

Endoscopic Ultrasound-guided Esophagojejunal Anastomosis for Delayed Reconstruction: A Case Series on the Novel Technique and our Experience

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ABSTRACT

Esophagojejunal (EJ) anastomoses are integral to gastrointestinal reconstructive surgeries following procedures such as gastrectomy, particularly in cases of cancer or Roux-en-Y reconstruction. However, the traditional surgical EJ anastomosis approach can pose challenges with notable risks such as anastomotic leakage, stricture, or fistula formation. Endoscopic interventions have been employed for managing these adverse outcomes through stent placement, but a primarily endoscopic EJ anastomosis technique has not yet been described. This retrospective case series details five patients who underwent delayed endoscopic EJ anastomosis, with each patient under differing circumstances of instability necessitating this emergent alternative to standard surgical reconstruction. This approach involved the placement of a lumen-apposing metal stent between the esophagus and jejunum. Successful endoscopic EJ anastomosis was achieved in all cases, with hospital stays ranging from 6-13 days. Adverse events included stent migration, dysphagia, and stricture. Subsequent management strategies for these adverse events included stent removal and exchange, balloon dilation, triamcinolone injection, and appropriate follow-up. Follow-up evaluations revealed successful outcomes with no mortalities or anastomotic leaks.

Primarily endoscopic EJ anastomosis for delayed reconstruction emerges as an advanced, minimally invasive alternative in complex patients deemed unsuitable for conventional surgical reconstruction secondary to instability or critical conditions. Within the literature, this is the first human case series description of an endoscopic EJ anastomosis with stent placement between the esophagus and jejunum. This novel technique offers the potential in improving patient outcomes which warrants further investigation to optimize these endoscopic techniques and assess its long-term efficacy across a larger patient cohort.

Key words: esophagojejunal anastomosis – minimally invasive approach – advanced endoscopic techniques – lumen-apposing metal stent – interventional endoscopy.

Abbreviations: EGD: esophagogastroduodenoscopy; EJ: esophagojejunal; EUS: endoscopic ultrasound; LAMS: lumen-apposing metal stent.

INTRODUCTION

Esophagojejunal (EJ) anastomoses are commonly performed following reconstructive gastrointestinal procedures that involve gastrectomy, typically using an open or minimally invasive approach. They are commonly performed for gastric and esophageal surgeries that require Roux-en-Y reconstruction. Despite the overall success and prevalence of surgical EJ

anastomosis, performing the procedure can be technically challenging and necessitate a prolonged recovery time, with previous work identifying the severe risk for an anastomotic leakage with high mortality rates, anastomotic stenosis, and fistula formation [1-5]. Multiple studies have described varying surgical anastomosis techniques, and endoscopic therapies have previously been used to manage any surgical adverse outcomes such as stent placement for leakage treatment [3, 4, 6, 7]. Moreover, there have been several descriptions of endoscopic ultrasound (EUS) guided gastroenterostomy [8-13], which is now a well-established management for malignant gastric outlet obstruction. However, there has been no published description of completing a primarily endoscopic EJ anastomosis.

This retrospective case series will describe our experience with EJ anastomosis using an endoscopic approach on five

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different patients. It describes the medical course of three male and two female patients ages 47-74 with history of gastrectomy and additional upper gastroenterology surgeries for various reasons including esophago-gastric tumors, Roux-en-Y reconstruction, paraesophageal hernia repair, or hiatal hernia repair. Each patient's case prior to the endoscopic procedure was complicated either by a life-threatening bleed, stricture, gastric torsion, or gastric perforation. Therefore, each case was selected for delayed reconstruction due to the resultant septic/hemorrhagic shock, contamination, patient instability, or critical condition. A multidisciplinary decision was made, including an advanced endoscopist, experienced surgical oncologists and general surgeons, to adopt a minimally invasive approach with an endoscopic EJ anastomosis and placement of an AXIOS (Boston Scientific, Marlborough, Mass, USA) lumen-apposing metal stent (LAMS) in all five cases. In terms of the type of endoscopes utilized, an Olympus GF-UCT180 was used for EUS, an Olympus GIF-2TH180 scope was used for the main procedure, and an Olympus GIF-1TH180 was used for the stent exchanges. The overall hospital length of stay from the endoscopic EJ anastomosis procedure to discharge ranged from 6-13 days (average of 9.2 days). To our knowledge, this is the first human case series description of an EUS-guided endoscopic EJ anastomosis technique with placement of a stent specifically between the esophagus and the jejunum.

