SCIENTIFIC PAPER

Comparison of Laparoscopic Versus Open Approach to Gastrostomy Tubes

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ABSTRACT

Background and Objectives: Gastrostomy tube insertion for enteral access may be performed through laparotomy (open) or through the laparoscopic approach. This study's purpose is to compare outcomes of these different approaches.

Methods: A retrospective chart review of all patients (age >18 years) who underwent insertion of a gastrostomy tube as a single elective procedure between 2004 and 2012 was performed. Primary end points included postoperative overall and tube-related morbidity, tube revision rates, and operative time.

Results: During the study period, 71 patients had a gastrostomy tube inserted via either the open (n = 46) or the laparoscopic (n = 25) approach. Preoperative variables including age, gender, body mass index, albumin, and American Society of Anesthesiologists score were statistically comparable between groups. There was no difference in rates of previous upper abdominal surgery (24% vs 26%, $P = .590$) or gastric surgery (12% vs 13%, $P = .720$) in the laparoscopic and open groups, respectively. Previous percutaneous endoscopic gastrostomy tube insertion rates were higher in the laparoscopic group (32% vs 6.5%, $P = .005$). Operative time was significantly longer in the laparoscopic group (76.8 ± 7 vs 55.8 ± 3, $P = .003$) but was not affected by previous abdominal surgery or higher body mass index. Overall morbidity, tube-related morbidity, and tube revision rates were similar between groups. However, there was a trend toward increased major complication rates in the open group (6.5% vs 0%, $P = .190$).

Conclusion: Laparoscopic gastrostomy tube insertion is safe and feasible, even in patients who have had prior upper abdominal surgery. Patients with a prolonged prognosis, obesity, and intact neurologic capacity may benefit the most from this approach.

Key Words: Gastrostomy, Outcomes, Laparoscopy.

INTRODUCTION

Enteral feeding via a gastrostomy tube (GT) is the treatment of choice for patients with a functional gastrointestinal tract who are unable to tolerate oral feeding and are at risk for malnourishment. Common indications for GT insertion are obstructing head and neck cancer, benign and malignant esophageal disease, neurologic dysfunction, trauma, and respiratory failure.

An open surgical gastrostomy was first described by Stamm in 1894 and was considered the standard for long-term enteral access and gastric decompression until the early 1980s, when the percutaneous endoscopic gastrostomy (PEG) was introduced.[1] Because of its simplicity and effectiveness, PEG has since been considered the method of choice.[2–4] Nevertheless, PEG is not always feasible. Reasons for avoiding PEG include inaccessible stomach because of an occluded aerodigestive tract, prior upper abdominal or gastric surgery, an overlying transverse colon, hiatal hernia with a high located stomach, hepatomegaly, or a previous failed attempt at PEG.[5] In such clinical settings, a surgical gastrostomy is preferred, and the surgeon may decide to perform the procedure either laparoscopically or using the open traditional Stamm technique.

Laparoscopy offers the patient a smaller incision size, less pain, better cosmetic outcomes, and lower risk of developing an incisional hernia. Laparoscopic GT also has the benefit of better visualization of the stomach and intra-abdominal cavity as opposed to the open approach. Previous studies described placement of a laparoscopic GT using a 2-port technique. One port was placed at the umbilicus and the other was placed in the left upper quadrant in an area above the stomach, through which the stomach was pulled to create the gastrostomy. The stomach was anchored to the anterior abdominal wall either

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DOI: 10.4293/108680813X13693422520927

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with T-fasteners or with regular sutures.[5–9] When compared with the standard open GT, it showed decreased operative time and equal cost.[5,7] Nevertheless, this approach may prove difficult when adhesions are present, causing challenging stomach mobilization in patients with prior upper abdominal surgery. In fact, some authors have described using up to 4 ports in cases when lysis of adhesions was required, whereas others have even considered prior upper abdominal surgery as an absolute contraindication for attempted laparoscopic GT.[5,8] Furthermore, some postoperative complications such as peristomal cellulitis, bleeding, and serous drainage have been attributed to the pressure the T-fasteners apply to the stoma site.[5]

At Mount Sinai Medical Center, we have been performing novel, fully laparoscopic GT insertion using 3 ports. This enables safe lysis of adhesions and placement of a GT, even in patients with prior upper abdominal or gastric surgery, because of better visualization and mobilization of the stomach. It also allows intracorporeal purse-string suture placement, safely securing the GT to the stomach and the stomach to the anterior abdominal wall, as in the Stamm procedure. Our laparoscopic approach and comparison of this approach with the standard open GT has yet been described in the surgical literature. The aim of this study is to compare the outcomes of this 3-port laparoscopic GT approach to the open GT approach.

