Hybrid Gastroenterostomy Using A Lumen-Apposing Metal Stent: A Case Report Focusing On Misdeployment.

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Case report

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Abstract

Background

Gastric outlet obstruction can result from several benign and malignant diseases, in particular gastric, duodenal or pancreatic tumors. Historically, surgical gastroenterostomy and enteral endoscopic stenting have represented effective therapeutic options. However, surgery is burdened by high complication and mortality rates, while endoscopic stenting demonstrates unsatisfactory patency after six months. Lately, endoscopic ultrasound-guided gastroenterostomy using lumen apposing metal stent (LAMS) is spreading in order to improve the outcome of this condition, but still complication rate remains not negligible. Our case report shows a hybrid (endoscopic and surgical) technique for LAMS deployment, reviews current literature on potential complications and demonstrates problem solving strategies.

Case presentation

A 60 year-old male patient, affected by metastatic pancreatic adenocarcinoma, developed gastric outlet obstruction due to a duodenal bulb stenosis. Endoscopic ultrasound-guided gastroenterostomy was performed in an operating room, but the first flange of LAMS was misdeployed opening in the epiploon retrocavity. Immediate diagnostic laparoscopy was carried out, LAMS was removed endoscopically and the first jejunal loop was identified by laparoscopy. The jejunal loop was placed near the stomach, allowing for endoscopic release of a second LAMS through the previous fistulous gastric tract, performing a laparoscopy-assisted gastroenterostomy.

Conclusions

This hybrid technique may offer an innovative strategy to overcome misdeployment of LAMS, which represents the most troubling complication of endoscopic ultrasound-guided approach. There are several significant advantages, such as the easy visualization of target loop and cystostome penetration, nevertheless the ability to considerably shorten overall procedure time.

Background

Gastric outlet obstruction (GOO) is a potential complication in malignancies of the upper gastrointestinal tract including gastric, duodenal, pancreatic or biliary tumors [1]. Conventionally, surgical gastroenterostomy (SGE) and endoscopic enteral stenting (ES) are common treatment options. However, SGE has higher complication and mortality rates than ES, which on the other hand demonstrates unsatisfactory patency in patients with life expectancy higher than 6 months [2, 3]. In recent years, endoscopic ultrasound-guided gastroenterostomy (EUS-GE) using lumen apposing metal stent (LAMS) has been introduced in order to overcome these limitations. Nevertheless, technical success is still suboptimal (around 90%) and complication rates is not negligible (9–17%) [4]. Alongside our case report, showing a hybrid technique for LAMS deployment, we lay focus on recent literature of complications in surgical and endoscopic gastrointestinal anastomosis.

Case Presentation

We report the case of a 60 year-old male patient affected by metastatic pancreatic adenocarcinoma who developed symptoms related to GOO. During esophagogastroduodenoscopy a duodenal bulb stenosis was diagnosed. Therefore, decision was taken to perform EUS-GE using an electrocautery enhanced (EC)-LAMS 15x10 mm (Hot-Axios, Boston Scientific Corp., Marlborough, Massachusetts, USA), which was performed under general anesthesia in the operating theatre.

For target loop identification, endoscopic antegrade freehand technique was used [5]: over a guidewire, a nasocystic tube was passed over the stricture and the jejunum was filled with contrast and methylene blue; under EUS-guidance, the target loop was identified and punctured using a 19 gauge needle, with aspiration of methylene blue confirming correct needle position in the jejunum. While maintaining the target loop in EUS-view, the EC-LAMS was deployed. However, LAMS release was complicated by misdeployment of the first flange which opened in the epiploon retrocavity, probably due to lack of penetration by the EC-LAMS cystotome into the jejunum.

As we performed the endoscopic procedure in an operating room, immediate exploratory laparoscopy was possible. Three laparoscopic trocars were placed (one 10mm supraumbilical trocar and two 5mm trocars in the right and left upper quadrants), the gastrocolic ligament was sectioned and the epiploon retrocavity was explored. The first flange of the stent was found open outside of the posterior gastric wall (Fig. 1), leaning against the transverse mesocolon. Jejunal and transvers colonic perforations were excluded.

EC-LAMS was removed endoscopically. Then, laparoscopically, the first jejunal loop after the ligament of Treitz was identified and placed near the stomach. With the help of laparoscopic guidance, we endoscopically released a second EC-LAMS 15x10 mm through the previous fistulous gastric tract, performing a laparoscopy-assisted gastroenterostomy (GE). A secure apposition of the LAMS was finally obtained, correct deployment was confirmed both endoscopically and laparoscopically (Fig. 2).