CASE PRESENTATIONS

Case 1

A 54-year-old female with past medical history of hypothyroidism, active smoking, a large paraesophageal hernia, and was status post a robotic hernia repair with Toupet fundoplication ten months prior, presented with complaints of epigastric abdominal pain, chest pain, and regurgitation. Imaging revealed a recurrent paraesophageal hernia and possible volvulus of the stomach. Endoscopic nasogastric tube placement was attempted but failed secondary to high-grade gastric torsion. She was taken emergently for a laparoscopic recurrent hiatal hernia repair with proximal esophagogastric resection and Roux-en-Y reconstruction. Due to significant contamination of the surgical field though, a staged approach to EJ construction was taken whereby the jejunum was sutured to the esophagus but the anastomosis was not created, with a subsequent plan for delayed EUS-guided esophagojejunostomy. This strategy was taken in hopes to avoid the high risk for EJ anastomotic leak postoperatively.

The endoscopic EJ procedure began by locating the blind end of the esophagus closed with surgical staples. It was difficult to locate a well-defined loop of jejunum, but with the aid of fluoroscopy, an adjacent portion of the stapled jejunum was identified. The jejunum was punctured with a 19-gauge Expect Slimline needle (Boston Scientific, Marlborough, Mass, USA), and partially distended with contrast, methylene blue, and saline. A 0.025-inch angled tip wire was passed through the 19-gauge needle and looped into jejunum. A guidewire was exchanged with the needle, and a 15 mm x 15 mm electrocautery enhanced LAMS was advanced over the wire into the small bowel and deployed. This allowed a flow of bilious fluid into the esophagus, confirming adequate placement within

the jejunum (Fig. 1). The overall hospital stay length from the endoscopic EJ anastomosis procedure to discharge was 13 days.

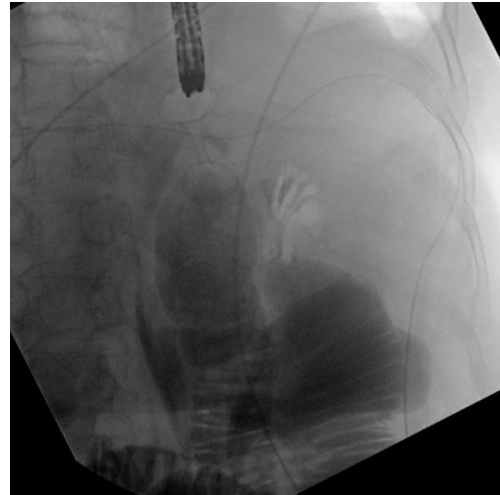


Fig. 1. X-ray fluoroscopy post-LAMS placement in case 1.

The patient was seen a month later with complaints of intermittent dysphagia. Follow-up EGD (Fig. 2) revealed a widely patent stent in place and what appeared to be a sharp angulation to the efferent loop, which was then dilated to 20 mm. The patient again returned two months later to upsize the stent to 20 mm x 10 mm and was dilated to 20 mm once more. The stent was removed 1 year after placement, and reevaluation proved patient stability and the anastomosis to have remained patent for months after stent removal so far.

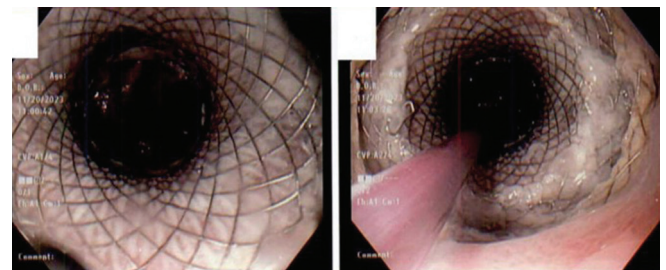


Fig. 2. Follow-up EGD findings from case 1 showing the patent stent in place.

