES**

1. Abell TL, Bernstein RK, Cuts T, Farrugia G, Forster J, Hasler WL, McCallum RW, Olden KW, Parkman HP, Parrish CR, Parsicha PJ, Prather CM, Soffer EE, Twillman R, Vinik AI. Treatment of gastroparesis: a multidisciplinary clinical review. *Neurogastroenterol Motil* 2006; 18: 263-283 [PMID: 16553582 DOI: 10.1111/j.1365-2982.2006.00760.x]

2. ASGE Standards of Practice Committee, Fukami N, Anderson MA, Khan K, Harrison ME, Appalaneni V, Ben-Menchach T, Decker GA, Fanelli RD, Fisher L, Ikenberry SO, Jain R, Jue TL, Krisny ML, Maple JT, Sharaf RN, Dominitz JA. The role of endoscopy in gastroduodenal obstruction and gastroparesis. *Gastrointest Endosc* 2011; 74: 13-21 [PMID: 21704805 DOI: 10.1016/j.gie.2010.12.003]

3. Samad A, Khanzada TW, Shoukat I. Gastric outlet obstruction: change in etiology. *Pak J Surg* 2007; 23: 29-32 [DOI: 10.21699/pjsp.21.2.10]

4. Tendler DA. Malignant gastric outlet obstruction: bridging another divide. *Am J Gastroenterol* 2002; 97: 4-6 [PMID: 11808968 DOI: 10.1111/j.1572-0241.2002.05391.x]

5. Lisotti A, Ricci C, Serrani M, Calvanesi C, Sferrazza S, Brighi N, Casadei R, Fusaroli P. Contrast-enhanced endoscopic ultrasound for the differential diagnosis between benign and malignant lymph
Cominardi A et al. EUS-GA for malignant gastric obstruction

nodes: a meta-analysis. Endosc Int Open 2019; 7: E504-E513 [PMID: 31044153 DOI: 10.1055/a-0854-3785]

6 Shone DN, Nikoomanesh P, Smith-Meek MM, Bender JS. Malignancy is the most common cause of gastric outlet obstruction in the era of H2 blockers. Am J Gastroenterol 1995; 90: 1769-1770 [PMID: 7572891]

7 Chowdhury A, Dhali GK, Banerjee PK. Etiology of gastric outlet obstruction. Am J Gastroenterol 1996; 91: 1679 [PMID: 8759707]

8 Bell RCW. Management of regurgitation in patients with gastroesophageal reflux disease. Curr Opin Gastroenterol 2020; 36: 336-343 [PMID: 32487853 DOI: 10.1097/MOG.0000000000001169]

9 Muratori R, Lisotti A, Fusaroli P, Caponi A, Gibino G, Eusebi LH, Azzaroli F, Brighi N, Altimari G, Bazzoli F. Severe hyoperstensia as a predictor of mortality after percutaneous endoscopic gastrostomy (PEG) placement. Dig Liver Dis 2017; 49: 181-187 [PMID: 27876199 DOI: 10.1016/j.dld.2016.10.015]

Ahmed O, Lee JH, Thompson CC, Fauxs A. AGA Clinical Practice Update on the Optimal Management of the Malignant Alimentary Tract Obstruction: Expert Review. Clin Gastroenterol Hepatol 2021 [PMID: 33813072 DOI: 10.1016/j.cgh.2021.03.046]

Fritscher-Ravens A, Mosse CA, Mills TN, Mukherjee D, Park PO, Swain P. A through-the-scope device for suturing and tissue approximation under EUS control. Gastrointest Endosc 2002; 56: 737-742 [PMID: 12397289 DOI: 10.1016/s0016-5107(02)23984-9]

Teoh AYB, Dhir V, Kida M, Yasuda I, Jin ZD, Seo DW, Alnadi M, Ang TL, Hara K, Hilmi I, Itoi T, Laktatika S, Matsuda K, Pausawadi N, Puri R, Tang RS, Wang HP, Yang AM, Hawes R, Varadarajulu S, Yasuda K, Ho LKY. Consensus guidelines on the optimal management in interventional EUS procedures: results from the Asian EUS group RAND/UCLA expert panel. Gut 2018; 67: 1209-1228 [PMID: 29463641 DOI: 10.1136/gutjnl-2017-313441]