MATERIALS AND METHODS

After approval of the hospital's institutional review board, a retrospective chart review was performed of all patients who underwent placement of a GT at the Mount Sinai Medical Center between August 2004 and May 2012. Excluded were patients that had GT placement as part of another procedure or those under the age of 18 years.

Demographic data including age, gender, body mass index, and preoperative albumin levels were reviewed, as well as the indication for the procedure and patient's history of prior abdominal surgery, gastric surgery, or PEG placement. Operative risk was assessed using the American Society of Anesthesiologists classification score. A preoperative prophylactic dose of antibiotics was administered intravenously to all patients. The surgeon's preference determined the surgical approach. The operative report was reviewed to identify the surgical approach (open vs laparoscopic), operative details (GT size, number of ports, incision size), estimated blood loss, and operative time. Postoperatively, all tubes were placed for gravity drainage until the following morning. An isotonic solution was then initiated at a rate of 10 mL/hr for the following day and, if tolerated, tube feedings were started. Patients' charts were reviewed to document postoperative course, overall morbidity, GT-related morbidity, mortality, and GT revision rates. Cost analysis was performed based on hospital charges for operative time, anesthesia, and equipment per procedure.

To compare between the laparoscopic and open surgery subgroups, univariate analysis with χ^2 and t test were used. Statistical calculations were completed using statistical software SPSS version 17 (IBM, Inc., Armonk, NY), and a P value $< .05$ was considered statistically significant for all comparisons.

Operative Technique

Open GTs were inserted using the Stamm technique. A small, vertical midline incision was performed in the upper abdomen and the stomach was exposed. Purse-string sutures were placed on the anterior wall of the stomach. A GT was passed through an incision in the left upper abdomen and inserted into the stomach through a gastrotomy. The purse-string sutures were then tied around the tube. Fixating sutures were then applied between the seromuscular layer of the stomach and the anterior abdominal wall around the entrance site of the tube.

Laparoscopic gastrotomies were performed using 3 ports. A pneumoperitoneum was achieved either through the open Hassan technique, the optically guided trocar, or the Veress needle. The first port was placed at the umbilicus and an additional two 5-mm ports were placed in the right and left abdomen. After inspection of the peritoneal cavity, a suitable site for the gastrostomy was selected. A double purse-string suture was placed intracorporeally in a seromuscular manner at the site of the future gastrostomy. A full-thickness gastrotomy was made within the inner purse-string suture using the ultrasonic shears. A GT was placed through a stab incision in the left upper quadrant and inserted into the stomach. The purse-string sutures were tied down to create a seal. Anchoring sutures were then placed intracorporeally in a seromuscular manner at the cardinal positions around the GT site. The suture passer was used to grasp these sutures, bring them out and tie them down, until the quadrants of the stomach surrounding the tube were fully tacked up to the anterior abdominal wall.

RESULTS

After performing a database search, 182 gastrostomy procedures were identified during the study period. Excluded

Table 1.
Comparison of Preoperative Variables

Variable	Open (N = 46)	Laparoscopy (N = 25)	*P* Value
Demographic			
Mean age (y)	61.4 ± 2.4	62.2 ± 3.2	.83
Male gender, n (%)	27 (56)	14 (58.7)	.8
Body mass index (kg/m^2)	23.6 ± 0.9	24.5 ± 1.2	.52
Preoperative albumin (mg/dL)	3.3 ± 0.1	3 ± 0.2	.38
ASA[a] score, n (%)			.46
1	0	0	
2	4 (8.6)	0	
3	21 (45.7)	11 (44)	
4	21 (45.7)	14 (56)	
Surgical			
Previous abdominal surgery, n (%)	12 (26)	6 (24)	.59
		Open gastrostomy (3)	
		Cholecystectomy (2)	
		Splenectomy (1)	
Previous gastric surgery, n (%)	6 (13)	3 (12)	.73
Previous PEG placement, n (%)	3 (6.5)	10 (40)	.005

[a]ASA = American Society of Anesthesiologists.

