SCIENTIFIC PAPER

Gastrojejunal Strictures after Roux-en-Y Gastric Bypass With a 21-MM Circular Stapler

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ABSTRACT

Introduction: Intraluminal staplers for gastrojejunostomy construction during Roux-en-Y gastric bypass (RYGBP) may be associated with postoperative strictures. We analyzed outcomes of a transabdominal circular-stapled RYGBP with evaluation of short- and long-term anastomotic complications.

Methods: All laparoscopic RYGBPs performed between January 2004 and December 2005 at an academic institution were reviewed. The gastrojejunostomy was created by using the transabdominal passage of a 21-mm intraluminal circular stapler into an antecolic, antegastric Roux limb. This retrospective chart review analyzes patient demographics, anastomotic complications, and weight loss.

Results: Between January 2004 and December 2005, 159 patients underwent transabdominal circular-stapled RYGBP. Fifteen patients developed a stenosis at the gastrojejunostomy, all requiring endoscopic balloon dilatation. One of these patients required laparoscopic revision of the gastrojejunostomy. Eleven strictures occurred after 30 days, whereas only 4 strictures occurred within 30 days of surgery. Two marginal ulcerations were seen within 1 year of surgery.

Conclusion: Our 9.4% stricture rate parallels what has been reported in the literature. The majority of strictures were amenable to one endoscopic treatment session. Transabdominal circular-stapled gastrojejunostomy is a reproducible construct for use in bariatric surgery.

Key Words: Stricture, Laparoscopic gastric bypass, Endoscopy, Morbid obesity.

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INTRODUCTION

Morbid obesity (Body Mass Index ≥40 or ≥35 with comorbidities) is a major health concern in the United States, affecting over 15 million people. Despite associated comorbidities in this population, <1% of patients seek surgical intervention. Bariatric surgery has been the only successful therapy for permanent weight reduction with resolution of the multiple comorbidities associated with morbid obesity. Roux-en-Y gastric bypass (RYGBP) is one of the most commonly performed bariatric procedures in the United States, although wide variation exists in the way the surgery is performed. Laparoscopic RYGBP studies have shown clear advantages over open RYGBP, specifically with less postoperative pain, decreased operative blood loss, shorter length of hospital stay, quicker return to normal physical activity, and fewer incisional hernias.[1]

Although the basic principles of performing a gastric bypass have been retained, several techniques can be utilized to create a laparoscopic gastrojejunostomy. These include formation of a hand-sewn, circular-stapled, or liner-stapled anastomosis. The size of the gastric pouch, position of the Roux limb (antegastric vs. retrogastric and antecolic vs. retrocolic), and stapler size reported in the literature also vary. Early and late complications, such as anastomotic leak, strictures, and marginal ulceration, however, do occur with all of these techniques.

Anastomotic stricture tends to occur with greater frequency among these complications.[2,3] The incidence of strictures with a circular-stapled gastrojejunostomy varies widely within the literature from 1% to 31%. Stricture rates of 1.1%[1] to 31%[4] have been reported with 21-mm circular-stapled anastomoses. Patients typically present weeks to months postoperatively with vomiting, dysphagia to solids and liquids, and little or no abdominal pain. Pathophysiologic mechanisms implicated in stricture formation include ischemia, inadequate technique, and nonischemia-related cicatricial narrowing. The only diagnostic modality usually required is direct visualization with endoscopy but may also include contrast radiography. Endoscopic balloon dilation is a safe, reliable treatment for strictures,[5–10] and surgical revision is typically reserved for strictures that have failed endoscopic attempts. Our aim was to examine

the incidence of strictures and therapy for a single technique of gastrojejunostomy.

