SCIENTIFIC PAPER

Laparoscopic-Assisted Transgastric Endoscopy: Current Indications and Future Implications

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ABSTRACT

Background: Endoscopic access to the proximal gastrointestinal tract may prove difficult for a variety of anatomic reasons. Under laparoscopic visualization, trocars can be placed into the stomach with the subsequent introduction of a flexible endoscope directly into the body of the stomach. The purpose of this study was to describe this technique and demonstrate that it is safe, effective, and feasible.

Methods: Six patients with altered proximal foregut anatomy were examined. Five patients had previously undergone laparoscopic Roux-Y gastric bypass, and one patient had severe distal esophageal stenosis precluding distal passage of an endoscope. All patients required endoscopic retrograde cholangiopancreatography (ERCP), and one patient underwent closure of a symptomatic gastrogastric fistula. In each patient, two 5-mm ports were inserted and tacking sutures placed between the gastric body and the anterior abdominal wall. Subsequently, a flexible endoscope was inserted into the stomach through a gastrotomy under direct visualization. Picture-in-picture technology enabled simultaneous monitoring of the laparoscopic and endoscopic field.

Results: The operative time ranged from 64 minutes to 93 minutes. All therapeutic endoscopic procedures were successful. The anterior gastrotomies were either closed primarily or a feeding tube was placed. Patients reported minimal postoperative pain. No complications resulted from the procedures.

Conclusion: In an age where surgeons and gastroenterologists are focusing on the stomach as an access point for transgastric endoscopic surgery, we view the stomach as a portal into the gastrointestinal tract. In patients with limited access for traditional endoluminal therapy, laparoscopic-assisted transgastric endoscopy can be performed safely and efficiently.

Key Words: Endoscopy, Laparoscopy, Transgastric.

INTRODUCTION

Although endoscopic visualization of body cavities dates back to the time of the Roman Empire, the first gastric endoscopy was performed in 1868 by Adolph Kussmaul via a rigid open tube.[1] Subsequent modifications in instrumentation by Elsner, Schindler, and Hirschovitz led to the creation of modern-day endoscopes.[2,3]

Almost all advanced diagnostic and therapeutic modalities of today, including variceal banding, management of peptic ulcer disease, biliary tract manipulation, and even transgastric exploration via natural orifice transluminal endoscopic surgery (NOTES), require normal anatomy and unobstructed access through the transoral route. However, access difficulties emerge when patients have altered anatomy of the upper gastrointestinal tract due to esophageal obstruction or altered anatomy following Roux-en-Y gastric bypass or Billroth II surgery. Methods of alternate access routes with variable degrees of success in resolving the patients' medical condition have been described in the literature. Percutaneous, ultrasound, and CT-guided transcatheter access to the gastric remnant, performed with injection of contrast, have been completed in patients after gastric bypass.[4,5] However, these are only diagnostic techniques that offer no concomitant opportunity for therapeutic intervention. Retrograde enteroscopy is the only endoscopic procedure for diagnosis and therapeutic intervention. The duodenum or stomach remnant can be visualized with a long endoscope passed via the gastric pouch into the Roux limb or the afferent Billroth II limb. This procedure is technically difficult, especially in patients with a long limb of excluded small

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bowel. With altered foregut anatomy, the success rate of endoscopic retrograde cholangiopancreatography (ERCP) is well below 70%.[6,7] Until recently, open surgery was the only available method for access to the biliary tree or stomach in this select group of patients. Not surprisingly, the associated morbidity, cost, and length of hospitalization make this an unattractive alternative.