Procedure time for laparoscopy was 95 minutes and EUS guided anastomosis via LAMS deployment needed 6 minutes. No intra-procedural adverse events occurred (Video).

72 hours after the procedure oral nutrition was initiated and the patient was discharged on postoperative day 7.

Discussion And Conclusions
Establishing gastrointestinal anastomoses is a relatively new endoscopic procedure implemented in 2012 by Binmoeller and Itoi et al using covered double-anchored metal stents placed via endoscopic ultrasound guidance [6, 7]. It rapidly achieved acceptance as a valued alternative for SGE as it was proven to be effective, less invasive and associated with less procedure related morbidity and mortality. Since 2012, foremost case reports or small case series have been published. Recently, two randomized controlled trials comparing endoscopic vs. surgical GE were published [5, 8, 9]. Patients with GOO in which GE becomes necessary are fragile and prone to high morbidity and mortality due to underlying diseases. Therefore, it is necessary to reduce procedure related mortality as effectively as possible. Use of LAMS for EUS-GE is still considered an off label use by the American Society of Gastrointestinal Endoscopy [10]. Technical and clinical success rates are reported to be as high as 93 and 90%, respectively [11]. Complications/adverse events associated with LAMS, including misdeployment, are as high as 12% in recent meta-analyses [4].

Various technical endoscopic approaches for EUS-GE exist [5, 12] and so far, it is not clear which one should be favored in order to reduce rate of complications. Chen et al compared the “direct puncture” with the “balloon assisted” method in a cohort of 77 patients resulting in comparative results concerning complications, technical and clinical success. Only procedure time has been different favoring the direct approach [13]. The “EPASS”-procedure (EUS-guided double-balloon-occluded gastrojejunostomy bypass), which uses a double balloon guided occlusion of the jejunal part which will then be connected to the gastric cavity via LAMS, was recently described as one of the safest approaches [14, 15] because of the stable fixation which thereby helps to avoid malpositioning or unsafe LAMS deployment. As for now, it remains in the hands of the endoscopist, which kind of treatment approach to choose, mostly depending on his own experience.

In recent reviews, reported complications associated with EUS-GE are ranging around 12%, including postinterventional pain, bleeding, stent obstruction, stent migration, peritonitis, and LAMS misdeployment [4, 11, 16, 17]. In Table 1 we collected the recent literature about complications after EUS-guided LAMS deployment.
## Table 1

**Complications of EUS-GE.** Review of recent literature with percentage of main complications associated with EUS-GE and techniques adopted.

