



Roux-En-Y gastric bypass following failed fundoplication

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Abstract

Introduction Roux-En-Y gastric bypass (RYGB) is an alternative to reoperative fundoplication. The aim of this study was to expand long-term outcomes of patients undergoing RYGB after failed fundoplication and assess symptom resolution.

Methods A single institution prospective study was performed of patients undergoing fundoplication takedown and RYGB between March 2007 and September 2016. Demographics, body mass index (BMI), preoperative symptoms, operative duration and findings, and postoperative outcomes were recorded. Data were assessed using standard statistical methods.

Results 87 patients with failed antireflux surgery underwent RYGB. Median age 58 years (range 25–79 years). Median preoperative BMI 32.4 kg/m² (range 21.6–50.6 kg/m²). Comorbidities included hypertension (48.3%) and diabetes (11.5%). Sixty-six patients had undergone 1 prior fundoplication, 18 had 2 prior fundoplications, and 3 had 3 prior fundoplications. At least one previous open antireflux procedure had been performed in 16.1% of patients. The most common recurrent symptoms were reflux (85.1%), dysphagia (36.7%), pain (35.6%), and regurgitation (29.9%). Median symptom-free interval from last antireflux surgery was 3 years (range 0–25 years). RYGB was performed laparoscopically in 47.1% of cases, robotically in 44.8% of cases, and open in 5.9%. Operative duration was longer in the robotic group ($p=0.04$). During RYGB, 85.1% patients were found to have an associated hiatal hernia, 34.5% had intrathoracic migration of the fundoplication, 32.2% a slipped fundoplication onto proximal stomach, and 13.8% had wrap disruption. Median length of stay (LOS) was 4 days (range 1–33 days). Median follow-up was 35.8 months, 11 patients (12.6%) had recurrent reflux symptoms. Excess body weight loss (%EWL) was 80.4%. There was no mortality but 8 patients required reoperation during follow-up.

Conclusions Fundoplication takedown with RYGB was successful for long-term reflux resolution. Most can be performed via a minimally invasive approach with acceptable perioperative morbidity, symptom resolution, and the additional benefit of %EWL.

Keywords Failed fundoplication · Gastric bypass · Revisional antireflux surgery · Minimally invasive surgery · Patient outcomes

As much as 40% of the US population suffers from gastroesophageal reflux disease (GERD) making it one of the most common diseases of the gastrointestinal tract. The incidence appears to be increasing due to several variables, including obesity [1]. More than 50% of U.S. adults are obese, and

more than 5% are severely obese [2]. Obesity correlates with GERD; the incidence of reflux is 61% in the obese population and is 70% in patients presenting for bariatric surgery evaluation [3, 4]. Increases in the prevalence of obesity and GERD have paralleled one another, and a dose–response relationship has been observed with worsening of GERD symptoms as BMI increases [5].

Laparoscopic fundoplication is the gold standard for surgical management of GERD. The volume of antireflux procedures surged in the 1990s with the introduction of laparoscopy, but peaked in the late 1990s and began to decline [6]. This is attributed to the introduction of over-the-counter proton pump inhibitors, as well as follow-up data indicating a long-term relapse of GERD symptoms following

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fundoplication can be as high as 50% [7]. Long-term studies following laparoscopic antireflux surgery demonstrated that up to 19% of patients experienced dysphagia and 50% required resumption of acid-controlling medications [7, 8], although the reason for the reinstatement of medications is often unclear. Increased intraabdominal pressure or decreased effectiveness of the lower esophageal sphincter places obese patients at a higher risk of relapse [9, 10]. Reoperation is technically challenging, with a success rate lower than primary fundoplication and risk of relapse as high as 60% at 5 years [11, 12].

As laparoscopic Roux-en-Y gastric bypass (RYGB) became the standard weight loss procedure over the last 20 years, it has been performed with increasing expertise and rapidly declining complications rates [13, 14]. GERD symptomatic relief is widely reported following RYGB, with some series showing relief in more than 95% of cases [3]. As a result, there has been consideration that minimally invasive RYGB should be recommended over repeat fundoplication for obese patients as RYGB effectively treats both obesity and GERD [9, 15]. Anatomically, the small gastric pouch, rapid emptying into the Roux limb, and the Roux limb's possible anchoring effect, keeping the gastric pouch intraabdominally, may reduce the risk of recurrent reflux. Indeed, for patients requiring reoperation for failed fundoplication, RYGB appears an appealing alternative to redo fundoplication [16–20].