Minimally invasive access to the stomach with a laparoscopic-assisted gastrostomy was first performed in 1991 for feeding purposes.[8–11] Similarly, the stomach remnant can be accessed in patients who underwent gastric bypass and require ERCP. **Table 1**[12–17] lists current published efforts with regards to laparoscopic-assisted, transgastric endoscopy. Using this approach, ERCP was first described in 2002 for management of a benign biliary stricture in a patient with Roux-en-Y gastric bypass.[12] The authors accessed the stomach remnant through a 15-mm port in the left upper quadrant. A gastrotomy was performed with ultrasonic shears and a purse-string suture placed around it for traction. Subsequently, Ceppa et al[13] performed successful transgastric endoscopy, or ERCP, or both, in 9 of 10 patients studied, and Nguyen et al[14] have described a similar technique. Variations of this technique use alternative means of accessing the gastric remnant. Martinez et al[15] initially placed a gastrostomy tube utilizing CT-scan guidance and fluoroscopy. The authors subsequently dilated the gastrostomy tract to allow passage of the endoscope a few weeks after the original procedure. Using this technique, successful endoscopy or ERCP was achieved in 6 patients. Laparoscopic gastrostomy has also been described. In this technique, the edges of the gastrostomy are sutured to the anterior abdominal wall fascia, which allows for immediate passage of an endoscope. After completion of the ERCP, a gastrostomy tube is left in place for future access to the stomach remnant should that be necessary.[16] Finally, we have previously described the transgastric approach for closure of a gastrogastric fistula after Roux-en-Y gastric bypass. In this scenario, 2 gastrostomies were created in the remnant stomach under direct laparoscopic visualization. The gastrogastric fistula was then closed primarily with several figure-of-eight sutures placed with the aid of an Endo Stitch (Autosuture, Norwalk, CT).[17]

METHODS

This study is a retrospective review of the patients who required laparoscopic-assisted, transgastric endoscopy at a single institution. Six such patients were identified, and the indications for the procedure are summarized in **Table 2**.

Although subtle variations existed from case to case, the following steps are highlighted: (1) Port placement: Carbon dioxide pneumoperitoneum is induced with a Veress needle to achieve a peritoneal pressure of 15 mm Hg. Afterwards, a 5-mm trocar is introduced in the right upper quadrant. Additional trocars are placed at the umbilical level (12 mm), left lower quadrant (5 mm), and left upper quadrant (12 mm) **(Figure 1)**.

(2) Gastrotomy: After visualization of the gastric remnant, a site is chosen on the greater curvature for the gastrotomy. Four #0 Ticron sutures (Autosuture, Norwalk, CT) are placed in a diamond-shaped configuration on the gastric corpus, with the center of the diamond being the future site of the gastrotomy **(Figure 2)**. A Veress needle and VersaStep sleeve (Autosuture, Norwalk, CT) are introduced through the left-upper quadrant-12-mm incision into the gastric corpus, in the center of the 4 previously placed sutures. Adequate traction and countertraction are placed on the 4 sutures to allow accurate insertion of the Veress needle into the stomach. The Veress needle is subsequently withdrawn, and a 12-mm port is inserted through the previously placed sleeve to dilate the subcutaneous tract and the gastrotomy. The trocar and sleeve are subsequently removed.

(3) ERCP: A sterile side viewing endoscope is inserted manually through the left-upper-quadrant-12-mm port site into the gastric fundus under direct laparoscopic visualization **(Figure 3)**. All of our patients required sphincterotomy. In 2 patients, the extraction of retained common bile duct stones was performed. Two other patients underwent Sphincter of Oddi manometry, which confirmed the preoperative diagnosis of sphincter of Oddi dysfunction.

(4) Closure of gastrotomy: Upon completion of the ERCP, the gastrotomy is usually closed in 2 layers: the first layer is a running stitch of #0 Polysorb (Autosuture, Norwalk, CT) **(Figure 4)**. This layer is then imbricated using interrupted #0 Ticron sutures placed in a horizontal mattress fashion.

In one patient, a pancreaticoduodenal drain was passed through the gastrotomy wound outside of the abdominal cavity. This patient had the gastrotomy closed in a single layer with a figure-of-eight #0 Silk (Autosuture, Norwalk, CT). Gastropexy was subsequently performed to suspend the stomach to the anterior abdominal wall. This was achieved with four #1 Ticron sutures. Another patient had 2 gastrotomies in the gastric remnant for closure of a gastrogastric fistula. The gastrotomies were closed en masse using a linear stapler.