MATERIALS AND METHODS

Patients with BMI>40 or BMI>35 with comorbidities were offered bariatric surgery. Preoperatively, a multidisciplinary team of dieticians, nurse practitioners, psychologists, and internal medicine physicians evaluated the patients. Between January 2004 and December 2005, we performed 196 laparoscopic RYGBP procedures at our institution. Thirty-seven patients were excluded from the study; the excluded population included patients with a hand-sewn or linear-stapled gastrojejunostomy, Roux limbs placed in the retro-colic position, and conversions of vertical banded gastroplasties to RYGBP. In the remaining 159 patients, the gastrojejunal anastomosis was created using the transabdominal passage of a 21-mm intraluminal circular stapler into an antecolic, antegastric Roux limb. Patients' dietary and behavioral modifications were initiated prior to operative intervention.

Our surgical technique involves placement of 5 trocars. Pneumoperitoneum is achieved by placement using an open technique of a 10-mm trocar at the umbilicus. A 100-cm to150-cm Roux limb is created depending on the patient's body mass index. A bidirectional jejunojejunostomy is created in side-to-side fashion using an Endo-GIA 60–2.5 stapler (Covidien, Mansfield, MA). The Harmonic scalpel (Ethicon, Somerville, NJ) is used to create a gastrotomy along the stomach's greater curvature. The Harmonic scalpel is then inserted through the gastrotomy to create a second 2-mm to 3-mm gastrotomy within the proximal stomach for anvil placement. A Prolene suture is inserted into the abdominal cavity, grasped with the jaws of the Harmonic scalpel, and withdrawn through the stomach and out of the abdominal cavity. Externally, it is fastened to the 21-mm ILS anvil, placed back into the abdominal cavity, and carried through the stomach so the anvil extrudes from the pouch. The initial gastrotomy is closed with a linear stapler. A 30-mL gastric pouch is then created with multiple applications of an Endo-GIA 60–4.8 linear stapler (US Surgical, Tyco, Princeton, NJ) with staple-line reinforcement (SeamGuard, Gore, Flagstaff, AZ). Next, an antecolic, antegastric gastrojejunostomy is created by first opening the end of the Roux limb, inserting the ILS through the abdominal wall into the Roux limb, and attaching the pin to the anvil in the pouch by using the 21-mm circular stapler introduced through the left-sided 15-mm port site. Routine staple line reinforcement was used for the gastrojejunostomy as well. The anastomosis is reinforced with interrupted 3–0 silk Lembert sutures. The gastrojejunostomy is leak-tested using air insufflation. Postoperatively, a Gastrograffin swallow is obtained on day one, and clear liquid diet is initiated. Patients are typically discharged on postoperative day 3.

RESULTS

Between January 2004 and December 2005, 196 patients underwent laparoscopic RYGBP. Patient demographics and clinical outcomes are listed in **Table 1**. Fifteen patients (9.4%) were endoscopically diagnosed with a gastrojejunal stenosis. Fourteen of these patients underwent successful endoscopic balloon dilation, while one patient required laparoscopic revision of her anastomosis. No complications occurred with any of the dilations performed. Dilation was considered successful if patients were able to maintain full nutritional support without recurrence of symptoms. **Table 2** depicts therapeutic outcomes of patients with anastomotic strictures. Eleven patients presented with symptoms >30 days postoperatively, while 4 patients presented at <30 days. The time between surgery and endoscopic balloon dilation ranged from 24 days to 99 days (median, 42; mean, 52). The majority of patients (54.5%) required only one endoscopic dilation for resolution of symptoms. The maximum dilation for 6 patients required a 15-mm CRE (controlled radial expansion) balloon (Boston Scientific, Natick, MA). Maximal balloon dilations ranged from 10mm to 18mm. The choice of initial balloon size and maximal dilation was determined by the individual endoscopist. None of the patients in the stricture group had any clinical signs of anastomotic leak postoperatively. The percentage of excess body weight loss (%EBWL) was 56.9% and 74.6% at 6 months and 12 months respectively in the stenosis group and 50.6% and 65.1% in patients without a stenosis. The difference in %EBWL between stenosis and nonstenosis groups at 6 months and 12 months postoperatively was statistically insignificant (P>0.05).