The authors have previously reported early experiences with RYGB after failed fundoplication [19, 20]. As the follow-up and volume has increased, the aim of the present study is to review feasibility, safety, and patient outcomes following RYGB for failed fundoplication.

Methods

All patients undergoing reoperative surgery for failed antireflux surgery between March of 2007 and September 2016 at Carolinas Medical Center and Carolinas Medical Center-Mercy in Charlotte, NC were entered in a prospective database. After IRB approval, all patients who had undergone RYGB for recurrent GERD were collected. All data were analyzed for demographics, prior surgery, presenting symptoms and weight, ideal body weight, BMI, comorbidities, intraoperative findings, length of hospital stay (LOS), perioperative and postoperative complications, and follow-up details including percentage of excess weight loss (%EWL) after surgery.

The ideal body weight was determined for men using the Devine formula for men (50 kg + 2.3 kg/in. for each 1 inch in height above 5 feet) and the Robinson formula for women (49 kg + 1.7 kg/in. for each inch in height above 5 feet).

Preoperative workup included history and physical, upper endoscopy, and upper gastrointestinal (GI) series. Additionally, select patients also underwent manometry and/or gastric emptying scan as indicated. A registered dietitian provided mandatory dietary counseling. Previous operative notes were obtained and reviewed.

Patient weight, complications, GERD symptoms, and co-morbid conditions were recorded at each visit. All data are reported as medians and range unless otherwise noted. Outcomes were compared between the obese and non-obese patients, as well as laparoscopic technique and robotic technique using Mann–Whitney test. All tests were two-sided with a $p \leq 0.05$ considered statistically significant. All statistical analyses were conducted using Statistical Analysis Software, version 9.4 (SAS Institute, Inc., Cary, NC).

Procedure description

The procedure has been previously described [20]. Three experienced foregut and bariatric surgeons performed all 87 operations. After admission of preoperative antibiotics and deep venous thrombosis prophylaxis, access to the peritoneal cavity was performed with the OptiView technique (5-mm Endopath XCEL® trocar with OptiView® Technology; Ethicon Endo-Surgery, Inc., Cincinnati, OH, USA) in a lateral location away from incisions to avoid intraabdominal injuries or by direct cut down. Four additional trocars were placed under direct visualization. Hiatus exposure was achieved by retracting the left lobe of the liver using a liver retractor. After initial lysis of adhesions as needed, the primary step was to identify the plane between the left lobe of the liver and the stomach to dissect the right crus. Then, a complex and through dissection to free the stomach from the bilateral crus and to then free it from the esophagus was performed. The previous fundoplication was completely taken down, which was confirmed by endoscopy. The dissection was carried into the mediastinum until at least 2 cm of the esophagus could be brought intraabdominally, but, preferably, 3 cm or more would be the goal. Posterior crural repair was performed, using biosynthetic mesh reinforcement when necessary. Sizing the crus closure was performed with a 56F Bougie dilator. Following repair of the hiatal hernia, a gastric pouch was created; for obese patients, a standard 30 cc pouch was created, whereas for non-obese individuals a larger 50 cc pouch was created. Typically, a 100–150 cm Roux limb was created with a stapled side–side jejunojejunostomy (JJ). Non-obese individuals had a shorter Roux limb, typically 60 cc–100 cm. An antecolic, antegastric stapled gastrojejunostomy (GJ) was created using a 25 mm transoral, circular stapler (DST Series™ EEA™ OrVi™ 25 mm Device, Covidien, Mansfield, MA, USA) or a GIA stapler. Both mesenteric defects were closed to prevent internal hernias. At the end of the case, a second intraoperative

endoscopy was performed to test the GJ anastomosis and assure hemostasis. A drain was left under the GJ anastomosis. One surgeon placed a gastrostomy tube (G-tube) selectively in the gastric remnant if a case was technically difficult.

The daVinci® Si Surgical System (Intuitive Surgical Inc., Sunnyvale, CA, USA) was utilized for 39 procedures. Most aspects of robotic-assisted procedures were similar to the laparoscopic technique with the following differences: three robotic arms were used, and the robot was typically docked after the creation of the JJ laparoscopically. Robot assistance was used primarily for adhesiolysis at the hiatus, fundoplication takedown, creation of a two-layer sewn GJ, as well as posterior crural repair of hiatal hernias.