Table 2.
Indication for Surgery

Indication	Open (N = 46)	Laparoscopy (N = 25)	*P* Value
Head and neck cancer, n (%)	22 (47.8)	11 (44)	.29
Esophageal and gastric cancer, n (%)	3 (6.5)	3 (12)	
Neurologic disorder, n (%)	11 (23.9)	7 (28)	
Respiratory failure, n (%)	2 (4.4)	3 (12)	
Gastrointestinal, n (%)	8 (17.4)	1 (4)	

Table 3.
Comparison of Operative Outcomes

	Open (N = 46)	Laparoscopy (N = 25)	*P* Value
Mean OR time (min)	55.8 ± 3.3	76.8 ± 7	.003
Estimated blood loss (mL)	24.3 ± 6.8	15.8 ± 2.07	.31
GT size (French)	21	21	.56
Incision size (cm)	5	N/A	

from analysis were gastrostomies that were performed as part of another procedure or concomitant with another procedure (n = 99) and those in patients under the age of eighteen (n = 12). This resulted in a cohort of 71 patients, of which 25 underwent a laparoscopic GT (35%) and 46 underwent an open GT (65%).

Comparison of patient characteristics between both groups is shown in **Table 1**. Groups were statistically comparable for age, gender, body mass index, preoperative albumin level, and American Society of Anesthesiologists scores. A significantly higher number of patients had a prior PEG in the laparoscopic group (40% vs 6.5%, $P = .005$). The laparoscopic group had almost comparable rates of prior gastric (12% vs 13%, $P = .73$) and abdominal surgery (24% vs 26%, $P = .59$). The groups did not differ in the indication for surgery, as shown in **Table 2**. Head and neck cancer was the most common indication for surgery in both groups, followed by neurologic disorder.

Table 3 summarizes the operative outcomes. The mean operative time was significantly longer in the laparoscopic group (76.8 ± 7 vs 55.8 ± 3 min, $P = .003$). There was no significant difference between the groups in the estimated blood loss reported (15.8 ± 2 vs 24.3 ± 6 mL, $P = .310$) or the GT size inserted (21 ± 1 vs 21 ± 1 Fr, $P = .560$). In the open group, the mean incision size was 5 cm. Fourteen patients (56%) from the laparoscopic group required lysis of adhesions during their procedure. When they were examined on a case-by-case basis, lysis of adhesions, prior PEG, or upper abdominal surgery did not appear to influence operating room time. Only one laparoscopic procedure was converted to open (4%): The surgeon had technical difficulties passing the GT through the gastrotomy and thus it was converted and completed in an open approach. Of note, this patient had a prior open splenectomy, and multiple adhesions were encountered, but they were easily lysed and were not the cause of conversion.

Comparison of postoperative outcomes is shown in **Table 4**. There were no mortalities in the laparoscopic group and 2 mortalities in the open group during the 30-day postoperative period. One death was caused by acute respiratory distress syndrome, and the other was caused by sepsis as a result of lower-extremity gangrene. Overall morbidity (24% vs 17.4%, $P = .500$) and GT-related morbidity (12% vs 8.7% $P = .350$) were similar between the laparoscopic and open groups, respectively. However, the major complication rate was nearly significantly higher in the open GT group (6.5% vs 0%, $P = .190$). In the laparoscopic group, 6 patients presented with morbidity during the postoperative 30-day period. Three had non–GT-related morbidity: tumor progression from an original brain tumor, worsening of preexisting pneumonia, and aspirated methylene blue given to test for a possible peritubal leak. All 3 patients who presented with GT-related morbidity in the laparoscopic group had minor complications. One had a surgical site infection that was treated bedside in the emergency department with suture replacement and oral antibiotics; this same patient, as well as 2 others, had leakage around their GT, requiring readmission and tube replacement. In the open group, 2 patients (4.3%) presented with minor complications. Both had persistent leakage around the GT site, requiring bedside tube replacement. Three patients in the open group (6.5%) had major complications. One patient presented with abdominal pain and dislodgement of the tube approximately 10 days after the procedure and was taken back to the operating room for tube replacement. One other patient had surgery to treat wound dehiscence 10 days after the initial GT placement. The third patient, who had a Moss GT placed during the initial operation, had further surgery because of a perforation of the fourth part of the duodenum on postoperative day 7. The perforation site was oversewn and a feeding jejunostomy was inserted.