Table 1.
Literature Reports on the Use of Laparoscopic Assisted Transgastric Endoscopy

Source	Year	N	Indication*	Access to the Stomach Remnant*	Procedure	Gastrotomy Closure	Outcome
Peters et al.[12]	2002	1	Benign biliary stricture	15 mm trocar LUQ	ERCP	Not specified	Resolution of symptoms
Pimentel et al.[16]	2004	1	Ascending cholangitis	Laparoscopic gastrostomy	ERCP	Gastrostomy tube left in place	Resolution of symptoms
Martinez et al.[15]	2006	6	Papillary fibrosis Dilated gastric remnant Evaluation of upper GI bleeding Evaluation of prepyloric ulcer Melena and increased LFT's Abdominal pain, vomiting, increased LFT's	Healed gastrostomy tract (previous gastrostomy tube placed under CT scan guidance)	ERCP (n = 2) Attempted ERCP (n = 1) Prepyloric ulcer biopsy (n = 2) Gastroscopy/ Duodenoscopy (n = 6)	Not specified	Resolution of symptoms
Nguyen et al.[14]	2007	1	Choledocholithiasis	15 mm trocar LUQ	ERCP	Running suture, 2 layers	Resolution of symptoms
Ceppa et al.[13]	2007	10	Benign biliary stricture (n = 2) Choledocholithiasis (n = 3) GI bleeding (n = 3) Abdominal pain (n = 2)	15 mm trocar LUQ	ERCP (n = 4) Attempted ERCP (n = 1) Duodenal tumor biopsy (n = 1) Gastroscopy/ Duodenoscopy (n = 5)	Running suture or linear stapler	Resolution of symptoms (n = 6) Chemotherapy (n = 1) Open repair of bleeding ulcer (n = 1) SMA syndrome (n = 1)
Roberts et al.[17]	2007	1	Gastrogastric fistula	12 mm port LUQ, 5 mm trocar LUQ	ERCP, intragastric closure of gastrogastric fistula	Stapled closure of both gastrotomies	Resolution of symptoms

* ERCP = endoscopic retrograde cholangiopancreatography; LUQ = left upper quadrant; GI = gastrointestinal; SMA = superior mesenteric artery.

RESULTS

Six patients underwent laparoscopic-assisted, transgastric endoscopy. All patients were female, and the average age was 46 years. All patients required endoscopic evaluation of the biliary tree, but had altered gastrointestinal anatomy, which precluded performance of esogastroduodenoscopy via the standard route. Five patients had previously undergone Roux-en-Y gastric bypass, and one patient had a distal esophageal stricture secondary to tumor, which did not allow passage of the endoscope.

Patient 1 was a 58-year-old female who was admitted for acute pancreatitis. She had a past medical history significant for a bone marrow transplant for non-Hodgkin's

Table 2.
Characteristics of Patients Who Underwent Laparoscopic-Assisted, Transgastric Endoscopy