Postoperatively patients took proton pump inhibitors for 2–4 weeks. Patients were discharged home on full liquid diet consisting of a no bread, no meat, no carbonated beverages diet according to surgeon preference. A regular diet was formalized when the patient was seen in follow-up.

Results

Demographics, operative details and outcomes for population

Patient characteristics are presented in Table 1. Eighty-seven patients with failed fundoplication surgery underwent RYGB during the study period. The median age was 58.0 years (range 25–79 years), and they had a median preoperative BMI of 32.4 kg/m² (range 21.6–50.6 kg/m²); 27 patients (31.0%) had BMI less than 30 kg/m². Comorbidities included hypertension (48.3%), dyslipidemia (25.3%), arthritis (24.1%), COPD (29.9%), diabetes (11.5%), and irritable bowel syndrome (4.8%).

Prior Nissen fundoplication was the most common previous antireflux procedure; 66 patients had undergone 1 prior fundoplication, 18 had 2 previous fundoplications, and 3 had 3 prior fundoplications. Sixteen percent of patients had previously undergone an open antireflux procedure. The median symptom-free survival interval after the last antireflux surgery was 3.0 years (range 0–25 years). The most common presenting symptoms were pyrosis/reflux (85.1%), dysphagia (36.7%), regurgitation (29.9%), and abdominal pain (35.6%).

All patients underwent a preoperative esophagogastroduodenoscopy (EGD), which identified 46 hiatal hernias and complete wrap disruption in 11 patients and a significantly loose wrap in 4 patients. Eleven patients had Barrett's esophagus. Upper GI series identified 14 slipped fundoplications. Manometry was performed for 29 patients, which demonstrated normal results in 12 patients, impaired motility in 11 patients, 1 patient with nutcracker esophagus, and hypotonic

Table 1 Patient characteristics

Variables	Patients (<i>n</i> = 87)
Age	58 years (range 25–79 years)
Preoperative BMI	32.4 kg/m ² (range 21.6–50.6 kg/m ²)
Hypertension	48.30%
Diabetes	11.50%
Sleep apnea	27.00%
Previous Open antireflux procedure	16.10%
Previous Nissen fundoplication	95.30%
1 prior NF	<i>n</i> = 66
2 prior NF	<i>n</i> = 18
3 prior NF	<i>n</i> = 3
Symptom-free interval from last antireflux surgery	3 years (range 0–25 years)
Pre RYGB symptoms	
GERD symptoms/reflux	85.10%
Dysphagia	36.70%
Regurgitation	29.90%
Preoperative evaluation	
EGD	
	11 wrap disruption
	46 hiatal hernias
	11 Barrett's esophagus
Upper GI	
	14 slipped fundoplications
	42 hiatal hernias
Manometry	
	11 decreased esophageal motility
	1 nutcracker esophagus
Gastric emptying scan	
	14 delayed gastric emptying

lower esophageal sphincter in 5 patients. Twenty-seven patients underwent gastric emptying scintigraphy, which revealed delayed gastric emptying in 14 cases.

Operative Details are presented in Table 2. RYGB was performed laparoscopically in 47.1% of cases, and with robotic assistance in 44.8% of cases. Seven cases were open, two of which were planned open repairs. One of the patients who underwent a planned open repair had three prior fundoplications, and the other had a large ventral hernia which required concomitant repair. The remaining five open cases were initiated laparoscopically but converted to open. All the converted cases were in patients with prior open antireflux surgery. Open procedure duration was 390 min (range 234–469 min). Operative duration for the entire sample size had a median time of 339 min (range 152–600 min). Laparoscopic median duration was 332 min (range 152–600 min) versus robotic time of 375 min (range 242–571 min) (*p* = 0.04).

Table 2 Operative characteristics

	Patients
Operative details	<i>n</i> = 87 (%)
Laparoscopic	41 (47.1)
Robotic	39 (44.8)
Open	7 (8)
EBL	100 mL (range 25–500 mL)
OR time	390 min (range 234–469 min)
Associated findings	
Associated hiatal hernia	74 (85)
Intrathoracic migration of the fundoplication	30 (34)
Slipped fundoplication	28 (32)
Wrap disruption	12 (13.8)
Intraoperative complications	4 gastric perforations (1 closed, 3 resected) 1 esophageal perforation (prior Angelchik) (patch closure)