Case 2

A 74-year-old male with a life-threatening upper gastrointestinal bleed and associated hemorrhagic shock related to diffuse large B-cell lymphoma of the stomach and fundal ulcerations underwent an emergent exploratory laparotomy and total gastrectomy after failure to control the life-threatening bleeding through multiple endoscopic and Interventional Radiology interventions. His esophagus was left in discontinuity with a roux limb of jejunum sutured to the esophageal staple line for delayed reconstruction due to the patient's ongoing hemorrhagic shock and associated critical condition, and an endoscopic EUS-guided EJ anastomosis was requested. A curvilinear echoendoscope was passed down to the sutured blind distal esophagus and EUS was used to try to identify a loop of small bowel. A loop of jejunum was punctured using a 19-gauge Expect Slimline needle with injection of methylene blue dye

and contrast, but it did not distend robustly, likely secondary to severe edema. Extensive attempts to distend a loop of small bowel were made, however it seemed inappropriate to deploy the stent, so the procedure was converted to a laparoscopic-assisted procedure. The surgeon was able to obtain access laparoscopically; however, the distal exit of the jejunum could not be distended. A guidewire was looped into the jejunum, the needle was exchanged, and a 20 mm x 10 mm LAMS was deployed. Contrast was injected into the loop of bowel which opacified loops of jejunum confirming adequate deployment. A post procedure upper contrast study confirmed patency and the patient was able to tolerate oral intake. The overall hospital stay length from the endoscopic EJ anastomosis procedure to discharge to an inpatient rehab was six days.

Two months later, an esophagogastroduodenoscopy (EGD) was done (Fig. 3) which confirmed that the stent was still widely patent. However, several months later, the patient developed dysphagia and was having difficulty tolerating solid food. Another EGD was performed and this time showed that the LAMS had migrated and there was a stricture at the EJ anastomosis (Fig. 4). A balloon dilation to 15 mm was performed and a 15 mm x 10 mm LAMS was placed across the stricture.

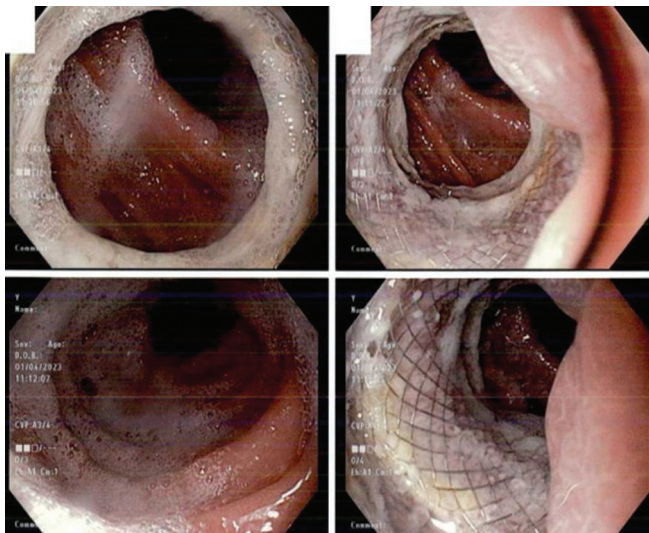


Fig. 3. Follow-up EGD findings from case 2 confirming a widely patent stent two months post-LAMS placement.

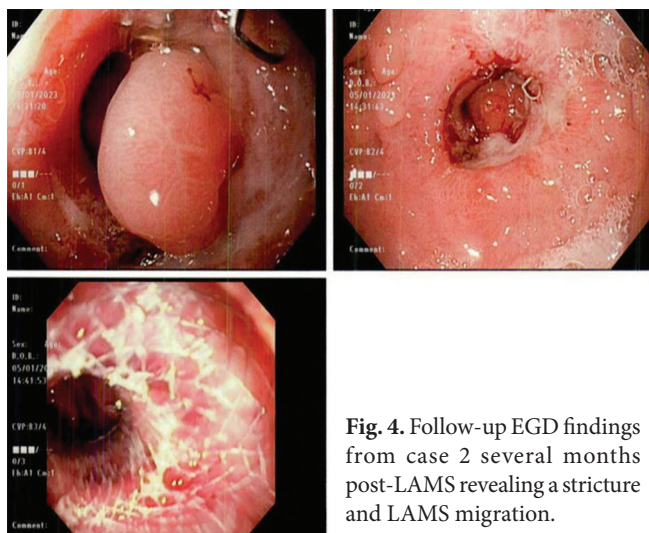


Fig. 4. Follow-up EGD findings from case 2 several months post-LAMS revealing a stricture and LAMS migration.

