Laparoscopic Intragastric Surgery With Endoscopic Assistance: A 2 Gastrostomy Approach With Multiple Applications

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Purpose: Laparoscopic intragastric resection is a surgical modality with acceptable oncologic outcomes for gastrointestinal stromal tumors and leiomyomas, particularly for masses located near the gastroesophageal junction (GEJ). We describe our technique of 2 gastrostomy laparoscopic, intragastric resection with endoscopic assistance.

Methods: We detail our technique and report a unique application of this versatile approach.

Results: Between December 2015 and July 2016, 4 patients underwent our combined technique of intragastric surgery. Complete resection was performed in the 2 patients who had gastrointestinal stromal tumors and 1 patient with a leiomyoma without complications. One patient had the unique diagnosis of gastritis cystica profunda. This mass could not be resected, but an effective Tru-cut core needle biopsy was obtained, and the mass was able to be diagnosed and decompressed.

Conclusions: Our technique of 2 gastrostomy laparoscopic intragastric surgery is feasible and offers an effective oncologic approach for resection of tumors near the GEJ.

Key Words: laparoscopic intragastric approach, leiomyoma, GIST, gastritis cystica profunda

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Minimally invasive approaches to gastric masses have evolved since the first case report of a laparoscopic intragastric resection of a gastrointestinal stromal tumor (GIST) in 2000.[1] This technique has often been used for submucosal gastric masses, such as GISTs or leiomyomas, which typically require negative margins to achieve appropriate oncologic resection.[2] Further, this technique has been employed in situations when the mass is located in a challenging location within the stomach, such as the cardia, posterior wall or in close proximity to the gastroesophageal junction (GEJ).

The laparoscopic intragastric approach allows for oncologic resection in these locations, obviating the need to perform a more radical and potentially more morbid surgery, such as open wedge resections or open/laparoscopic proximal gastrectomies, to resect these masses. Since the first described report, there have been some case series which have shown the benefit of laparoscopic intragastric resection for benign gastric masses or early gastric cancer.[3–5] Here, we describe our unique approach and applications of laparoscopic intragastric surgery with endoscopic assistance and provide high quality illustrations detailing our technique.

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METHODS

Preoperative Evaluation

Our protocol for evaluation of a patient evaluation with a gastric mass includes an endoscopic ultrasound (EUS) with biopsy. Computerized tomography (CT) scan is used to determine if the masses are appropriate and amenable to a laparoscopic intragastric resection, as well as exclude the presence of metastases. Similar to the cited studies, we consider patients appropriate for this technique if they have benign gastric masses (benign GIST, leiomyoma) located in the cardia, GEJ, or upper posterior wall of the stomach. Patients are routinely discussed at our multidisciplinary case conference where their imaging and pathology are reviewed to assist in the decision making process.

Operative Description

The following description pertains to a mass located near the GEJ. The patient is placed in the supine position. We request the assistance of one of our expert gastroenterologists for the endoscopic portions of the procedure, which include endoscopic visualization, retraction, and extraction of the specimen via the oral cavity. Figure 1 shows the port placement for our approach to laparoscopic intragastric resection of a proximal gastric submucosal tumor. The abdomen is accessed in the left upper quadrant along the lateral subcostal margin with a 5 mm Optiview trocar under direct visualization. Additional starting trocars include a 5 mm trocar placed approximately 12 cm inferior to the xiphoid just to the left of the midline, a 5 mm trocar placed in the right upper quadrant along the subcostal margin, and a 12 mm trocar in the right abdomen just lateral to the rectus abdominus muscle, which are all placed under direct vision. The operating surgeon stands on the patient's right side utilizing the 2 right sided ports, whereas the assistant stands on the opposite side operating the high definition, 30-degree camera and instruments via the 2 initially placed left sided trocars. The endoscopist stands at the head of the bed.