Table 1.
Patient Characteristics

Females	133 (83.6%)
Males	26 (16.4%)
Mean Age (years±STD)	42.6±9.2
Mean BMI±STD	47.7±9.7
Comorbidities	4 (range, 0–10)
Mean EBWL at 6 mo	71±13.9 (50%)
Mean EBWL at 12 mo	83±14.7 (64%)

Table 2.
Stricture Patients With Follow-up (n=11)

Dilations* Required per Patient		
1	6	54.5
2	2	18.2
3	2	18.2
4	1	9.1
Maximal Dilation* per Patient		
10 mm	1	10
12 mm	2	20
15 mm	6	60
18 mm	1	10

*Mean days to dilation = 52.

One patient required 4 dilations, the first occurring 38 days postoperatively with a 12-mm CRE. Subsequently, she had recurrent symptoms that required repeat endoscopies performed 6 days and 13 days later with 16-mm and 15-mm CRE balloons, respectively. The fourth dilation occurred 114 days postoperatively and required a 15-mm CRE balloon for dilation. A follow-up endoscopy performed 40 days later revealed a normal-appearing gastrojejunostomy with no evidence of a stricture or marginal ulceration.

One patient required laparoscopic revision of her gastrojejunal anastomosis. Her initial postoperative course was complicated by anemia not requiring transfusion. She developed a stricture within 30 days; 2 attempts at endoscopic treatment failed. A laparoscopic stricturoplasty was performed over a bougie. The patient has had no problems since.

Of the procedures performed in 159 patients, 2 (1.3%) anastomotic leaks and 2 (1.3%) marginal ulcerations at the gastrojejunostomy occurred, and no mortalities. Each patient with an anastomotic leak required reoperation and intraabdominal drain placement at the gastrojejunostomy anastomosis. Each had an extended hospital course with uneventful discharges home. One patient, a 33-year-old female, presented with symptoms of pain, nausea, and vomiting 2 weeks postoperatively. She underwent 4 dilations, and retained suture material was noted in all of her endoscopies. She presented 6 months later with epigastric pain. An endoscopy revealed marginal ulceration at the gastrojejunal anastomosis, and she was started on proton pump inhibitors. *Helicobacter pylori* biopsies were negative. Almost 16 months postoperatively, she re-presented for an endoscopy that revealed additional marginal ulcerations. A second patient who required dilation of a gastrojejunal stricture at 6 weeks to 8 weeks postoperatively was diagnosed with a marginal ulcer on repeat endoscopy at 9 months.

DISCUSSION

Our 9.4% gastrojejunal stricture rate is consistent with what has been previously described in the surgical literature. Fortunately, this complication following laparoscopic RYGBP can be treated successfully in the majority of cases without reoperation via therapeutic endoscopic techniques. In our series, the majority of gastrojejunal anastomotic strictures were treated successfully by a gastroenterologist, with one endoscopic dilation treated by using a 15-mm CRE balloon.

Several studies have looked at anastomotic complications between 21-mm and 25-mm circular staplers and their successful endoscopic management. In a series of 438 laparoscopic RYGBP patients, Suggs et al[11]describe a 9.4% and 2.9% gastrojejunal anastomotic stricture rate using 21-mm and 25-mm circular staplers respectively. All strictures resolved with balloon dilation. Nguyen et al[5] describe data on 29 patients who developed an anastomotic stricture following RYGBP. Strictures occurred more frequently with the use of the 21-mm compared with the 25-mm circular stapler (26.8% vs. 8.8%, $P<0.01$). The majority of patients (82.8%, 24 of 29) were treated successfully with one endoscopic dilation, and the median time interval between gastric bypass and presentation of the stricture was 46 days. Gould et al[6] describe a stricture rate of 15.9% with a 21-mm gastrojejunostomy compared with 6.2% with a 25-mm circular stapled anastomosis ($P=0.03$). The mean interval to therapeutic endoscopy was 7.5 weeks and 12.2 weeks, respectively. Despite the decreased frequency of stenotic complications seen with 25-mm circular staplers, there may be some disadvantages with its use. Positioning the 25-mm stapler through the anterior abdominal wall requires a larger skin and fascial incision and may result in more postoperative pain. Transoral placement of a 25-mm anvil may pose a higher risk of pharyngeal or esophageal injury, although safe transoral placement has been described.[12] Nguyen et al[13] describe a hypopharyngeal perforation after transoral passage of a 21-mm anvil. In addition, placing the 25-mm circular stapler into the end of the small intestine may be challenging, because the bowel diameter decreases the farther one gets for the ligament of Treitz.