Lisotti A, Linguerri R, Bachiglie A, Cominardi A, Marocchi G, Fusaroli P. EUS-guided gallbladder drainage in high-risk surgical patients with acute cholecystitis: procedure outcomes and evaluation of mortality predictors. Surg Endosc 2021 [PMID: 33507383 DOI: 10.1007/s00464-021-08318-z]

Mussetto A, Fugazza A, Fuccio L, Triossi O, Repici A, Anderloni A. Current uses and outcomes of lumen-apposing metal stents. Ann Gastroenterol 2018; 31: 535-540 [PMID: 30174389 DOI: 10.20524/aog.2018.0287]

Itori T, Barson TH, Khashab MA, Tsuchiya T, Irani S, Dhir V, Bun Teoh AY. Technical review of endoscopic ultrasonography-guided gastroenterostomy in 2017. Dig Endosc 2017; 29: 495-502 [PMID: 28032663 DOI: 10.1111/den.12794]

Wang G, Liu X, Wang S, Ge N, Guo J, Sun S. Endoscopic Ultrasound-guided Gastroenterostomy: A Promising Alternative to Surgery. J Transl Int Med 2019; 7: 93-99 [PMID: 31637179 DOI: 10.2478/jtimit-2019-0021]

Rimbas M, Larghi A, Costamagna G. Endoscopic ultrasound-guided gastroenterostomy: Are we ready for prime time? Endosc Ultrasound 2017; 6: 235-240 [PMID: 28820145 DOI: 10.1111/eus.14717]

Khishab MA, Barson TH, Binmoeller KF, Itoi T. EUS-guided gastroenterostomy: a new promising technique in evolution. Gastrointest Endosc 2015; 81: 1234-1236 [PMID: 25864896 DOI: 10.1016/j.gie.2014.12.053]

Fusaroli P, Serrani M, Lisotti A, D’Ercole MC, Ceroni L, Caletti G. Performance of the forward-view echoendoscope for pancreaticobiliary examination in patients with status post-upper gastrointestinal surgery. Endosc Ultrasound 2015; 4: 336-341 [PMID: 26643703 DOI: 10.4103/2303-9027.170427]

Binmoeller KF, Shah JN. Endoscopic ultrasound-guided gastroenterostomy using novel tools designed for transluminal therapy: a porcine study. Endoscopy 2012; 44: 499-503 [PMID: 22531985 DOI: 10.1055/s-0032-1309382]

Itori S, Barson TH, Itori T, Khishab MA. Endoscopic gastroenterostomy: techniques and review. Curr Opin Gastroenterol 2017; 33: 320-329 [PMID: 28767501 DOI: 10.1097/MOG.0000000000000389]

Wang G, Liu X, Wang S, Ge N, Guo J, Sun S. Saline with methylene blue-assisted endoscopic ultrasound-guided gastrojejunostomy using a double-flared fully covered metal stent. Endoscopy 2018; 50: E17-E19 [PMID: 29069704 DOI: 10.1055/s-0043-119981]

Itori T, Ikawa F, Uraoka T, Gotoda T, Hori J, Goto O, Moriyasu F, Moon JH, Kitagawa Y, Yahagi N. Novel EUS-guided gastrojejunostomy technique using a new double-balloon enteric tube and lumen-apposing metal stent (with videos). Gastrointest Endosc 2013; 78: 934-939 [PMID: 24237949 DOI: 10.1016/j.gie.2013.09.025]

Itori S, Tari T, Barson TH, Khishab MA. EUS-guided gastroenterostomy: techniques from East to West. VideoGIE 2020; 5: 48-50 [PMID: 32051906 DOI: 10.1016/j.vgie.2019.10.007]

Kawakubo K, Kuwatan M, Kato S, Sugiura R, Sano I, Sakamoto N. Direct puncture of the ampulla as a modified Endoscopic ultrasound-guided rendezvous technique. Endosc Ultrasound 2018; 7: 133-134 [PMID: 28836519 DOI: 10.1016/j.eus.2013.09.025]

Patel A, Sethi A. Endoscopic management of malignant gastric outlet obstruction. Tech Innov Gastroent Endosc 2020; 22: 220-224 [DOI: 10.1016/j.tgine.2020.03.011]