The patient underwent a follow up EGD a couple months later, which showed the stent was widely patent and in place (Fig. 5); the patient's dysphagia resolved, so the stent was then removed. The anastomosis was patent after stent removal and triamcinolone was injected to discourage restenosis. The patient has been doing well stent-free for 2 years now.

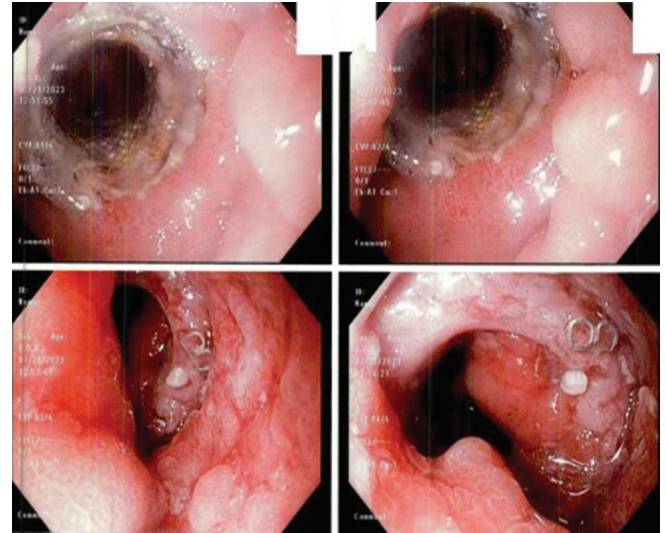


Fig. 5. Follow-up EGD showing a widely patent stent in place over the previous stricture from case 2.

Case 3

A 47-year-old male with no significant medical or surgical history was found incidentally on lung nodule screening to have a gastric mass measuring 5.2 x 3.5 cm (Fig. 6). EUS/EGD showed a complex multilobulated submucosal lesion extending from the gastroesophageal junction at 40 cm along the gastric cardia to 45 cm with two penetrating ulcers on the lesion. Pathology returned positive for a leiomyoma. The patient underwent a robotic-converted-to-open partial gastrectomy at the esophagogastric junction. However, the patient was taken back to the operating room a few days later due to a leak at the suture line and peritonitis requiring a proximal gastrectomy. The patient was too unstable with septic shock to undergo a complete reconstruction, so the esophagus was left in discontinuity sutured in an end-to-side fashion to a roux limb of jejunum with plans for delayed endoscopic EJ reconstruction

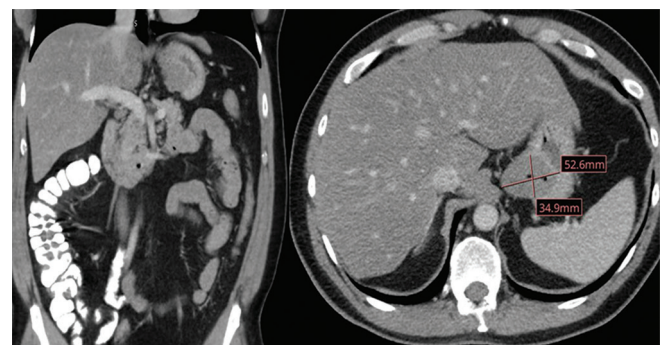


Fig. 6. CT abdominal/pelvis with contrast; coronal and axial views from case 3L abnormal soft tissue seen at the level of the gastroesophageal junction of the stomach.

once stable. Meanwhile an nasogastric tube was placed to manage secretions and total parenteral nutrition was started.

