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Endoscopic Ultrasound-Guided Gastroenterostomy vs Duodenal Stenting vs surgical Gastrojejunostomy for the Treatment of Malignant Gastric Outlet Obstruction; Review Article

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ABSTRACT

Background: Gastric outlet obstruction (GOO) is a clinical condition caused by a mechanical blockage of the upper digestive tract at the level of the distal stomach, pylorus or duodenum. Often encountered in the context of advanced malignancy, it is associated with debilitating symptoms including intractable nausea and vomiting, inability to tolerate oral nutrition, abdominal pain and decreased quality of life.

Objective: The aim of the review is to evaluate endoscopic ultrasound-guided gastroenterostomy vs duodenal stenting vs surgical gastrojejunostomy for the treatment of malignant gastric outlet obstruction.

Methods: PubMed, Google scholar and Science direct were searched using keywords. The author also screened references from the relevant literature, including all the identified studies and reviews, only the most recent or complete studies were included, which were published between 1992 and 2022. Documents in a language apart from English have been excluded as sources for interpretation was not found. Papers apart from main scientific studies had been excluded: documents unavailable as total written text, conversation, conference abstract papers and dissertations.

Conclusion: Ultrasound-guided gastroenterostomy (EUS-GE) is emerging as a potential treatment option for GOO. When compared to duodenal stenting and surgical gastrojejunostomy (SGJ), EUS-GE may provide a longer lasting treatment for GOO. In the hands of experts, EUS-GE appears to be similar in efficacy and safety when compared to surgery; yet it may be less costly.

Keywords: Duodenal Stenting, Endoscopic Ultrasound-Guided Gastroenterostomy, Malignant Gastric Outlet Obstruction, Surgical gastrojejunostomy.

INTRODUCTION

Gastric outlet obstruction (GOO) among patients with malignant neoplasms within or adjacent to the gastric antrum, duodenum, or pancreatobiliary tract has become increasingly encountered in clinical practice and is associated with significant morbidity and decreased quality of life [1]. Obstructive symptoms may present as intractable nausea or vomiting, abdominal discomfort, fullness, early satiety, or dehydration along with multiple electrolyte derangements. Given these associated symptoms and a significant decrease in quality of life, effective treatments aimed at palliation remain critically important [2].

Traditionally, the palliative treatment of malignant GOO was relegated to the operating room—only able to be achieved with surgical gastrojejunostomy (SGJ), which aimed to provide a long-term luminal bypass of the area of obstruction [3]. However, since the 1990s [4], endoscopic placement of a self-expanding metal stent (SEMS) has been shown to be an effective treatment strategy and an increasingly utilized alternative to SGJ. This endoscopic strategy involving duodenal stent (DS) placement possesses some advantages compared to a surgical approach, including less invasiveness, decreased procedure-associated morbidity, and shorter hospital stay. Yet, despite these advantages, DS placement has been associated with higher rates of reintervention due to stent obstruction and migration—especially among patients with life expectancies greater than 6–12 months. Given this increased rate of reintervention and concern for DS migration, as well as the invasiveness of SGJ, alternative endoscopic strategies to improve the quality of life for these patients have been employed [5,6].

Within the last 6 years, endoscopic ultrasound-guided gastroenterostomy (EUS-GE) with the placement of a lumen-apposing metal stent (LAMS) has become an increasingly adopted approach for the management of malignant GOO. This strategy, similar to SGJ, aims to bypass the site of gastrointestinal obstruction and reduce the associated morbidity and complication rates associated with a traditional surgical strategy [7]. The EUS-GE procedure involves the creation of an anastomosis between the stomach and an adjacent duodenal or jejunal loop via the placement of an anastomotic LAMS. The goal, unlike DS placement, is to bypass the gastric drainage course from the obstructive lesion to the small intestine distal to the site of obstruction—potentially decreasing the risk of tumor ingrowth. Furthermore, as the LAMS bypasses the site of obstruction, there is no risk of stent-related biliary obstruction. Hence, a presumed increase in clinical success and a decreased need for reintervention may be expected [8].

The aim of the review to evaluate endoscopic ultrasound-guided gastroenterostomy vs duodenal stenting vs surgical gastrojejunostomy for the treatment of malignant gastric outlet obstruction.

Surgical gastrojejunostomy, duodenal stenting, and endoscopic ultrasound (EUS)-guided gastroenterostomy are the 3 methods currently available

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to palliate or treat patients with malignant gastric outlet obstruction.