Troncone E, Fugazza A, Cappello A, Del Vecchio Blanco G, Monteleone G, Repici A, Teoh AYB, Anderloni A. Malignant gastric outlet obstruction: Which is the best therapeutic option? World J Gastroenterol 2020; 26: 1847-1860 [PMID: 32390697 DOI: 10.3748/wjg.v26.i16.1847]

Khishab MA, Kumbhari V, Grimm IS, Ngaruenghong S, Aguila G, El Zein M, Kallou AN, Barson TH. EUS-guided gastroenterostomy: the first U.S. clinical experience with video). Gastrointest
Cominardi A et al. EUS-GA for malignant gastric obstruction

Endosc 2015; 82: 932-938 [PMID: 26215646 DOI: 10.1016/j.gie.2015.06.017]

Tyberg A, Perez-Miranda M, Sanchez-Ocaña R, Peñas I, de la Serna C, Shah J, Bimmoeller K, Gaidhane M, Grimm I, Baron T, Kahaleh M. Endoscopic ultrasound-guided gastrojejunostomy with a lumen-apposing metal stent: a multicenter, international experience. Endosc Int Open 2016; 4: E276-E281 [PMID: 27004243 DOI: 10.1055/s-0042-171789]

Itoli T, Ishii K, Ikeuchi N, Sofuni A, Gotoda T, Moriyasu F, Dhir V, Teoh AY, Bimmoeller KF. Prospective evaluation of endoscopic ultrasonography-guided double-balloon-occluded gastrojejunostomy bypass (EPASS) for malignant gastric outlet obstruction. Gut 2016; 65: 193-195 [PMID: 26282674 DOI: 10.1136/gutjnl-2015-310348]

Brewer Gutierrez OI, Nieto J, Irani S, James T, Pieratti Bueno R, Chen YI, Buhkri M, Sanaei O, Kumbhari V, Singh VK, Ngamruengphong S, Baron TH, Khاشah MA. Double endoscopic bypass for gastric outlet obstruction and biliary obstruction. Endosc Int Open 2017; 5: E893-E899 [PMID: 28924596 DOI: 10.1055/s-0043-115386]

Perez-Miranda M, Tyberg A, Polhetto D, Toscano E, Gaidhane M, Desai AP, Kunta NA, Fayad L, Nieto J, Barthet M, Shah R, Brauer BC, Shairahto RZ, Kahaleh M. EUS-guided Gastrojejunostomy Versus Laparoscopic Gastrojejunostomy: An International Collaborative Study. J Clin Gastroenterol 2017; 51: 896-899 [PMID: 28697151 DOI: 10.1097/MCG.0000000000000887]

Khashab MA, Buhkri M, Baron TH, Nieto J, El Zein M, Chen YI, Chavez YH, Ngamruengphong S, Alawad AS, Kumbhari V, Itoli T. International multicenter comparative trial of endoscopic ultrasonography-guided gastroenterostomy versus surgical gastrojejunostomy for the treatment of malignant gastric outlet obstruction. Endosc Int Open 2017; 5: E275-E281 [PMID: 28382326 DOI: 10.1055/s-0043-161692]

Chen YI, Itoli T, Baron TH, Nieto J, Haino-Chavez Y, Grimm IS, Ismail A, Ngamruengphong S, Buhkri M, Hajiyeva G, Alawad AS, Kumbhari V, Khاشah MA. EUS-guided gastroenterostomy is comparable to endoscopic stenting with fewer re-interventions for gastric outlet obstruction. Surg Endosc 2017; 31: 2946-2952 [PMID: 27834024 DOI: 10.1007/s00464-016-5311-1]

Chen YI, Kundu R, Storm AC, Aridi HD, Thompson CC, Nieto J, James T, Irani S, Buhkri M, Gutierrez OB, Agarwal A, Fayad L, Moran R, Alammar N, Sanaei O, Canto MI, Singh VK, Baron TH, Khاشah MA. EUS-guided gastroenterostomy: a multicenter study comparing the direct and balloon-assisted techniques. Gastrointest Endosc 2018; 87: 1215-1221 [PMID: 28750837 DOI: 10.1016/j.gie.2017.07.030]

Urrecham A, JL Khor C, Ka Chin Y, Assokkumar R, Tan D. IDDF2018-ABS-0171 Eus-guided gastrojejunostomy using a lumen apposing metal stent in patients with symptomatic gastric outlet obstruction. Gut 2018; 67: A64-A65 [DOI: 10.1136/gutjnl-2018-iddfabstracts.138]