Table 4.
Comparison of Postoperative Outcomes

	Open (N = 46)	Laparoscopy (N = 25)	*P* Value
Overall morbidity, n (%)	8 (17.4)	6 (24)	.5
GT-related morbidity, n (%)	4 (8.7)	3 (12)	
Minor, n (%)	2 (4.3)	3 (12)	.35
Surgical site infection	0	1	
GT leak	2	3	
Readmission	3	3	
Major, n (%)	3 (6.5)	0 (0)	.19
Bowel perforation	1	0	
Wound dehiscence	1	0	
GT dislodgment	1	0	
Tube adjustment/ replacement, n (%)	3 (6.5)	3 (12)	.62
Mortality, n (%)	2 (4.3)	0 (0)	.29

The cost for additional equipment needed for laparoscopic GT placement (eg, trocars, endoscopic shears, ultrasonic shears) was approximately $800. Operative time was charged in 30-minute blocks of time. Based on the longer operative time (76.8 ± 7 vs 55.8 ± 3.3 min, $P = .003$), the laparoscopic GT operations cost an additional $1600. This resulted in an overall additional charge of approximately $2400 per case in the laparoscopic GT group.

DISCUSSION

GT insertion for enteral feeding is considered the standard of care for patients with a functioning gastrointestinal tract who are unable to tolerate oral feeding and are at risk for developing malnutrition. The open Stamm gastrostomy was the method most commonly used until the invention of PEG, which is now considered the preferred method for GT placement. However, patients who have failed PEG insertion are candidates for surgical placement of a GT either by the open or the laparoscopic approach.

During the last 2 decades, several studies have described their experience with laparoscopic GT.[5–13] The first published were descriptive noncomparative studies.[10–14] Descriptions included modifications of the traditional Stamm technique using T-fasteners, a laparoscopic-assisted approach, 2 or 3 ports, or a combination of all of these. Hsieh et al described a laparoscopic Witzel gastrostomy, but with no comparison with the open approach.[15] The study included only head and neck or esophageal cancer patients, of which only 2 were noted to have had prior gastric surgery. These studies were followed by comparative studies showing similar results when compared with the standard Stamm gastrostomy and PEG techniques,[6,9] with others showing even fewer complication with the open approach.[5]

The 2-port technique, described in previous studies, obviously shortens operative time but is practically impossible in cases where lysis of adhesions is required. This has led some authors to consider prior abdominal surgery as a relative contraindication to the laparoscopic approach.[5,6]

Kandil et al. described a 2-port laparoscopic technique in which double purse-string sutures were placed once the stomach was exteriorized through the port placed above it, avoiding the use of T-fasteners. In their study, 3 of 14 (21.5%) patients needed as many as 4 ports placed because of lysis of adhesions.[8]

These technical challenges have led us at The Mount Sinai hospital to modify and innovate a 3-port fully laparoscopic approach. Our novel approach enables safe lysis of adhesions, even in patients with prior upper abdominal or gastric surgery, because of better visualization and mobilization of the stomach. It also allows intracorporeal purse-string suture placement, safely securing the GT to the stomach and the stomach to the anterior abdominal wall as in the Stamm procedure, without the need for T-fasteners or other extracorporeal techniques.

In our study, the rate of prior PEG placement (40%) or prior upper abdominal surgery (24%) was relatively high. Despite this, only one procedure was converted to the open approach and not because of adhesions or inaccessibility to the stomach. We attribute this to our 3-port approach, facilitating lysis of adhesions even in cases in which a prior major upper abdominal surgery was done. To note, lysis of adhesions was performed in 14 patients (56%) in the laparoscopic group, even in patients without a history of abdominal surgery, further emphasizing the advantage of our technique. Interestingly, increase in OR time was not related to lysis of adhesions or to prior upper abdominal surgery.

The postoperative mortality rate in our series (4.3%) was comparable with the mortality rates shown in previous studies.[6,9] The 2 patients who died, one from sepsis and the other from acute respiratory distress syndrome, were 84 and 90 years old, respectively. They both had major comorbidities such as coronary artery disease, chronic obstructive pulmonary disease, hypertension, and dementia. No statistical correlation could be made between age or surgical approach and mortality but this result is limited by the relatively low number of patients in our cohort. Although the deaths were not directly related to the procedure, the relatively high postoperative mortality rate in our study and others emphasizes the role of careful patient selection preoperatively. This is especially true when considering offering a patient the laparoscopic approach.