Slightly over a week later, the gastroenterologists performed the endoscopic EJ anastomosis. During the endoscopy, there was a spontaneous fistulous tract, specifically a 5 mm EJ fistula going to the stapled distal end of the esophagus, and therefore a 15 mm by 10 mm LAMS was deployed across the EJ fistula (Fig. 7). The stent was then dilated to 13.5 mm. The overall hospital stay length from the endoscopic EJ anastomosis procedure to discharge was ten days. An upper gastrointestinal study was done the next day which confirmed contrast freely passing through the stent with no extravasation (Fig. 8). Patient did not follow up outpatient as recommended, however it was noted that the patient was evaluated in the hospital seven months post procedure with stent removal and a dilation was performed. He now continues to follow up outpatient and is doing well with no adverse events.

Case 4

A 50-year-old female presented to the emergency department with intractable nausea and vomiting with an extensive surgical history of a Roux-en-Y with Nissen fundoplication three years prior to presentation as well

as a robotic laparoscopic hiatal hernia repair with partial gastrectomy and small bowel resection of the blind limb one year prior both of which were done at a different facility. The patient had developed intractable pain from a 3 cm penetrating deeply-cratered likely penetrating marginal anastomotic ulcer, which was sutured closed endoscopically. The patient did well for ten days, but returned for a follow up EGD which demonstrated suture break down and she developed a life-threatening bleed which failed endoscopic therapy. The patient was sent for emergent surgical revision. At surgery, an actively bleeding ulcer was found and sutured. The remaining gastric pouch and previous gastrojejunostomy were removed as the back wall of the gastric pouch was obliterated by scarring and the ulcer. Due to the patient being on maximum pressors, a primary anastomosis was not done, leaving the esophagus and jejunum in discontinuity, and a nasogastric tube was left in the blind end of the esophagus to manage secretions. Once the patient was off pressors, gastroenterologists was asked to perform an endoscopic EJ anastomosis. A computed tomography abdomen/pelvis with contrast was done which clarified that there was an adjacent loop of jejunum to the distal esophagus/remnant portion of the stomach.

EGD confirmed a 1.5 to 2 cm blind gastric pouch remnant, as it had been resected and oversewn. For the EUS-guided portion of the case, the echosonography was used to secure an avascular window of a loop of jejunum adjacent to the gastric pouch remnant that was then punctured using a 19-gauge Expect Slimline needle. Saline mixed 50-50 with isovue contrast was injected to fill the loop of jejunum with fluoroscopy showing contrast flowing down the jejunal loop all the way to the mid small bowel. 500cc of the contrast saline solution was then used to distend the loop of bowel. A 20 mm x 10 mm electrocautery enhanced LAMS was then advanced down the echoendoscope and the stent was advanced across the gastric pouch remnant wall into the loop of jejunum. This was confirmed on fluoroscopy (Fig. 9). The stent was dilated to 12 mm using a 10 to 12 mm CRE TTS dilating balloon. Upper gastrointestinal studies and KUB post-procedure showed the stent in place and free flow of contrast (Fig. 10). The overall hospital stay length from the endoscopic EJ anastomosis procedure to discharge was nine days.

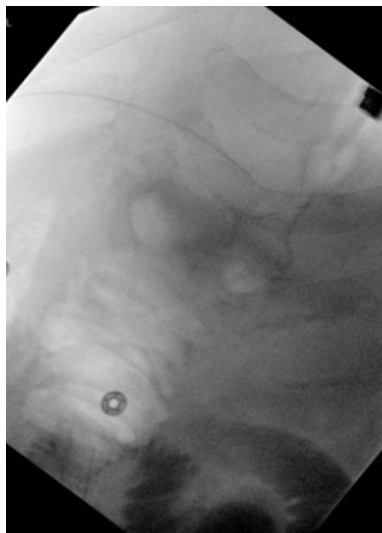


Fig. 7. X-ray fluoroscopy showing stent in place from case 3.



Fig. 8. Case 3: A: Abdominal x-ray two days post esophagojejunal anastomosis procedure showing stent in place. B: Upper GI study with gastrografin two days post esophagojejunal anastomosis procedure showing stent in place and no evidence of extravasation. C: CT abdomen/pelvis three months post-procedure showing stent present in the distal esophagus.