Ge PS, Young JY, Dong W, Thompson CC. EUS-guided gastroenterostomy versus enteral stent placement for palliation of malignant gastric outlet obstruction. Surg Endosc 2019; 33: 3404-3411 [PMID: 30725254 DOI: 10.1007/s00464-018-06636-3]

Kersdirtirichairat T, Irani S, Yang J, Brewer Gutierrez OI, Moran R, Sanaei O, Dbouk M, Kumbhari V, Singh VK, Kalioo AN, Khشاشة MA. Durability and long-term outcomes of direct EUS-guided gastroenterostomy using lumen-apposing metal stents for gastric outlet obstruction. Endosc Int Open 2019; 7: E144-E150 [PMID: 30705945 DOI: 10.1136/gutjnl-2018-iddfabstracts.3]

Xu G, Shen Y, Lv Y, Zhou X, Li W, Wang Y, Hassan S, Wang L, Zou X. Safety and efficacy of endoscopic ultrasound-guided gastroenterostomy using double balloon occlusion method: a clinical retrospective study in 36 patients with malignant gastric outlet obstruction. Endosc Int Open 2020; 8: E1690-E1697 [PMID: 33140026 DOI: 10.1055/a-1221-9656]

Hu J, Wang G, Zhang K, Ge N, Wang S, Guo J, Liu X, Sun S. Retrieval anchor-assisted endoscopic ultrasound-guided gastroenterostomy for gastric outlet obstruction. Scand J Gastroenterol 2020; 55: 865-868 [PMID: 32643452 DOI: 10.1080/00365521.2020.1778077]

Kastelijin JB, Moons LMG, Garcia-Alonso FJ, Pérez-Miranda M, Masaryk V, Will U, Tarantino I, van Dulllemen HM, Bijlsma R, Polev JW, Schwartz MP, Vleggaar FP. Patency of endoscopic ultrasound-guided gastroenterostomy in the treatment of malignant gastric outlet obstruction. Endosc Int Open 2020; 8: E1194-E1201 [PMID: 32904815 DOI: 10.1055/a-1214-5659]

Wannhoff A, Ruh N, Meier B, Riecken B, Caca K. Endoscopic gastrointestinal anastomoses with lumen-apposing metal stents: predictors of technical success. Surg Endosc 2021; 35: 1997-2004 [PMID: 32358692 DOI: 10.1007/s00464-020-07594-3]

Khashab M, Alawad AS, Shin EJ, Kim K, Bourdel N, Singh VK, Lennon AM, Hutfless S, Shairahto RZ, Amatteau S, Okolo PI, Makary MA, Wolfgang C, Canto MI, Kallooo AN. Enteral stenting versus gastrojejunostomy for palliation of malignant gastric outlet obstruction. Surg Endosc 2013; 27: 2068-2075 [PMID: 23299137 DOI: 10.1007/s00464-012-2712-7]

Jeurnink SM, Steyerberg EW, van Hooft JE, van Eijck CH, Schwartz MP, Vleggaar FP, Kuipers EJ, Siersenza PD. Dutch SUSTENT Study Group. Surgical gastrojejunostomy or endoscopic stent placement for the palliation of malignant gastric outlet obstruction (SUSTENT study): a multicenter randomized trial. Gastrointest Endosc 2010; 71: 490-499 [PMID: 20003966 DOI: 10.1016/j.gie.2009.09.042]

Kouanda A, Bimmoeller K, Hamerski C, Nett A, Bernabe J, Watson R. Endoscopic ultrasound-guided gastroenterostomy versus open surgical gastrojejunostomy: clinical outcomes and cost effectiveness analysis. Surg Endosc 2021 [PMID: 33479837 DOI: 10.1007/s00464-020-08221-z]

Bronswijk M, Vanella G, van Malestein H, Laleman W, Jaekers J, Topal B, Daams F, Besselinck MG, Arcidiacono PG, Voermans RP, Fockens P, Larghi A, van Wanrooij RLJ, Van der Merwe SW.
Laparoscopic versus EUS-guided gastroenterostomy for gastric outlet obstruction: an international multicenter propensity score-matched comparison (with video). *Gastrointest Endosc* 2021 [PMID: 33852900 DOI: 10.1016/j.gie.2021.04.006]