Endoscopic ultrasonography guided gastroenterostomy techniques:

EUS-GE is an interventional EUS technique, in which an anastomosis of the stomach and enteric wall is created. EUS-GE creates a shortcut in the food pathway, similar to a surgical bypass, which is expected to lead to a longer stent patency than conventional EES, owing to its shorter stent length and the fact that it is fully covered; besides, EUS-GE is theoretically thought to be less invasive than SGJ [9].

The EUS-GE technique was developed through various clinical trials and animal experiments, and at present there are three main techniques: direct EUS-GE, device-assisted EUS-GE, and EUS-guided double balloon-occluded gastrojejunostomy bypass (EPASS).

Technique 1: Direct EUS-GE: [10-21]

Step 1: EUS is used to carefully identify the duodenum or jejunum adjacent to the gastric body for safe puncturing. However, the intestinal loop is often not clearly visualized by EUS, owing to an insufficiently distended intestine or too much intestinal gas. In such cases, a large amount of liquid (approximately 500 mL) should be injected before visualization by EUS. It is desirable to use saline and contrast medium with/without methylene blue rather than water to prevent hyponatremia owing to the absorption of a large amount of water, and to confirm that puncture and stent placement are properly performed at the intended site in a subsequent step. The intestine can be filled with liquid in two ways: injection using a 22-gauge needle as a test puncture just before direct puncture with a 19-guage needle; or use of a preloaded gastrointestinal endoscope and the devices of endoscopic retrograde cholangiopancreatography (ERCP) to fill the intestine from behind the obstruction, or if possible, across the obstruction before insertion of the EUS endoscope.

Step 2: Following confirmation of the distended intestine filled with liquid containing contrast medium under EUS and fluoroscopy, EUS-guided needle puncture using a 19-gauge fine needle is performed. The enterogram, with injection of contrast medium through the needle or aspiration of the blue liquid from the needle, confirms that the target intestine can be correctly punctured to avoid unintentionally puncturing the colon.

Step 3: A 0.025- or 0.035-inch stiff guide wire (GW) is placed downstream of the jejunum through the needle. The needle tract is dilated using a balloon or electrocautery dilator following deployment of the LAMS over the GW.

The aforementioned technique is a classical GW-based technique that has been used frequently in previous studies. However, the technique has become simpler owing to the application of EC-LAMS, which has enabled one step procedure including puncturing, dilating anastomosis and deployment of the stent, without GW guidance.

Technique 2: Device-assisted EUS-GE (balloon catheter, nasobiliary tube, and ultraslim endoscope) [10-18]

The device-assisted EUS-GE use a device, such as a balloon catheter, a thin nasobiliary tube, or an ultraslim endoscope, to reliably identify the target small intestine. Among them, the balloon-assisted method, which is often favored and used in previous reports, is described below.

Balloon-assisted technique

Step 1: A 0.025- or 0.035-inch stiff GW is placed downstream of the jejunum beyond the obstruction under gastrointestinal endoscope guidance.

Step 2: After the endoscope is withdrawn, a dilation balloon or a stone extraction balloon catheter is advanced over the wire into the jejunum under fluoroscopic guidance.

Step 3: The inflated balloon is punctured using a 19-gauge fine needle under EUS guidance. Another 0.025- or 0.035-inch stiff GW is placed downstream of the jejunum through the needle.

Step 4: The LAMS is finally deployed over the GW after dilation of the needle tract, as described above.

Technique 3: Endoscopic ultrasonography-guided double balloon-occluded gastrojejunostomy bypass [10-17]

Developed the EPASS technique based on the results of an animal study. Owing to our various experimental results and clinical experience, currently perform a procedure involving a special double-balloon enteric tube. This tube has two balloons which enable wedge the target jejunum, and an independent supply ports, which enables liquid irrigation into the space between the two balloons.

Step 1: A standard gastroenteroscope, with an overtube for a single balloon enteroscope, is advanced behind the stenotic site (pylorus of the stomach or duodenum). The overtube is used to avoid looping of the special double balloon enteric tube in the fornix of the stomach, and facilitate the tube passage through the pyloric-duodenal stenosis. A stiff 0.025- or 0.035-inch GW is advanced into the jejunum as far as possible using an ERCP catheter through the working channel of the scope.

Step 2: After withdrawal of the endoscope, leaving the overtube and the GW in place, the special balloon tube is perorally inserted over the GW by pulling back the GW, and is placed where the jejunum intended for stent placement is positioned, at the center of the two balloons under fluoroscopic guidance. A small amount of contrast medium (approximately 5 mL for each balloon) followed by saline (approximately 40–50 mL for each balloon) is injected into the two balloons simultaneously in order to prevent the balloons from moving under fluoroscopy. The injection of saline

should be continued until each balloon transforms from a spherical shape into a “barrel shape”.