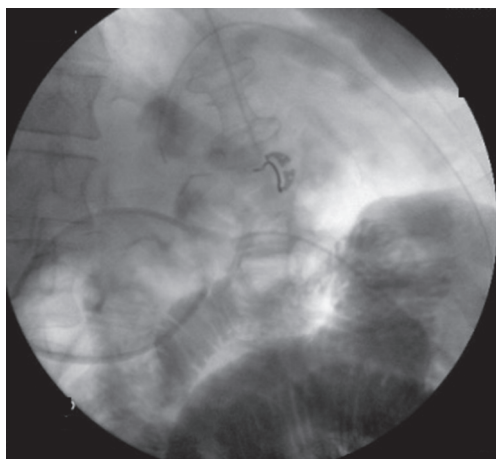


Fig. 9. X-ray fluoroscopy showing stent in place from case 4.

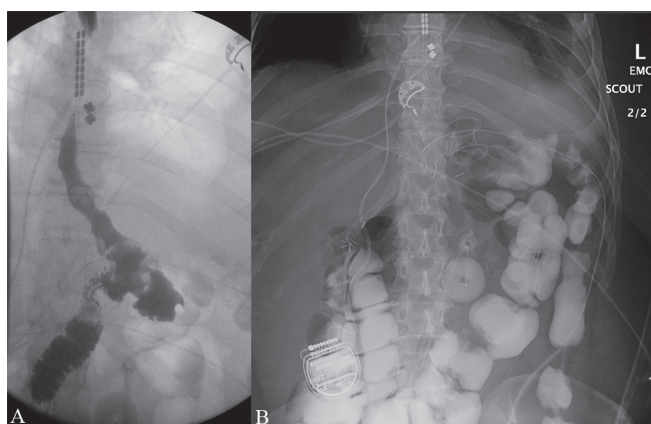


Fig. 10. Case 4: A: Upper GI study showing contrast flowing freely and stent in place. B: Abdominal KUB showing stent in place.

A follow-up EGD was done two months later for evaluation of the anastomosis and possible removal/exchange of the stent. The EGD revealed a widely patent EJ anastomosis but concluded that the stent likely migrated due to it not being visible on fluoroscopy. The stent was present on chest x-ray two days prior to this follow-up EGD, but KUB and chest x-ray following the EGD confirmed stent passage. One year and four months after the original endoscopic EJ anastomosis, EGD was performed and showed unremarkable postsurgical anatomy of the EJ anastomosis, with 1 cm of stomach left forming part of the anastomosis and no other findings. Patient's last follow up was 2.5 years after the procedure, reporting that he has been asymptomatic, continues to do well and follows up outpatient.

Case 5

A 56-year-old male with history of a vertical sleeve gastrectomy five years prior to presentation with a recent diagnosis of invasive gastroesophageal junction squamous cell carcinoma presented with a spontaneous perforation at the top of the staple line to the left of the gastroesophageal junction. Multiple attempts were made to manage this perforation endoscopically but due to the tumor location being directly adjacent to the perforation, endoscopic repair was not feasible. Endoscopic stents were used for management instead.

A week after stent placement, the patient continued to have leakage around the stent, therefore, the stent was removed and the patient underwent surgical management for resection of the mass and control of his sepsis. Surgeries included total gastrectomy with Roux-en-Y preparation without reconstruction due to the high risk of a leak, distal pancreatectomy with splenectomy, partial colectomy with colostomy, partial diaphragmatic resection, partial left lower pulmonary lobectomy, and tube thoracostomy. Since the distal esophagus was left in discontinuity, gastroenterologists were asked to perform an endoscopic EJ anastomosis, which was performed five days later.