Initially, the abdomen is explored for any metastatic disease by carefully evaluating the peritoneum and liver surface to corroborate the preoperative diagnosis of a

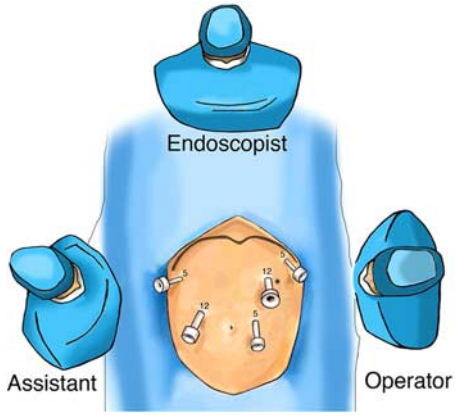

FIGURE 1. Port placement for approach to laparoscopic intragastric resection of proximal stomach submucosal tumor. The abdomen is entered in the left upper quadrant along the subcostal margin with a 5 mm Optiview trocar. Additional trocars include a 5 mm placed approximately 12 cm inferior to the xiphoid just to the left of the midline, a 5 mm placed in the right upper quadrant, and a 12 mm in the right abdomen just lateral to the rectus abdominus muscle. An additional 12 mm trocar is placed in the left abdomen (marked with an asterisk), which serves as one of 2 laparoscopic intragastric trocars.

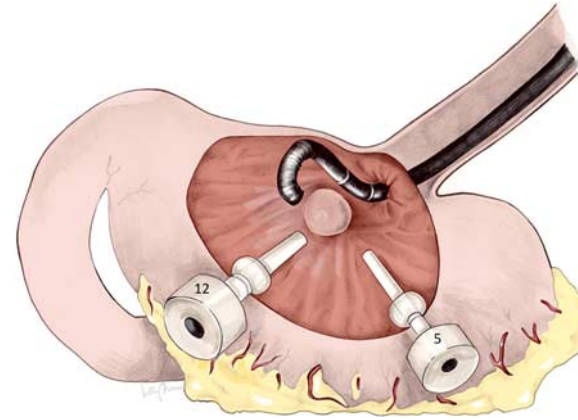

FIGURE 2. After both laparoscopic and endoscopic visualization of the proximal gastric mass near the GEJ, 2 gastrotomies are made. These are along the body of the stomach about halfway and two-thirds distally and medial to the greater curvature, taking care to avoid the gastroepiploic vessels. Depending on the location of the gastric mass, the 12 mm intragastric trocar may be placed either proximal or distal to the 5 mm intragastric trocar. Locations vary based on the specific location of the tumor as described in the text.

benign process. Any questionable lesions are biopsied and evaluated by our pathologist at the time of the operation. An intraoperative ultrasound may be included as part of the intraoperative examination at this time; however, this is not routinely performed, particularly in the setting of negative preoperative imaging. The patient is placed in a reverse Trendelenburg position. Mobilization of the stomach is not required as the intragastric technique allows for adequate visualization and dissection of the mass. The endoscope is then inserted and the jejunum clamped at the ligament of Treitz to prevent over distension of the bowel. The location of the gastric mass is confirmed both endoscopically and laparoscopically.

After dual visualization of the gastric mass as shown in Figure 2, 2 gastrotomies are made with the cautery via the laparoscopic ports. These are along the anterior body of the stomach about halfway and two-thirds distally and medial to the greater curvature, taking care to avoid the gastroepiploic vessels. The location for placement of the 5 mm and 12 mm intragastric ports is important and is dependent on the location of the tumor. If the tumor is located on the proximal lesser curvature side of the GEJ, the 12 mm port is placed distal to the 5 mm port. If the tumor is located on the proximal greater curvature side, the 12 mm port is placed more proximal to the 5 mm port. The placement of the intragastric 12 mm port in either of these locations with respect to the intragastric 5 mm port facilitates the position of the stapler to resect the gastric mass. Figure 1 shows the placement location of the additional 12 mm port in the left abdomen, which is marked with an asterisk, for an approach to a greater curve tumor. Alternatively, the 5 mm port to the left of the umbilicus may be upsized to a 12 mm port and an additional 5 mm port placed in the left abdomen if the tumor is located more on the lesser curvature side of the GEJ.

The ports should be placed into the stomach far enough away from each other so they do not interfere with each other (about 5 cm). Insertion of the trocars is assisted by use of the laparoscopic ports on the right side and by placement of an endosuture(s) on the stomach wall for anterior traction. These ports are then pulled up against the abdominal wall to create a sufficient seal for intragastric insufflation and the insufflation is removed from the laparoscopic ports. To facilitate this seal and minimize leak of insufflation around the intragastric port sites, balloon trocars are used to help appose the stomach wall to the abdominal wall. Following placement of the intragastric ports, the carbon dioxide is then directed through the 12 mm intragastric trocar and set to a cut-off pressure of 8 mm Hg.