Intraoperatively complications were early in experience and included one esophageal and four gastric injuries. Three of the gastric injuries occurred in the fundus portion which was resected; the other one in the greater curvature, which occurred during lysis of adhesions. All injuries underwent suture repair with no further sequelae. One patient who had three prior antireflux procedures, as well as the placement and removal of an Angelchik prosthesis, experienced the esophageal injury during dissection of the stomach from the left lobe of the liver. The perforation appeared to be previously contained and sealed by the liver; this was repaired primarily in two layers. A single surgeon placed 11 G-tubes in the gastric remnant, two in patients with BMI < 30 kg/m². All G-tubes were removed within one month of surgery. During preoperative evaluate or intraoperatively, 74 (85.1%) patients were found to have an associated hiatal hernia, 30 patients (34.5%) had intrathoracic migration of the fundoplication, 28 patients (32.2%) a fundoplication which had slipped onto proximal stomach, and 12 patients (13.8%) had wrap disruption.

Post-operative outcomes are presented in Table 3. The median LOS was 4 days (range 1–33 days). Ten patients required reoperation: anastomotic obstruction (1), adhesions (2), anastomotic leak (2), internal hernia (3), and incisional hernia (2). Three small bowel obstructions occurred, one at the JJ anastomosis, one at a site of dense omental adhesions, and one related to a swiss cheese-type hernia which had been primarily repaired at the first surgery. Two patients suffered an anastomotic leak. One leak occurred at the GJ five days postoperatively after a robotic procedure; one occurred at the JJ anastomosis four

Table 3 Postoperative outcomes

	RYGB <i>n</i> = 87 (%)
LOS	4 days (range 1–33 days)
Unplanned reoperation	10 (11.4)
BMI decrease	6.5 kg/m ²
% Excess weight loss (EWL)	80.4% (range 53–140%)
Recurrence GERD, dysphagia and regurgitation	11 (12.6)
Follow-up	35.8 months (range 2–93)

days postoperatively after a laparoscopic procedure. Both patients recovered well after a prolonged hospitalization.

In addition, two complication, one anastomotic bleed and stricture at the GJ were treated endoscopically. A patient presented 3 weeks postoperatively with retroperitoneal abscess drained percutaneously. On work up with EGD, via gastrotomy, the patient was found to have a duodenal diverticulum. Patient was placed on antibiotics and TPN and recovered well with G-tube removal 10 days later.

Within 30 days of discharge, three patients were readmitted with poor oral intake; another developed melena and was admitted for observation of melena that resolved without intervention. Non-operative complications included aspiration pneumonitis and one case of clostridium difficile colitis. No perioperative deaths occurred. All three internal hernias occurred more 6 months after RYGB conversion; they were taken to the operating room for reduction of hernia and repair. Two patients underwent diagnostic laparoscopy and adhesiolysis for abdominal pain, both at greater than 24 months after RYGB.

Median follow-up was to 35.8 months, with a range of 2.1–92.7 months, with only 6 of our patients having less than 6 months follow-up. All patients were initially symptom-free of GERD and dysphagia at their first postoperative visit and 76 (87.3%) patients have complete resolution of symptoms of reflux, dysphagia, or regurgitation at long-term follow-up. The median BMI decrease was 6.1 kg/m² (range – 5.9 to – 20.3) with average excess body weight loss (%EWL) of 80.4%.

11 (12.6%) patients experienced postoperative symptoms such as pyrosis, sensation of reflux, or dysphagia. Comparing patients with and without postoperative symptoms, there was no difference in age, preoperative symptoms, or weight loss experienced. The median BMI at follow-up was 24.7 kg/m² for those with symptoms and 25.8 kg/m² for those without (*p* > 0.05). All patients who redeveloped symptoms underwent endoscopy. At postoperative endoscopy, two patients complaining of reflux and regurgitation were found to have GJ anastomotic stricture without esophagitis; dilatation was successfully performed in both. Four patients had normal endoscopy and upper GI series, however continued to have reflux symptoms controlled with medications. Five

of the patients experiencing recurrence of preoperative symptoms had difficulty following the post-RYGB diet, one of which continued tobacco use, NSAID use, and developed a marginal ulcer.