Altered Anatomy (number)	Preoperative Diagnosis	Stomach Access*	Procedure*	Gastrotomy Closure
Esophageal stricture (1)	Gallstone pancreatitis	12 mm port LUQ, traction sutures placed on the stomach in triangular-shape configuration. Gastrotomy performed in the center of the triangle.	ERCP, sphincterotomy, extraction of stone, feeding gastrostomy tube	Feeding gastrostomy tube
Roux-en-Y gastric bypass (5)	Ampullary stricture, gastrogastric fistula	12 mm port LUQ, traction sutures placed on the stomach in triangular-shape configuration. Gastrotomy performed in the center of the triangle. 5 mm trocar LUQ for transgastric laparoscope.	ERCP, sphincterotomy, endoscopic closure of gastrogastric fistula	Stapled closure of both gastrotomies.
	Periampullary stricture	12 mm port LUQ, traction sutures placed on the stomach in triangular-shape configuration. Gastrotomy performed in the center of the triangle.	ERCP, sphincterotomy	Two-layer suture closure
	Oddi's dysfunction	12 mm port LUQ, traction sutures placed on the stomach in diamond-shape configuration. Gastrotomy performed in the center of the diamond.	LOA, ERCP, sphincterotomy, Oddi manometry, gastropexy	Single-layer suture closure around a pancreatico-biliary drain. Stomach pexyed to the anterior abdominal wall.
	Ascending cholangitis, choledocholithiasis	12-mm port LUQ, traction sutures placed on the stomach in diamond-shape configuration. Gastrotomy performed in the center of the diamond.	LOA, ERCP, sphincterotomy, extraction of stone	Two-layer suture closure
	Oddi's dysfunction	12 mm port LUQ, traction sutures placed on the stomach in triangular-shape configuration. Gastrotomy performed in the center of the triangle.	LOA, ERCP, sphincterotomy, Oddi manometry	Two-layer suture closure

*ERCP = endoscopic retrograde cholangiopancreatography, LOA = lysis of adhesions, LUQ = left upper quadrant.

lymphoma (5 years earlier). Her alkaline phosphatase level was elevated (1300), and abdominal ultrasound and CT scan revealed multiple gallstones. Laparoscopic cholecystectomy was performed, and the intraoperative cholangiogram showed impacted stone at the ampulla of Vater. Intraoperative ERCP was attempted but was not possible due to previously undiagnosed esophageal stricture from graft versus host disease. Laparoscopic-assisted transgastric endoscopy was subsequently performed with successful ERCP, sphincterotomy, and extraction of stone. A feeding gastrostomy tube was placed through the gastrotomy wound at the end of the procedure.

Patient 2 was a 35-year-old female who was evaluated for intermittent episodes of right upper quadrant abdominal pain. The patient had undergone cholecystectomy and Roux-en-Y gastric bypass 3 years earlier and had a documented gastrogastric fistula. Her preoperative liver function tests were elevated. Abdominal ultrasound and CT scan as well as magnetic resonance cholangiopancreatography (MRCP) revealed a dilated common bile duct (12 mm). The patient underwent ERCP, sphincterotomy, and transgastric closure of the gastrogastric fistula.

Patient 3 was a 39-year-old female who presented with right upper quadrant abdominal pain. She had a past surgical history significant for cholecystectomy and Roux-en-Y gastric bypass (2 years prior). The patient had elevated alkaline phosphatase levels. Abdominal ultrasound and MRCP revealed common bile duct dilatation (12mm) and likely periampullary stricture. ERCP and sphincterot-

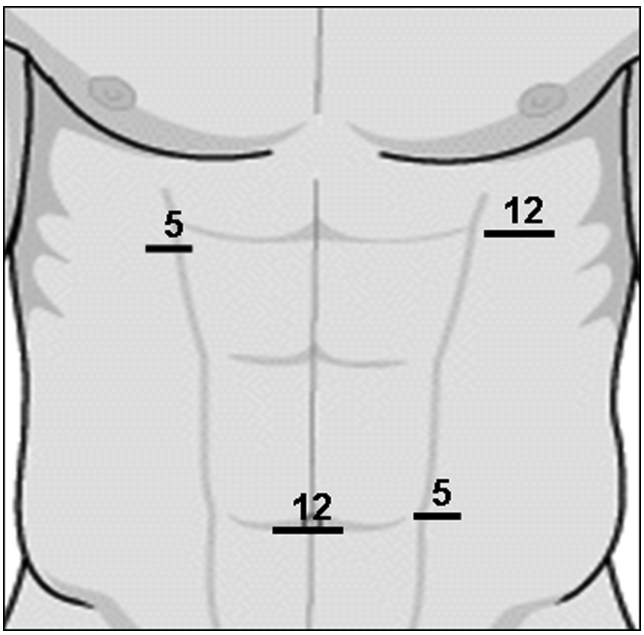

Figure 1. Laparoscopic port placement.