As shown in Figure 3, the submucosal gastric mass is visualized using a 5 mm high definition camera through the proximal gastric port. The method for resection is determined

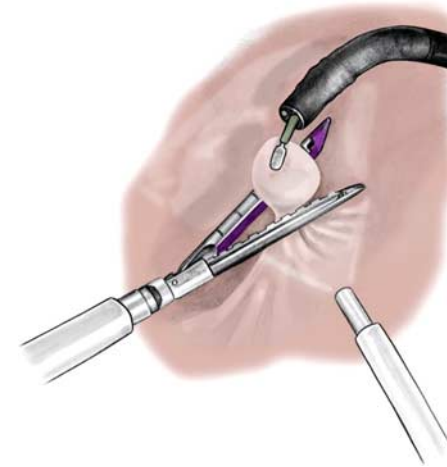

FIGURE 3. The gastric mass in visualized laparoscopically using a 5 mm high definition camera. The gastroesophageal junction is identified and protected by the flexible endoscope. The endoscopist uses biopsy forceps to help position the mass for transection with a Covidien 30 mm Endo GIA stapler. Multiple fires (3 to 5) of the Tri-Staple purple load are used to resect the mass intragastrically.

by assessing its mobility and proximity to the GEJ. The GEJ is identified and protected by the flexible endoscope. If the mass is pedunculated, the endoscopist uses biopsy forceps to help position the mass for removal with an articulating Covidien 30 mm Endo GIA stapler. A 30 mm stapler is utilized given anatomic space constraints within the stomach. Then multiple fires of the Tri-Staple purple load are used to resect the mass intragastrically. If the mass is more sessile, an endosuture can be placed on the mass and then traction is performed by the endoscopist. The hook Bovie cautery is utilized to divide the mucosa and muscularis of the stomach wall as necessary. The stomach wall can then be reapproximated from the inside with deep bites utilizing the endosuture or free sutures. The sutures are left long and are tied utilizing a knot pusher.

Once the mass is completely separated from the gastric wall, an endoscopic specimen retrieval bag (Roth net) is deployed through the flexible endoscope. As shown in Figure 4, intragastric assistance is provided to help place the specimen into the bag. The specimen, secured within the endoscopic retrieval bag is guided up through esophagus and removed through the mouth.

The stomach is desufflated, and the pneumoperitoneum is restored. The 2 gastrotomies are now closed with a Covidien 30 to 45 articulating mm Endo GIA stapler after removal of the intragastric trocars. The right sided 12 mm port site provides the optimal approach for the stapler that is used to close the gastrotomies. The staple loads are reinforced with peristrips to ensure hemostatic closure of the stomach wall. This is shown in Figure 5.

Postoperative Management

In general, the patient is keep NPO overnight and then started on a clear liquid diet on postoperative day 1.

FIGURE 4. Once the mass is completely separated from the gastric wall, an endoscopic specimen retrieval bag (Roth net) is deployed through the flexible endoscope. Laparoscopic assistance is provided to help orient the specimen into the bag, and the specimen is guided up the esophagus and removed through the mouth.

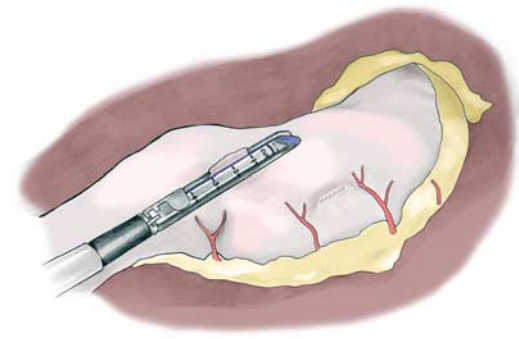

FIGURE 5. The 2 gastrotomies are closed with a Covidien 30 or 45 mm Endo GIA stapler after removal of the intragastric trocars. The patient is keep NPO overnight and then started on a clear liquid diet on POD 1. Postoperative imaging is not routinely performed. The patient is discharged on a full liquid diet for 1 week after which time the patient is advanced to a soft diet.

Postoperative imaging (gastrograffin upper gastrointestinal series) is not routinely performed. The patient is discharged on a full liquid diet for 1 week, after which time the patient is advanced to a soft diet. The patient can advance his or her diet as an outpatient before routine follow-up, which is typically within 2 weeks from surgery. To help ensure compliance with the postoperative instructions, a physician extender and dietician routinely call the patient to assess compliance.