Although several studies describe a lower stricture rate

with the use of a 25-mm circular stapler, it is interesting to note that at 1-year follow-up, the %EBWL remains statistically insignificant between stricture and nonstricture groups. The 21 procedures complicated by a stricture seen by Gould and associates[6] had a 69.3% EBWL compared with 67.3% in the nonstricture group (P=0.60) at 12 months postoperatively. In addition, they reported a 67.6% versus 68.0% EBWL in 21-mm and 25-mm groups, respectively, (P=0.643) at one year for 130 patients. Nguyen et al[5] report no difference in %EBWL one year postoperatively when comparing stricture versus nonstricture groups (68.7% vs. 69.8%, P=0.7) and between 21-mm and 25-mm groups (68.2% vs. 70.2%, P=0.8). Pfeifer et al[14] describe endoscopic management of anastomotic strictures in 43 of 801 patients receiving open or laparoscopic RYGBP. Strictures were dilated to 15.5mm (± 0.4mm) with no perforations or clinically significant bleeding, and 93% of the strictures were managed with 1 or 2 endoscopic sessions. Dilation to at least 15mm did not affect weight loss at one year compared with weight loss in the group without a stricture (76% stricture group vs. 74% no stricture group). Rossi et al[9] report in a retrospective review that %EBWL at 12 months was 86% vs. 75% in stricture and nonstricture groups, respectively. Laparoscopic bypasses were performed with a 21-mm stapler in 223 consecutive patients.

The variability seen in the %EBWL in 21-mm versus 25-mm groups as well as stricture versus nonstricture groups may involve several factors including gastric pouch size, circular stapler internal diameter differences, and length of the Roux limb. The internal anastomotic diameter of a 21-mm versus 25-mm circular stapler is approximately 12-mm and 16-mm, respectively. The 4-mm difference in diameter changes the cross-sectional area from 113mm^2 to 201mm.^{2} Gould et al[6] describe differences in circular staplers. Depending on the manufacturer, there may be a difference in internal diameter of 1-mm between similarly sized staplers. For example, the Ethicon Endosurgery Inc. (Cincinnati, OH) 25-mm circular stapler has an internal diameter of 16.4mm compared with the 15.3-mm diameter of a Covidien (Norwalk, CT) circular stapler. The difference of 1.1mm diameter between the two 25-mm staplers correlates to a 14.7% larger cross-sectional area (211mm^2 vs. 184mm^2). Whether this difference is important enough clinically to affect the stricture rate or restrictive component of weight loss is unclear. The Orvil (Covidien, Mansfield, MA) EEA stapler, which has been available since 2006, also has an outer diameter of 25mm, but an internal diameter of 16.9mm.

Could the higher stricture rate with 21-mm staplers be a result of procedures performed on the steep portion of the laparoscopic and/or gastric bypass learning curves? Unnecessary manipulation of the small bowel and gastric pouch, improper positioning of the gastrojejunal anastomosis, added tissue dissection, poor stapler manipulation, and improperly placed Lembert sutures may all lead to early technical errors leading the anastomotic complications. A search of the literature did not reveal any case series that began with the use of a 25-mm stapler then switched to a 21-mm stapler. Andrew et al[15] describe a series of 201 consecutive laparoscopic RYGBP performed by a single surgeon over 2 years. Patients were divided into 3 consecutive groups of 67 patients for analysis. Anastomotic stricture rates decreased from 11.9% in the first 67 patients to 3.0% in both the second and third groups (P<0.01). The group concluded that, "operative time and anastomotic stricture rates decreased with experience." Carter et al[16] describe a series of 654 consecutive RNYGB performed open or laparoscopically. Univariate analysis revealed that surgeon experience was a risk factor for stricture formation for the first 50 gastric bypasses (odds ratio 2.9, P<0.04).