Step 3: After gently removing the overtube from the mouth, the EUS endoscope is advanced into the stomach, and the target jejunum between the two balloons is visualized by EUS after irrigation of tap water or saline (100–200 mL) with contrast medium (approximately 20 mL). The irrigation should be continued until sufficient distension of the target jejunum is observed on the EUS image and fluoroscopy.

Step 4: The AXIOS-EC delivery system is directly advanced from the gastric wall into the target jejunum while applying an electrocurrent of cut mode (100 W, 550 Vp) provided by the electric generator. Finally, the AXIOS-EC is deployed in one step using the technique of intrachannel deployment, which is used for proximal flange deployment of the LAMS in the working channel of the endoscope; this technique may be helpful to prevent misdeployment of the LAMS into the abdominal cavity owing to excessive pulling back of the delivery system during the deployment.

Duodenal Stenting:

Palliative procedures for patients with malignant gastroduodenal obstruction must be readily available, have a rapid onset of action, and be well tolerated by a patient with terminal cancer. Laparoscopic gastroenterostomy and insertion of self-expanding stents are emerging as the current methods of choice. An increasing number of dedicated enteral stents with different properties are now available. These can be placed under fluoroscopic guidance alone or with the help of an endoscope. Endoscopic placement has several advantages but requires good collaboration between the endoscopists and the radiology department. Appropriate imaging and work-up of each case at multidisciplinary meetings is required. Coexisting biliary obstruction may be dealt with endoscopically, but frequently requires percutaneous biliary stent placement prior to duodenal stenting. Reintervention is required in up to 25% of patients, usually due to stent occlusion by further tumor growth [22,23].

Anecdotal evidence and some retrospective studies suggest that stenting has a lower morbidity and a quicker recovery rate than surgery, but unfortunately the evidence base regarding gastroduodenal stenting is currently still of low grade. There is a distinct lack of controlled studies comparing the standard treatment of surgical gastroenterostomy with stenting or even with the newer surgical alternative of laparoscopic gastroenterostomy, which is superseding open gastroenterostomy [24].

Surgeons are of the view that gastroenterostomy is preferable to stenting, possibly because they have operated on patients whose stents have not functioned adequately. Radiologists will just as often point to the fact that they regularly reimage patients who have had an unsuccessful gastroenterostomy. In the absence of Grade A research-based evidence, perhaps a consideration of first principles (what is best for the patient) is best. Most patients develop gastroduodenal obstruction in the last few months of their lives. Many will be debilitated by the presence of metastatic malignancy and may take time to recover from a surgical procedure. There will be a few days of fasting following a surgical gastroenterostomy, a time when continued immobility and intravenous infusion are required. After gastroduodenal stenting a patient can usually drink immediately, eat within 24 hours, and leave the hospital within 2 to 3 days. These facts are likely to mandate in favor of gastroduodenal stenting, even if stent dysfunction leads to a higher reintervention rate in stented compared with operated patients. The reduced time spent in the hospital, however, is also reflected in a significantly reduced cost of the stenting procedure when compared with surgical bypass, despite the relatively high cost of the stent itself [25,26].

Pain and other complications after gastroduodenal stenting are not common and usually patients can start drinking clear fluids as soon as they have recovered from sedation. Provided there is no ill effect from this, free fluids and a light soft liquid diet can be given. If the patient has been vomiting significantly for some time before stent placement, it can be difficult to regain the confidence that eating can take place without the risk of vomiting. A steady progressive increase in intake and more solid texture of food should be encouraged, with constant reassurance by the patient's caregivers. Normally, patients can be discharged 24 to 48 hours following stent placement, provided they have immediate access to assistance should problems occur. In the absence of an obvious clinical complication there is no advantage to undertaking a routine contrast meal examination following stent placement [26].

Surgical gastrojejunostomy:

Gastrojejunostomy is a surgical procedure in which an anastomosis is created between the stomach and the proximal loop of the jejunum. This is usually done either for the purpose of draining the contents of the stomach or to provide a bypass for the gastric contents. Gastrojejunostomy can be done via either an open or a laparoscopic approach. Percutaneous gastrojejunostomy may be performed, in which a tube is placed through the abdominal wall into the stomach and then through the duodenum into the jejunum [27,28].