The endoscopic procedure began by introducing the echoendoscope against the blind end of the esophagus, and the opposed loop of jejunum was identified and punctured using a 19-gauge Expect Slimline needle. Methylene blue, contrast, and saline mixture was injected through a pump, opacifying the loop of jejunum with contrast outlining the valvulae conniventes. It did not significantly distend. Following this, a 0.025-inch-long guidewire was looped through the 19-gauge needle and wire could be seen looping into the jejunum. The guidewire was exchanged. Next, a 15 mm x 15 mm electrocautery enhanced LAMS was advanced down the accessory channel of the echoendoscope. Initial attempt to gain access into the jejunum was unsuccessful as the stent would not go to the staple line, so a separate spot away from the staple line was secured. Under fluoroscopy and endosonography, a 15 mm x 15 mm LAMS was advanced over the wire into the jejunum and subsequently deployed (Fig. 11). Contrast opacification was done to ensure the stent was in proper position with contrast opacifying the loops of jejunum. An esophagram was done two days later which showed no leakage or obstruction. The patient did not experience any adverse events. The overall hospital stay length from the endoscopic EJ anastomosis procedure to discharge was eight days. The patient followed up outpatient and was doing well with the anastomosis remaining patent for nine months. However, the patient happened to develop acute pancreatitis and a pseudoaneurysm unrelated to the anastomosis, resulting in a gastrointestinal bleed and death.

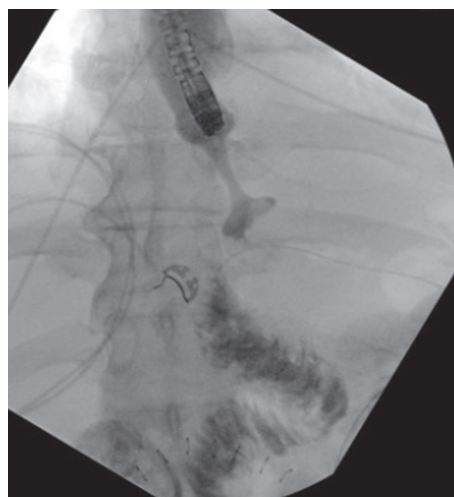


Fig. 11. X-ray fluoroscopy during endoscopic EJ anastomosis procedure showing stent in place from case 5.

DISCUSSION

Advanced endoscopic techniques are minimally invasive procedures that offer a wide range of treatment modalities, with faster recovery and reduced adverse events among many other benefits compared to a standard surgical approach. A LAMS can be used during endoscopies, which was originally designed for transmural drainage of pancreatic fluid collections but has expanded indications now including transmural, gallbladder, bile duct, and abscess drainage, as well as creation of enteric anastomosis for malignant and benign obstructions, treatment of afferent loop syndrome, and refractory gastrointestinal strictures [14]. One of the earliest EUS-guided gastroenterostomy procedures to use LAMS was in 2012 using porcine models [15]. Since then, a multitude of papers have been published describing their experience with EUS-guided endoscopic gastric bypass in live swine [16] and EUS-guided gastroenterostomy in humans [8-13].

For patients with proximal gastric cancer, a total gastrectomy with EJ reconstruction is often required; with various surgical approaches to reconstitute the gastrointestinal tract being technically difficult [7]. The advantages of performing specifically a Roux-en-Y reconstruction after a gastrectomy include reducing reflux gastritis and esophagitis, reducing the risk of gastric cancer recurrence, and decreasing the surgical complication of ruptured sutures [17]. Previously, a postoperative leak following a surgical anastomosis has been managed with stent placement across the anastomotic leakage site to avoid another complex procedure (relaparotomy) on already inflamed tissues [5]. Many open and laparoscopic surgical reconstructive techniques have already been extensively described in literature [3, 4, 6, 7]. However, an endoscopic EJ anastomosis with LAMS placement post-gastrectomy has not yet been published.

These five cases present a feasible, efficacious, minimally-invasive alternative for an EJ anastomosis compared to the traditional surgical approach. This EJ anastomosis does not serve as a bridge to surgery; rather, this procedure is a definitive solution, as supported by the extended post-operative follow-up time in each case and absence of requiring further surgical

intervention. This was primarily in emergency cases when the risk of a primary EJ anastomotic leak is high and the patient was too unstable for surgical completion of the anastomosis reconstruction. As previously described, the esophagus is prioritized to be disconnected surgically to prevent ongoing mediastinal soilage or from another emergent need, but the esophagus is left in discontinuity because it is better to delay or complete the anastomosis in stages under better clinical conditions, such as after recovery from sepsis or shock [18]. The surgeon sutures a loop of jejunum that has been passed above or below the transverse colon to the blind end of the esophagus in an end to side fashion using interrupted seromuscular non-absorbable sutures in preparation for the delayed endoscopic EJ anastomosis (Fig. 12). The EJ anastomosis procedure is described and depicted as an illustration in Fig. 13.