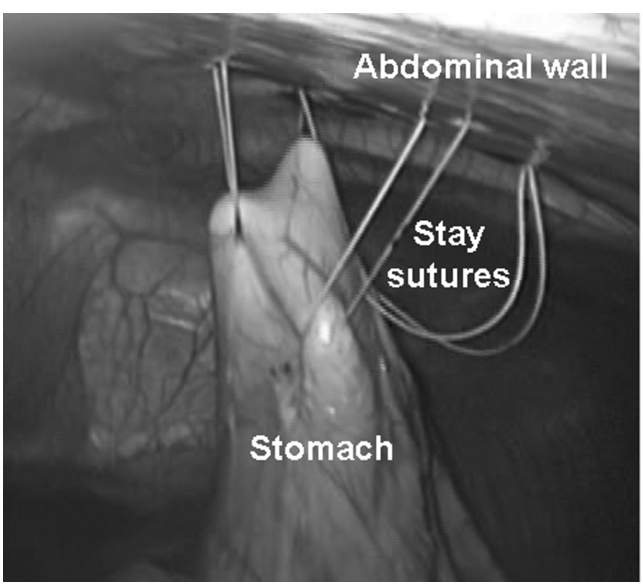

Figure 2. Stomach is being pulled up to the anterior abdominal wall.

omy were performed, after which the gastrotomy was closed in 2 layers.

Patient 4 was a 44-year-old female with a history of laparoscopic Roux-en-Y gastric bypass and laparoscopic cholecystectomy who was admitted with chronic right upper quadrant abdominal pain. The pain was similar to her right upper quadrant pain before cholecystectomy.

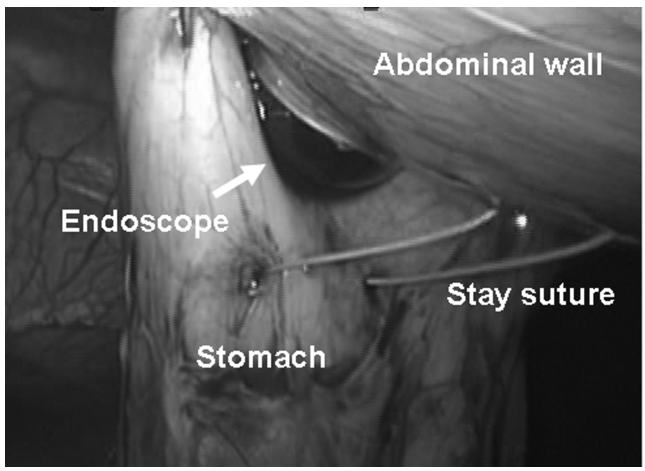

Figure 3. Endoscope is being advanced into stomach.

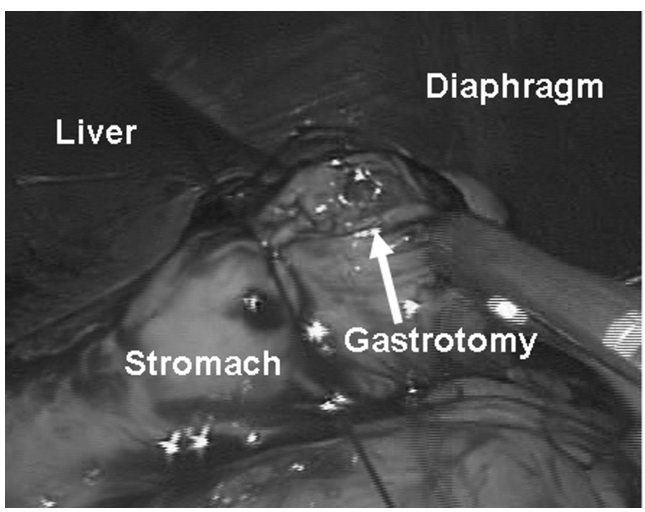

Figure 4. Closure of gastrotomy.