Gastric outlet obstruction (GOO) is the most common indication for gastrojejunostomy. It may occur in the following clinical scenarios. For chronic duodenal or prepyloric ulcer with pyloric scarring, one of the methods for relieving the obstruction is to perform a gastrojejunostomy along with truncal vagotomy to decrease acid production [28]. Another alternative method is to perform vagotomy and antrectomy with the Billroth II reconstruction. Gastrojejunostomy is indicated after gastrectomy for chronic gastric ulcer refractory to medical therapy or when there is suspicion

of malignancy in the gastric ulcer. Corrosive injury of stomach with GOO is common after acid ingestion. Because of pylorospasm following corrosive ingestion, prepyloric gastric strictures are common. An alternative procedure is Billroth I gastrectomy. For resectable carcinoma of the antropyloric region, gastrojejunostomy is performed after radical subtotal gastrectomy to maintain continuity of the gastrointestinal (GI) tract. For nonresectable malignancies of the stomach, duodenum, or pancreatic head with GOO, gastrojejunostomy is indicated as palliative treatment [29].

Gastroparesis may be seen in patients who have diabetes or who have undergone gastric surgery. Cases unresponsive to medical management and percutaneous gastrostomy may require a subtotal gastrectomy with gastrojejunostomy to relieve symptoms [30].

At present, laparoscopic gastrojejunostomy is preferred to open gastrojejunostomy whenever possible and feasible, especially in a palliative setting for advanced malignancy. Several studies have evaluated the feasibility and advantages of single-incision laparoscopic surgery (SILS) as compared with conventional multiport techniques for gastrectomy with gastrojejunostomy [31]. Better cosmesis, decreased postoperative pain, and earlier recovery have reported. Reports have described hybrid techniques for placing gastrojejunostomy tubes in patients with distal esophageal stents in situ. Laparoscopic gastrojejunostomy tubes are inserted under endoscopic guidance so as to cause minimal manipulation of the stent itself [32].

In a systematic review and meta-analysis of 12 studies (N = 285), **Iqbal *et al.*** [32] evaluated the safety and efficacy of endoscopic ultrasonography (EUS)-guided gastroenterostomy (EUS-GE) in patients with gastric outlet obstruction (GOO). The technical success rate was 92%, and the clinical success rate was 90%. The adverse event rate was 12%, and the symptom recurrence rate was 9%.

In a meta-analysis of 12 studies (N = 290), **Antonelli *et al.*** [33] assessed the outcomes of EUS-guided gastroenteric anastomosis (EUS-GEA). GOO was the primary indication for the procedure (62.4% of patients). The most commonly used technique was direct puncture (68.2%), for which the technical success rate was 93.5% and the clinical success rate was 90.1%. Adverse events were minimal and occurred in 11.7% of the patients.

Comparison of the 3 methods:

Surgical gastrojejunostomy is a routine procedure for general or pancreaticobiliary surgeons. Duodenal stenting can be performed by general gastroenterologists who are trained in enteral stenting, the use of guidewires, and fluoroscopy, but in general, it is best performed by therapeutic endoscopists. EUS-guided gastroenterostomy, which is a more challenging procedure than duodenal stenting, is performed by therapeutic endoscopists who have significant expertise in pancreaticobiliary endoscopy and, specifically, with interventional EUS [28].

The technical success rate for both procedures is above 90%, and approximately 80% to 90% of patients undergoing either procedure achieve clinical success. Patients who do not achieve clinical success are typically those who experience technical failure (e.g. the stent could not be placed), those with advanced malignancy or gastroparesis related to malignancy, or those who have significant peritoneal carcinomatosis or metastatic deposits causing more distal obstruction [29].

Recurrent obstruction with EUS-guided gastroenterostomy is rare and has been observed in only 4% of patients up to 1 year of follow-up. However, symptom recurrence with duodenal stenting is seen in the majority of patients who survive longer than 6 to 12 months, as the lifespan of these stents is approximately 3 months. The reason for this difference is that duodenal stenting entails placement of an uncovered stent across the malignant stricture, which carries a high risk for tumor ingrowth and overgrowth within a few months following insertion. In contrast, EUS-guided gastroenterostomy involves placement of a fully covered stent during a bypass procedure, in which the stent is placed away from the tumor, eliminating the risk of tumor ingrowth and overgrowth [34].