RESULTS

Between May 2015 and October 2016, 4 patients underwent our combined technique of laparoscopic intragastric surgery with endoscopic assistance. Two patients were female, and 2 were male. The average age was 62 years (range, 47 to 77). The average body mass index of the 4 patients was 34.6 (range, 26.6 to 45.9). The patients had an ASA score (American Society of Anesthesiologists grade) of 2 to 3. Each patient had routine preoperative laboratory work, including a complete blood count and basic metabolic panel, which showed no abnormalities. The average operative time was 170 minutes (range, 101 to 227 min). No patients required intraoperative or perioperative blood transfusion. There were no intraoperative or postoperative complications.

The average tumor size was 2.8 cm. Two patients had a GIST. The pathologic stage for patient 1 was pT2, consisting of a 2.8 cm tumor with 2 of 50 mitoses per high-power field. For patient 2, the pathologic stage was pT1 (2.0 cm tumor with 0 mitoses). A third patient had a leiomyoma, which measured 3.5 cm. All specimens had negative margins.

For our patient with the 2.8 cm GIST, a modification of our approach was needed because the tumor was adherent to the muscular wall of the stomach along a broad base. Because the mass was not pedunculated, the stapler was unable to be deployed in a manner to obtain an appropriate margin on the stomach wall. Therefore, hook cautery was used to open the mucosa overlying the tumor and dissected the tumor away from the mucosa and muscular wall. A portion of the muscular wall of the stomach was excised using the hook cautery, and the specimen was completely removed. This resulted in a defect in the stomach wall measuring approximately $3 \times 2\,cm^2$. Using an endosuture with 2-0 silk sutures, the stomach wall was repaired using full thickness interrupted knots. An intraoperative leak test using endoscopic

air insufflation was performed and was negative. Because of the more extensive dissection and repair than our normal approach, an UGI gastrografin study was performed on postoperative day 2 to evaluate for leak. No leak was detected.

The fourth patient had an unknown preoperative diagnosis. The EUS for this patient described a proximal submucosal mass. The EUS-guided fine needle aspiration (FNA) was nondiagnostic and reported only inflammatory tissue. The CT scan, depicted in Figure 6, showed features consistent with a benign process such as a GIST or leiomyoma. Interestingly, this patient also had a moderately sized hiatal hernia, which did not require reduction or repair to gain intragastric access to the mass. Because the hiatal hernia was asymptomatic and the patient had multiple comorbidities, we elected not to address the hernia at the time of operation. For this patient, the mass could not be resected using our described technique, as the mass was firm and nonmobile. During attempted manipulation, purulent fluid was expressed from the mass through the mucosa of the stomach. Following this, the mass seemed to decompress. Because there was no definitive diagnosis, we utilized our laparoscopic intragastric technique to obtain sufficient tissue for diagnosis, which was neither possible with the EUS FNA nor with a percutaneous biopsy approach given the mass location (Fig. 6). A Tru-cut needle was deployed through the distal 12 mm trocar to obtain a core needle biopsy before ending the surgery. Interestingly, this core biopsy was able to provide the diagnosis, which was gastritis cystica profunda. This is a rare, benign disease characterized by polypoid hyperplasia and cystic dilatation of the gastric glands that extend into the submucosa of the stomach.[6,7]

For our series, the average inpatient length of stay was 3.5 days (range, 2 to 5 d). On postoperative follow-up each patient was doing well, tolerating a soft diet. The median follow-up was 100 days (range, 18 to 240 d). None of the patients reported any functional complaints related to their surgery at follow-up.

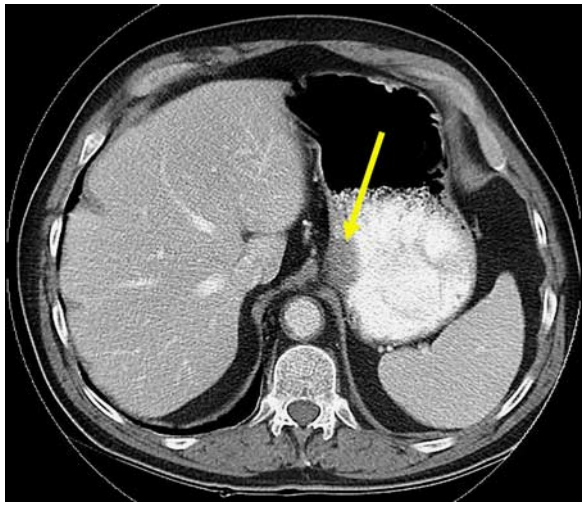

FIGURE 6. Computerized tomography scan showing proximal gastric mass for patient who underwent laparoscopic intragastric surgery. Preoperative endoscopic ultrasound-guided biopsy was nondiagnostic. The patient underwent attempted laparoscopic intragastric resection, but during the procedure the mass decompressed after expressing purulent fluid. The laparoscopic intragastric approach allowed for core needle biopsy with a Tru-cut needle under direct visualization, successfully providing enough tissue for a diagnosis of gastritis cystica profunda.