Sphincter of Oddi dysfunction was suspected, and the patient underwent laparoscopic lysis of adhesions, transgastric ERCP, sphincterotomy, and sphincter of Oddi manometry. A pancreaticoduodenal drain was passed through the gastrotomy site and connected extracorporeally for gravity drainage. The gastrotomy was closed with a figure-of-eight suture around the drain and the stomach was anchored to the anterior abdominal wound.

Patient 5 was a 60-year-old female with a history of Roux-en-Y gastric bypass and laparoscopic cholecystectomy who was admitted for ascending cholangitis secondary to choledocholithiasis. The patient underwent laparoscopic lysis of adhesions, transgastric ERCP, sphincterotomy, and extraction of the retained stone. The gastrotomy wound was closed in 2 layers.

Patient 6 was a 45-year-old female who was evaluated for chronic right upper quadrant pain. The patient had a history of open cholecystectomy and Roux-en-Y gastric bypass. With the suspected diagnosis of sphincter of Oddi sphincter dysfunction, the patient underwent laparoscopic lysis of adhesions, transgastric endoscopy, sphincterotomy, and sphincter of Oddi manometry. The gastrotomy wound was closed in 2 layers.

The operative times ranged between 64 minutes to 93 minutes. The patients reported minimal postoperative pain, and no postoperative complications were encountered.

DISCUSSION

Laparoscopic-assisted, transgastric endoscopy was successfully performed in 6 patients with altered upper gastrointestinal tract anatomy. This technique was originally described in 2002,[12] but it was not until recently that it was adopted in clinical practice. In most of the case reports, the technique was used in patients who had previously undergone Roux-en-Y gastric bypass for morbid obesity. To our knowledge, this is the first description of the procedure in a patient with malignant esophageal stricture. Performing an upper endoscopy via the gastrostomy feeding tube site has been previously described in patients with benign esophageal strictures.[18–20]

Several variations in the described technique are possible: the number of ports may be as few as 2, although we found 3 to be optimal. The placement of ports may also vary depending on the patient's anatomy and previous operations. In most cases, we attempted to place the ports through the previous healed laparoscopic incisions from the laparoscopic Roux-en-Y gastric bypass or laparoscopic cholecystectomy. Nevertheless, one large port (12 mm or 15 mm) needs to be placed in the left upper quadrant to allow easy mobilization of the gastric remnant and the creation of the future gastrotomy. The chosen site of the gastrotomy on the anterior gastric remnant wall is circumscribed by the placement of 3 sutures or 4 sutures in a triangular or diamond-shape configuration, which will aid in providing adequate retraction and exposure. In our series, variations also existed in the type of gastrotomy closure: the authors' preferred method is the double-layer technique, although single-layer and stapled closure were used in special circumstances, ie, when a pancreaticoduodenal drain was passed through the gastrotomy site and when 2 gastrotomies were performed in the gastric remnant, respectively. Additionally, a gastrostomy tube can be left in place should the patient need a tube for enteral feeds or if subsequent access to the gastric remnant is envisioned.

The role of transgastric surgery may expand in the future. The described technique could easily be used to treat a Dieulafoy's lesion or bleeding peptic ulcer, resect a proximal lesser curve gastric tumor, or resect a benign duodenal tumor. In addition, transgastric surgery may be an adjunct to capsule endoscopy in the localization and treatment of occult gastrointestinal bleeding. Finally, this surgical technique could also be applicable as an immediate bridge to natural orifice surgery.

CONCLUSION

In an age where surgeons and gastroenterologists are focusing on the stomach as an access point out of the gastrointestinal tract and into the peritoneal cavity, we also view the stomach as a portal into the gastrointestinal tract. In the patient with limited access for traditional endoluminal therapy, laparoscopic-assisted, transgastric endoscopy can be performed safely and efficiently.

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