| Authors                        | EUS-GE technique | Misdeployment | Peritonitis | Perforation | Stent obstruction | Post-procedural bleeding | Post-operative excessive pain | Other                          |
|-------------------------------|------------------|---------------|-------------|-------------|-------------------|-------------------------|-------------------------------|--------------------------------|
| Chen et al Surg Endosc 2016   | n = 22 EPASS, n = 6 balloon assisted and n = 2 direct GE | 3/30 (10%) misdeployment into the peritoneum | n = 2/30 (6.7%) | | | n = 2/30 (6.7%) | n = 2/30 (6.7%) | cholangitis |
| Itoi et al Gut 2016           | EPASS n = 20     | 2/20 (10%) stent misplacement location unknown | | | | | | |
| Tyberg et al Endosc Int Open 2016 | NOTES n = 2, Direct n = 3, Balloon assisted n = 13, Ultraslim endoscope assisted n = 5, Nasobiliary tube assisted n = 3 | 7/26 (26.9%) partial LAMS misdeployment, either proximal or distal flange | n = 2/26 (7.7%) | | | 1/26 (7.7%) | |
| Perez-Miranda et al J Clinical Gastroenterol 2017 | Direct n = 6, Balloon assisted n = 9, Ultraslim endoscope assisted n = 7, Nasobiliary tube assisted n = 3 | 9/25 (36%) localization unknown | 1/25 (4%) | | | 2/25 (8%) | |
| Khashab et al Endosc Int Open 2017 | Direct n = 2, Balloon assisted n = 6, EPASS n = 22 | 3/30 (10%) misdeployment of the stent first flange in the peritoneum | - | - | 1/30 (3.3%) | 2/30 (6.7%) abdominal pain episodes requiring hospitalization. | n = 1/22 (4.5%) LAMS mesh erosion |
| Ge et al Surg Endosc 2017     | Direct n = 22    | 2/22 (8.3%) misdeployment resulting in perforation | | | Stent ingrowth = 1 /22 (4.5%) | | n = 1/22 (4.5%) | LAMS mesh erosion |
| Chen et al GIE 2018          | Direct n = 52, Balloon assisted n = 22 | 5/74 (7%) misdeployment into the peritoneum | | | 1/74 (1.3%) stent obstruction due to inflammatory ingrowth | | |
| Chen et al Endosc Int Open 2018 | Direct n = 15, Balloon assisted n = 7, EPASS n = 4 | 2/26 (7.7%) misdeployment of the LAMS with the distal end failing to anchor in the small bowel. | | | n = 1/26 (3.8%) gastric leak needing surgical intervention following stent removal | |
| Kerdsirichairat et al Endosc Int Open 2019 | Direct n = 57 | 2/57 (3.5%); with proximal flange misdeployed in the peritoneum | | | n = 1/57 (1.7%): LAMS in place, but traversing the mesocolon, resulting in leakage | n = 1/57 (1.7%) hemoperitoneum from EUS GE site | |
Different technical problems can occur during LAMS deployment. Both the proximal or distal flange can be misdeployed, resulting in gastric or jejunal perforation. Also no target organ puncture can be part of the misdeployment, such as transversing the mesocolon or the transverse colon itself. No standard strategies to overcome LAMS misdeployment exist, its management is up to clinical expertise of each endoscopist. We hereby name the most frequently used strategies according to the initial LAMS misdeployment problem:

1. **LAMS proximal flange misdeployment**: The fistulous tract into the jejunum is already established but the proximal flange is misdeployed into the peritoneum and is not anchored in the gastric wall. Through the gastric puncture site, another LAMS or a fully covered metal stent can be placed in order to bridge the already placed LAMS [8, 18]. Alternatively, LAMS can be removed completely, the gastric puncture site closed with an Over-The-Scope-Clip (OTSC, Ovesco Tübingen Germany) and a new LAMS placed via a new access [19, 20].

2. **LAMS distal flange misdeployment**: During puncture of the jejunum, the jejunum dislocates, and the distal flange cannot be opened or is only partially opened into the target site. The distal flange therefore partially remains in the peritoneum creating a free perforation of the gastric wall. Here, either LAMS can be completely removed and a fully covered bridging stent can be placed in order to bridge the already placed LAMS [8, 18]. Alternatively, LAMS can be removed completely, the gastric puncture site closed with an Over-The-Scope-Clip (OTSC, Ovesco Tübingen Germany) and a new LAMS placed via a new access [19, 20]. During misdeployment of the distal flange without puncturing the jejunum in two patients reported by Kashab et al, LAMS removal and only conservative treatment was performed. An additional option is to create a NOTES access in which the originally created fistulous tract, created by the LAMS, can be secured endoscopically [18, 22]. In cases where the jejunal wall defect could not be reached by endoscopy, Wannhoff et al preferred to insert a duodenal fully covered stent to bridge the GOO inducing tumor, whereas the jejunal puncture was not occluded [20]. Interestingly this did not result in further peritonitis originating from the jejunum.

3. **Stent misdeployment perforating other organs such as the mesocolon or the transverse colon is a complication which needs surgical intervention [23].**

4. **Stent misdeployment into the peritoneal cavity**: in rare cases, when LAMS cannot be retrieved endoscopically from the peritoneal cavity, stent removal by abdominal surgery might be necessary [24].

The hybrid technique described in this case report has several significant advantages. Probability of incorrect deployment of the first flange is up to 27% [16]. Therefore, a laparoscopically-assisted procedure outperforms the limitation of a 2 dimensional endoscopic exam, in this case the incorrect visualization of the target loop by endoscopic ultrasound and furthermore the lack of correct cystostome penetration of the jejunal wall.

Furthermore, this hybrid approach may have the ability to considerably shorten overall procedure time whilst securing success of endoscopic LAMS deployment. Mean procedure time for laparoscopic GE varies widely from 75 to 170 minutes in literature [25]. In our case, time for laparoscopy was 95 minutes, which included the exclusion of jejunal and colonic perforations and recovery of the flange of EC-LAMS. However, procedure time for GE by LAMS was only 6 minutes.