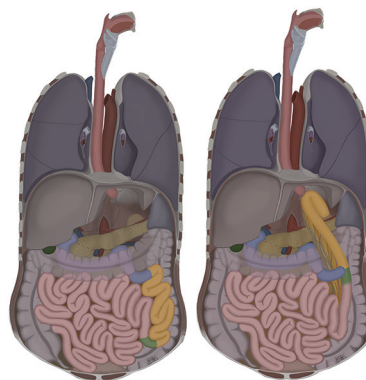


Fig. 12. An illustration depicting the surgical anatomy in preparation for the delayed EJ anastomosis procedure, showing that the surgeon sutures a loop of jejunum either above or below the transverse colon to the blind end of the esophagus in an end to side fashion. Illustration created by Hosameddine Talab.

By utilizing this novel endoscopic technique, we were able to achieve successful anastomoses with excellent clinical outcomes and no anastomotic leaks or mortalities. Overall, the length from the endoscopic EJ anastomosis procedure to discharge ranged from 6-13 days (average of 9.2 days). The most common post-procedure adverse effects were stent

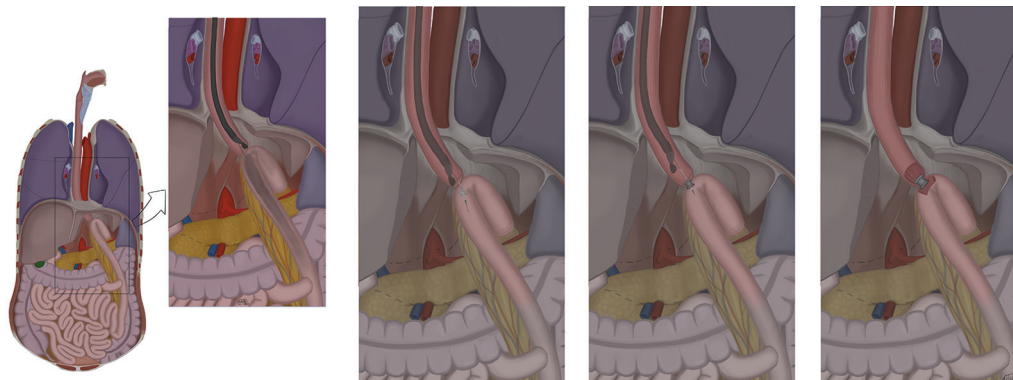


Fig. 13. An illustration representing the EJ anastomosis procedure. First, locate the blind end of the distal esophagus and an avascular window of a loop of jejunum with EUS. Then, puncture the jejunum with a 19-gauge needle and distend the jejunum with contrast, methylene blue, and/or saline. Finally, pass a 0.025 inch angled tip wire through the 19-gauge needle, loop the guidewire into jejunum, retract the needle, and deploy the AXIOS LAMS. Illustration created by Hosameddine Talab.

migration, dysphagia, and stricture. These adverse events can be circumvented or subsequently treated by stent removal, stent exchange, balloon dilation, triamcinolone injection to discourage restenosis, and proper follow-up. Of note, over-the-scope clips can be utilized to anchor the LAMS and prevent migration [19–21]. It is important to keep in mind the learning curve of a complex procedure such as this, with competency assessment data for EUS-guided LAMS type procedures having reported better efficiency with each procedure, and mastery achieved after roughly 25–35 cases [22]. Further research and additional follow-up studies are needed to fully evaluate the long-term efficacy of this more novel endoscopic technique across a larger patient cohort.

CONCLUSIONS

Minimally invasive delayed endoscopic esophagojejunal anastomosis can serve as a helpful option and promising advancement in complex or emergent cases where a patient may be too unstable to undergo standard surgical reconstruction. These five cases serve as an initial description of the feasibility and success of this novel approach.

Conflicts of interest: None to declare.

Authors' contributions: A.K. and A.S. conceived and designed the study. A.K. drafted the manuscript. S.S., M.B. B.A. and A.S. revised the manuscript for important intellectual content. All the authors read and approved the final version of the manuscript.

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