Passage of a guidewire across the stricture is a prerequisite for duodenal stenting. Sometimes, the guidewire cannot be passed due to high-grade obstruction. In these instances, endoscopists can use endoscopy and fluoroscopy, injection of contrast, different guidewires, and, occasionally, endoscopic retrograde cholangiopancreatography cannulas and catheters to advance the guidewire across the stricture. In patients with a more distal small bowel obstruction, use of enteroscopes or colonoscopes is required. For EUS-guided gastroenterostomy, technical failure can be avoided with adequate training in interventional EUS, an understanding of the intricacies of the procedure, and extensive experience with placement of a lumen-apposing metal stent [26].

Importantly, endoscopists should ensure adequate filling and distention of the small bowel with fluid and contrast so that the loop of small bowel distal to the obstruction is apposed to the stomach. A lumen-apposing metal stent can then be placed. During stent placement and puncturing of the small bowel, endoscopists should use a cautery-tipped lumen-apposing metal stent rather than a guidewire, as advancement of the guidewire can push the small bowel away from the stomach and make the procedure risky or impossible. Endoscopists should also avoid jabbing, such as when performing fine-needle aspiration. Instead, access to the small bowel is achieved with a slow advancement of the catheter using the cautery tip [30].

The most reported adverse event for EUS-guided gastroenterostomy is stent misdeployment, which

typically occurs during the initial learning curve. For the most part, this risk can be avoided by following the tips mentioned previously. Perforation, leakage, bleeding, stent obstruction due to food impaction, and peritonitis have all been reported with EUS-guided gastroenterostomy as well [35].

The main adverse event associated with placing a duodenal stent is perforation. Although perforation is rare, endoscopists are advised to avoid placement of the flanges around luminal angulations and bends. Additionally, the stricture should be tight enough to hold the stent in place; otherwise, the stent may migrate and put the patient at risk for small bowel perforation. Recurrent gastric outlet obstruction due to tumor ingrowth or food impaction is another major concern with this procedure. Of note, biliary obstruction and pancreatitis owing to a duodenal stent impinging on the papilla are rare adverse events that may occur with placement of duodenal stents across the ampulla [28].

Typically, patients with malignant gastric outlet obstruction are inpatients who are admitted with signs and symptoms of the disease and an inability to tolerate oral intake. When stents are placed, these patients can begin eating the following day and, thus, can be discharged after 1 day. In general, patients are started on a liquid diet and then advanced to a low-fiber, low-residue diet 24 hours after stent placement. These procedures do not affect survival. Rather, survival is dictated by the stage of malignancy that the patient has. Patients with late-stage pancreaticobiliary malignancies usually have a length of survival of a few months [35].

In patients whose survival is expected to be fewer than 3 months, placement of a duodenal stent is preferred over EUS-guided gastroenterostomy, as patients will likely not experience the benefit of a bypass procedure. Duodenal stenting is also the more straightforward and technically easier procedure for this patient population. EUS-guided gastroenterostomy can be risky in patients who have perigastric varices (resulting from pancreaticobiliary tumors) that can be detected on preprocedural imaging. In addition, EUS-guided gastroenterostomy is best avoided in patients with massive ascites, usually due to peritoneal carcinomatosis, as this procedure can lead to peritonitis, leakage, or stent or anastomotic dehiscence [34].

The main priority of research is to standardize EUS-guided gastroenterostomy and determine the best technique (e.g., direct vs balloon-assisted), as currently the procedure is technically difficult to perform. Studies are needed comparing EUS-guided gastroenterostomy to duodenal stenting [35].

The technical success rates between DS and EUS-GE were comparable, EUS-GE was associated with improved clinical success and lower rates of serious adverse events (SAEs). Furthermore, EUS-GE demonstrated a significantly lower rate of reintervention and stent obstruction. Despite lower rates of technical success when EUS-GE was compared to SGJ, EUS-GE was associated with reduced length of hospital stay and no differences in all other evaluated outcomes such as clinical success, SAEs, need for reintervention, and 30-day all-cause mortality [34].

Despite these promising results to support the use of EUS-GE, it is worth mentioning that laparoscopic gastrojejunostomy has traditionally been considered the gold standard and provides more durable luminal patency compared to DS placement. As such, SGJ may continue to be indicated for patients with a life expectancy greater than 2 months, especially in centers with limited experience with EUS-GE [35].

CONCLUSION

EUS-GE is emerging as a potential treatment option for GOO. When compared to duodenal stenting and SGJ, EUS-GE may provide a longer lasting treatment for GOO. In the hands of experts, EUS-GE appears to be similar in efficacy and safety when compared to surgery; yet it may be less costly.

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