Another advantage of this hybrid approach may be the possibility of performing anastomoses between the posterior gastric wall and the first jejunal loop, therefore maintaining a maximum of intestinal absorption surface and reducing the risk of malabsorption and malnourishment [26].

| Authors                  | EUS-GE technique            | Misdeployment                                  | Peritonitis | Perforation | Stent-obstruction | Post-procedural bleeding                  | Post-operative excessive pain | Other                           |
|--------------------------|-----------------------------|------------------------------------------------|-------------|-------------|------------------|------------------------------------------|-------------------------------|---------------------------------|
| James et al GIE 2019     | orojejunals tube-assisted water instillation in n = 5 (22.7%), balloon-assisted in n = 8 (36.4%), and fluid instillation with freehand puncture using electrocautery was performed in n = 9 (40.9%) | 1/22 (4.5%) trans colonic misdeployment into the jejunum -> no signs of perforation |             |             | n = 1/22 (4.5%) bleeding from gastric ulcer from the anastomatic site | n = 1/22 (4.5%) | n = 1/22 (4.5%) spontaneous LAMS migration one year after the initial procedure -> surgical removal via laparotomy; n = 1/22 (4.5%) necrotic pancreatitis requiring multiple necrosectomies |
| Wannhoff et al Surg Endosc 2020 | Direct n = 36, Others n = 2 | 4/35 (11.42%) dislocation of distal stent flange; n = 1 dislocation of proximal stent flange; n = 1 unsuccessful puncture of the targeted loop |             |             | n = 1/40 (2.5%) tumor ingrowth into LAMS | n = 1/40 (2.5%) | n = 4/40 (10%) stent migration; infection 2/40 (5%); n = 1/40 (2.5%) deep vein thrombosis / pulmonary embolism |
| Kouanda et al Surg Endosc 2021 | orojejunals tube-assisted water instillation in n = 40 | 1/40 (2.5%) deployment into the peritoneum, | n = 1/40 (2.5%) | | n = 1/40 (2.5%) | | |
However, limitations are mainly related to the availability of infrastructure and medical staff. EUS-GE usually is not performed in an operating theater. Moreover, this hybrid approach requires simultaneous involvement of two teams, surgeons and endoscopists, which is uncommon and more costly.

To our knowledge, the clinical case reported here is the first to show a combined endoscopic and surgical treatment approach in order to overcome endoscopic restrictions for GE, in particular LAMS misdeployment. In cases where endoscopic orientation is difficult and LAMS deployment therefore is at risk, we propose a promising combined technique in order to provide time sparing and more safety for patients. Further studies need to confirm this observation.

**Abbreviations**

| Abbreviation | Description |
|--------------|-------------|
| ES           | Endoscopic enteral Stenting |
| EUS          | Endoscopic Ultrasound |
| EUS-GE       | Endoscopic Ultrasound Guided Gastro-Enterostomy |
| GE           | Gastroenterostomy |
| SGE          | Surgical Gastroenterostomy |
| GOO          | Gastric Outlet Obstruction |
| LAMS         | Lumen Apposing Metal Stent |

**Declarations**

- Ethics approval and consent to participate: not applicable.
- Consent for publication: obtained.
- Availability of data and materials: All data generated during this study are included in this published article and its supplementary information files. Further minor datasets are available from the corresponding author on reasonable request.
- The authors declare that they have no competing interests.
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- Authors’ contributions: The manuscript has been read and approved by all the authors; the requirements for authorship have been met; each author believes that the manuscript represents honest work.

Fabbri C., Agnoletti V. and Ansaloni L. were directly involved in the entire procedure and designed the clinical case. Binda C., Fugazzola P. and Jung CFM. screened the literature. Sbrancia M., Tomasoni M., Coluccio C. and Prosperi E. were responsible for data acquisition and creation of supplementary information files. Binda C., Fugazzola P., Sbrancia M., Tomasoni M., Coluccio C., Jung CFM. and Prosperi E. were involved in manuscript preparation. Fabbri C. and Ansaloni L. were involved in critical revision, editing and reviewing of the paper. All authors approved the final version of the manuscript.

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Figure 1

Misdeployment: View of the EC-LAMS opened on the posterior gastric wall.

Figure 2

Hybrid technique: Laparoscopic view of gastroenteroanastomosis with the EC-LAMS.
Supplementary Files

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