Laparoscopic versus robotic-assisted surgery

When the laparoscopic and robot-assisted RYGB patients were compared (Table 4), there was no difference in age ($p = 0.83$), BMI ($p = 0.38$), or rates of comorbidities ($p > 0.05$). There was no difference in preoperative symptom-free survival ($p = 0.09$) or the number of prior funduplications ($p = 0.14$). Laparoscopic had shorter operative time with a median duration of 332 min (range 152–600 min) versus robotic time of 375 min (range 242–571 min) ($p = 0.04$). There was no difference in estimated blood loss (EBL) between surgical techniques with laparoscopic median blood loss of 129 ml (range 10–500 mls) and robotic median EBL 134 ml (range 25–650 mls) ($p = 0.57$). LOS was higher in the laparoscopic group at 4 days (range 1–33 days) compared to robotic-assisted cases with a median LOS of 3 days (range 1–12 days) ($p = 0.01$). Reoperation rates were the same between techniques ($p = 0.68$). Recurrence of reflux symptoms trended to favor laparoscopy over robotic (9.8% laparoscopic vs. 15.4% robotic) with the laparoscopic group being followed approximately 6 months longer (35 vs. 29.4 months).

Obese versus non-obese

There were 60 obese patients compared to 27 non-obese patients (Table 5). Preoperative BMI for non-obese patients was 27.5 kg/m² (range 21.6–29.3 kg/m²) compared to 35.5 kg/m² (range 30.0–50.6 kg/m²) for the obese ($p < 0.001$). Obese patients were younger, with a median age of 56 years (range 25–79 years) compared to non-obese patient's median age of 62 years (range 36–74 years) ($p = 0.04$). Of the 27 non-obese patients, two had 3 prior funduplications, eight had 2 prior, and seventeen 1 prior. When compared to obese patients there was no difference in number of prior Nissen funduplications ($p = 0.15$). Preoperatively, there was no difference in rates of comorbidities ($p > 0.05$) or presenting rates of reflux, pain, dysphagia, regurgitation, or respiratory symptoms complaints ($p > 0.05$). There was no difference in symptom-free interval years prior to conversion to RYGB between obese (3.5 years) and non-obese (3.0 years) ($p = 0.74$). There was no difference in operative time ($p = 0.64$) or EBL ($p = 0.62$). Roux limb length was longer in the obese, with an average 115 ± 29.3 cm in the obese and 88 ± 18.6 cm in the non-obese ($p < 0.001$). There was no difference in LOS ($p = 0.33$).

Median follow-up for obese patients was 34.3 months and for non-obese patients 29.3 months ($p = 0.62$). At follow-up, %EWL in the obese was 78.7% (range 53–101%). %EWL in the non-obese was higher at 83.7% ($p = 0.02$). Postoperative

Table 4 Laparoscopic versus robotic technique

	Laparoscopic $n = 41$	Robotic $n = 39$	p value
Age	58 years (range 25–76 years)	58 years (range 25–79 years)	0.83
Preoperative BMI	33.5 kg/m ² (range 21.6–50.2 kg/m ²)	34.6 kg/m ² (range 22.9–50.9 kg/m ²)	0.37
Hypertension	45.00%	55.00%	0.37
Migraine	2.50%	17.50%	0.05
Sleep apnea	15.00%	17.50%	0.76
Number previous Nissen fundoplication	1.3	1.1	0.3
1 prior NF	72.50%	84.20%	0.11
2 prior NF	22.50%	10.50%	0.11
3 prior NF	5%	0.00%	0.11
Symptom-free interval from last antireflux surgery	4.5 ± 5.5 years	5.6 ± 4.8 years	0.11
Pre RYGB symptoms			
GERD symptoms	75%	75%	
Dysphagia	22.50%	40.00%	0.09
Regurgitation	20.00%	22.50%	0.78
Operative time	332 min (range 152–600 min)	375 min (range 242–571 min)	0.04
Estimated blood loss (EBL)	129 ml (range 10–500 mls)	134 ml (range 25–650 mls)	0.57
LOS	4 days (range 1–33 days)	3 days (range 1–12 days)	0.01
Reoperation	4 (9.76%)	6 (15.3%)	0.68
Recurrence of reflux symptoms	5 (9.8%)	6 (15.3%)	0.46
Follow-up	35.02 months (range 4–91 months)	29.40 months (range 2–57 months)	0.11