Several other factors may lead to a higher stricture rate, including demographic attributes, comorbid disease, and the use of nonabsorbable Lembert sutures to reinforce the gastrojejunostomy.[17] Blackstone et al[18] report on a series of 1351 patients who underwent laparoscopic RYGBP over a 51-month period. The operative procedure included the use of a 21-mm transoral circular stapler and a retrocolic/retrogastric positioned Roux limb. A change to absorbable polyglactin suture for Lembert reinforcement proved to be significant, resulting in a lower stricture rate (6.8% vs. 2.8%, P=0.028). The addition of H2 antagonists did not show any significant difference in stricture formation. Univariate and multivariate logistic regression analysis identified factors associated with the development of anastomotic strictures. Gastroesophageal reflux disease and age were each shown to be statistically significant independent predictors of stricture formation. Taylor et al[19] compared outcomes between patients with morbid obesity and super-super morbid obesity. Groups with a BMI<60 (n=444 patients) versus BMI>60 (n=60) were evaluated. No statistically significant difference existed in stricture rate between the 2 groups (0.9% vs. 1.7%, P>0.05). Taylor et al[20] analyzed stricture rates looking at the position of the alimentary limb. The group (n=216) of patients who had placement of the Roux limb anterior to the transverse colon had 1 stricture (0.5%) compared with 3 strictures (1.0%) in patients (n=228) (P>0.05) with the

limb placed through an opening created in the transverse mesocolon.

A review of the surgical literature revealed one study that discussed the affects of fibrin glue reinforcement on stricture rates in gastric bypass patients. Silecchia et al[21] report on a series of 204 laparoscopic RYGBP patients randomized to a study group receiving fibrin glue applied to the gastro-jejunal and jejuno-jejunal anastomosis or the control group that did not receive fibrin glue. The incidence of GJ anastomotic stricture was significantly lower in 93 study patients compared with the 111 control patients (2.2% vs. 4.5%). The study did not mention whether this difference was statistically significant. The mean time to diagnosis was 30 days and 51 days for the study and control groups, respectively.

In regards to staple-line reinforcement, Jones and associates[22] found a 93% reduction in anastomotic strictures (9.3% versus 0.7%; P=0.0005) using Seamguard bioabsorbable material (GORE, Flagstaff, AZ) for creation of a 25-mm circular stapled gastrojejunal anastomosis. This was a retrospective review comparing 138 patients who received staple-line reinforcement with a group of 255 control patients. The authors hypothesize that there are 2 mechanisms by which staple-line reinforcement reduces anastomotic complications: first, by reducing tension across the staple line by the even distribution of force over the area of Seamguard, and secondly by buttressing against small defects that may have been present within the staple line. Hope and associates[23] histologically and mechanically analyzed circular-stapled anastomoses with and without Seamguard in a porcine model. At 1 week, the authors found a decrease in collagen content with Seamguard stapled anastomosis and no difference in vascularity, adhesions, or inflammation. It is unknown whether the clinical implication of decreased collagen at 1 week influences future anastomotic stricture formation.

CONCLUSIONS

Transabdominal circular-stapled gastrojejunostomy is a reproducible construct for use in bariatric surgery. Our 9.4% stricture rate parallels what has been reported in the surgical literature. The majority of strictures were amenable to one endoscopic treatment using a 15-mm CRE balloon. The creation of the gastrojejunal anastomosis is a challenging step during laparoscopic RYGBP. Multiple techniques have been described for successful creation of this anastomosis. Overall, a review of the surgical literature revealed a lower incidence of GJ stenosis when 25-mm circular staplers were used without any adverse effect on postoperative weight loss compared with 21-mm circular staplers. Other factors affecting the stricture rate may include surgeon experience, patient comorbidities, technical considerations, and staple-line reinforcement.

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