Previous studies comparing laparoscopic with open GT placement have failed to show a statistically significant difference in postoperative complication or tube revision rate. Murayama et al showed an 11% versus 6% postoperative complication rate when comparing open and laparoscopic GT insertion. In a later study, Ho et al found a postoperative complication rate of 24.9% versus 18.3% and a revision rate of 6.7% versus 10% in the open and laparoscopic groups, respectively. Although it had a large cohort (356 patients), his study included patients undergoing GT placement alone and as part of another procedure, and elective as well as emergent procedures, thus skewing the sole impact of the actual GT insertion on outcome results. Furthermore, the main indications for surgery were trauma and burn, which may have influenced outcomes, especially those related to respiratory or surgical site infection.[9] A higher postoperative complication rate using laparoscopy (7.7%) versus open (0%) was found in a study published by Bankhead et al. Complications in the laparoscopic group included 1 episode each of cellulitis, bleeding, and serous drainage around the tube, all attributed to the use of T-fasteners. His study excluded patients who had prior upper abdominal surgery and focused more on nutritional outcomes and complications.[5] In our study, overall complications (24% vs 17.4%, $P = .5$), as well as GT-related complications (12% vs 8.7%) rates, were similar between the laparoscopic and open groups, respectively. Nevertheless, the open group had a nearly significant higher rate of major complications (6.5% vs 0%, $P = .19$). Duodenal perforation, wound dehiscence, and GT dislodgement required reoperation and were followed by longer and more complicated postoperative courses. The laparoscopic approach might have prevented these complications because it offers better visualization of the entire intraabdominal cavity and minimizes the risk for wound dehiscence. In our study, the laparoscopic group had no events of tube dislodgment. Other studies using different techniques have shown tube dislodgment rates of up to 14%.[8,9] We attribute our relatively low rate of tube dislodgment to the double purse-string suture and seromuscular sutures placed intracorporeally, further reinforcing the tube to the stomach and the stomach to the anterior abdominal wall.

The mean operative time for laparoscopic GT placement in our study (76.8 min) was significantly longer than that shown in other studies. Several factors might have prolonged our operative time. First, the novel laparoscopic approach we describe is more technically demanding than the previously described 2-port laparoscopically assisted approach. Our technique requires intracorporeal suturing and knot-tying skills, as well as the ability to perform an extensive laparoscopic lysis of adhesions in some cases, obviously lengthening the procedure. Second, as opposed to some previous studies excluding patients who had prior upper abdominal surgery from the laparoscopic approach, our series had a

relatively high rate of patients who had prior PEG placement (40%) or gastric (12%) or upper abdominal (24%) surgery. All of these cases required lysis of adhesions to some extent, prolonging operative time. Finally, our hospital is a teaching institution and residents participate in the procedures assisted and supervised by an attending physician. Undoubtedly, most surgical trainees find laparoscopic adhesiolysis and intracorporeal suturing to be more difficult than performing these tasks in an "open" approach, further adding to the length of the procedure. Despite laparoscopy surgery's possible influence on operative time, we believe this procedure is an excellent advanced skill challenge for our residents, exposing them to upper gastrointestinal tract surgery.

The cost-effectiveness of laparoscopic surgery is frequently questioned when assessing the feasibility of laparoscopy. Using more expensive laparoscopic equipment and prolonged operative time lead to substantially higher costs. The benefits of laparoscopy have been well-described: shorter length of hospital stay, decreased pain medication requirement, earlier return to basic function, better cosmesis, etc. These factors were difficult to assess in this study considering the patient population. Our laparoscopic GT group had fewer major complications; we can consider this a cost advantage over open GT placement.

This study has several limitations. The retrospective nature of the study promotes selection bias. To maximally clarify the association between procedure and outcome, we included only patients who had a GT inserted as the sole procedure. This resulted in a more limited cohort of patients. With a larger cohort, we may have been able to show statistically significant differences between the groups. Also, we could not conduct a surgeon-control analysis of the data because more than 15 different attending and resident surgeons have performed the procedures. The data obtained revealed no association between surgeon and complication rate.

Despite its limitations, our study is the first to describe an entirely laparoscopic Stamm gastrostomy and compare it with the open approach. The study showed that using our 3-port approach, laparoscopic GT is feasible and safe, even in patients with prior upper abdominal surgeries. We believe that patients with morbid obesity, intact mental capacity, and prolonged prognosis should be considered candidates for the laparoscopic approach because they could potentially benefit the most from the advantages of laparoscopy. Future prospective studies comparing our 3-port total laparoscopic approach to the previously described 2-port laparoscopic assisted approach and open GT insertion are needed to determine the superiority of either approach.

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