DISCUSSION

In this report, we have illustrated our approach for laparoscopic intragastric surgery using 2 gastrotomies with placement of one 5 and a 12 mm port and with endoscopic assistance. The utilization of this technique has been well established for benign lesions of the stomach and has also been reported for early adenocarcinoma located in anatomically challenging regions for resection.[8–10] Although gastric GISTs are often confined to the stomach, it is important to note that some may be malignant, requiring a careful multimodal approach to treatment that may or may not include surgery. We have chosen a 2 gastrotomy approach with endoscopic assistance whereby the tumor is removed endoscopically through the esophagus and the oral cavity. We emphasize that the success of our technique relies on an experienced endoscopist. Otherwise, surgeons who are already skilled in laparoscopy should readily adapt to this method as the fundamental principles are the same. Endoscopic assistance also minimizes the number of gastrotomies that are required.

This approach can be utilized for both pedunculated and small sessile tumors. The advantages of this approach include preservation of gastric functioning with no need to mobilize the stomach and low chance for any injury to the vagus nerve and subsequent gastroparesis. However, larger sessile tumors would represent a challenge for this approach, particularly if the lesion cannot be technically resected or performed safely without narrowing the GEJ. In addition, only 2 gastrotomies are utilized and their size is minimized by obviating the need to remove the specimen through the stomach and abdominal wall. Minimizing both the number and size of gastrotomies assists in the gastric wall closure and theoretically decreases the risk for gastric leaks compared with techniques which use ≥ 3 gastrostomies. Furthermore, the technique can be utilized even in the presence of a hiatal hernia without the need to reduce or repair the hernia. This can have important implications in cases where the patient has poor performance status or multiple comorbidities when it would be advantageous to minimize the total operative and anesthesia time. These benefits may be even more realized in obese patients, as was the case for 2 of our patients, by providing a more direct route to the tumor through the stomach. It is important to note that proper placement of the intragastric trocars, as described above, is essential to the success of the operation, particularly for obese patients where surgery may be more difficult if trocars are suboptimally placed.

For 2 of our patients, we utilized unique applications of our technique. In the first case, we performed laparoscopic intragastric suture repair of the gastric wall following resection of a sessile, broad-based GIST. This is a modification of our technique that has not been previously reported. In the second case, we performed a successful core biopsy of a gastric mass of unknown etiology. This mass could not be accessed percutaneously because of its central location, and the EUS-guided FNA was insufficient for diagnosis. Moreover, because of the patient's hiatal hernia, the mass could not be easily visualized laparoscopically and would have required reduction of the hernia for a safe laparoscopic approach for biopsy. In contrast, the laparoscopic intragastric approach with core needle biopsy using a Tru-cut needle passed through an intragastric trocar offers a novel diagnostic approach which has not been previously reported. The mass was also decompressed though this approach, which provided symptomatic relief for the patient.

The oncologic results for this approach have been reported to be favorable with no cases of local recurrence.[11,12] Consistent with our series, each of these patients underwent a laparoscopic intragastric approach with endoscopic assistance. Although these case series are small, with approximately 15 patients per study, these patients were highly selected, having tumors present in challenging locations within the stomach (proximal, lesser curve, posterior body, antrum) and an average tumor size of about 3.5 cm. We recognize that this study and others have few numbers of patients, which limits long-term analysis of outcomes. However, regarding short-term outcomes, there were no significant intraoperative or postoperative complications. Our operative times and hospital length of stay were also comparable with other reports, with mean operative times ranging from approximately 2 to 3 hours and mean length of stays ranging from 3 to 6 days.[8,12] It is our practice to not routinely acquire postoperative imaging for these patients unless there is a clinical concern for leak.

In conclusion, the laparoscopic intragastric approach to gastric masses offers a technically safe and oncologically appropriate operation in highly selected patients. Novel applications of this approach can also be utilized, including successful biopsy to obtain diagnosis of unclear gastric processes, when other diagnostic approaches are limited or contraindicated.

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