Statistically significant values ($p < 0.05$) are given in bold

Table 5 Obese versus non-obese

	Obese 60	Non-obese 27	<i>p</i> value
Age	56 years (range 25–79 years)	62 years (range 36–74 years)	0.04
Preoperative BMI	35.5 kg/m ² (range 30.0–50.6 kg/m ²)	27.5 kg/m ² (range 21.6–29.3 kg/m ²)	<0.001
Hypertension	45.00%	55.00%	0.15
Pre RYGB symptoms			
GERD symptoms	88.30%	77.80%	0.20
Dysphagia	36.70%	37.00%	0.97
Regurgitation	25.00%	40.70%	0.14
Respiratory symptoms	23.30%	11.50%	0.1
Operative time	342 min (range 190–480 min)	338 min (range 152–600 min)	0.81
Roux limb length	mean 88 ± 18.6 cm	mean 115 ± 29.3 cm	<0.001
Estimated blood loss (EBL)			0.62
LOS	4 days (range 1–12 days)	3.5 (1–33 days)	0.33
Reoperation			
Recurrence of symptoms	3.85%	16.39%	0.16
Follow-up	34.3 months (range 6–91.4 months)	29.3 months (range 2–92.1 months)	0.62
Postoperative BMI	27.5 kg/m ² (range 20.8–45.8 kg/m ²)	22.1 kg/m ² (range 18.3–30.4 kg/m ²)	<0.001
% EWL	78.7% (range 53–101%)	83.7% (range 79–140%)	0.02
Patients with normal weight BMI (18.5–24.9 kg/m ²) at most recent follow-up	17	23	

Statistically significant values ($p < 0.05$) are given in bold

median BMI in the obese group was 27.5 kg/m² (range 20.8–45.8 kg/m²) compared to a median BMI of 22.1 kg/m² (range 18.3–30.4 kg/m²) in the non-obese ($p < 0.001$). Of the 60 obese patients, 37 are no longer obese. 20 are now overweight (BMI 25.0–29.9 kg/m²) and 17 now have a normal weight (BMI 18.5–24.9 kg/m²). Of the 27 non-obese, one has gained weight and now has a BMI of 30.4 kg/m², 3 are overweight (BMI 25–29 kg/m²) and 23 have a normal weight (BMI 18.5–24.9 kg/m²). One non-obese patient has returned with recurrence of reflux symptoms, compared to 10 in the obese (3.85 vs. 16.39%; $p = 0.16$).

Discussion

This study examined long-term follow-up in a population of patients who underwent conversion to RYGB, following failed, often multiple, antireflux procedures. Reoperative antireflux surgery produces diminishing returns, with excellent results observed in 90% of patients after the first operation, 75% after the second, and less than 60% after the third [21]. RYGB diverts the gastric antrum and body, as well as duodenal contents from contact with the esophagus and may represent a superior alternative to reoperative fundoplication [9, 11, 15–18, 20, 22–24]. However, conversion to RYGB is technically challenging and can be associated with perioperative morbidity, with some reports of major complication rates between 29 and 32% [22, 23]. The goal

of the present study was to evaluate the success of GERD control by conversion to RYGB after previous fundoplication in both obese and non-obese individuals. With median follow-up of 35 months, the long-term outcomes demonstrated herein show excellent GERD symptomatic control, with 87% resolution of reflux symptoms and no mortality. The added benefit of weight loss in the obese patients, and excellent weight maintenance in the non-obese population, presents RYGB conversion as a considerable alternative to reoperative fundoplication.

Reoperative intervention after failed fundoplication is tempting when there is concern that the primary fundoplication may have been inappropriately constructed [25]. Dallemagne et al. [12] found redo fundoplications, despite promising short-term results, have poor longer term symptomatic control. Revisional forget surgery also presents the increased risk of vagal injury, which is more likely to occur during reoperative surgery in scarred planes, and resultant gastroparesis may adversely affect outcomes after fundoplication. In RYGB, vagal injury may actually serve to protect against marginal ulcer formation [26].

Although subjective, the rate of successful reflux relief in the current series is consistent with other reports of reflux after RYGB. Yamamoto et al. showed 65.6% of their patients had complete resolution of symptoms or only minimal symptoms at follow-up, with no difference when comparing redo fundoplication and RYGB [27]. However, when examining patients with severe symptomatology, defined as greater than

4 risk factors for antireflux failure (morbid obesity, esophageal dysmotility, short esophagus, severe preoperative dysphagia, and extraesophageal GERD symptoms) [27], those who underwent redo fundoplication had 18.2% resolution of symptoms compared to 66.7% for RYGB in the same high risk population.

Reoperation at the hiatus and conversion to gastric bypass is a complex surgical undertaking, requires experienced surgeons in an appropriate facility, and the patient should understand the high risk of morbidity. RYGB in a reoperative field is challenging with a risk of gastric or esophageal injury, anastomotic leak, and even injury to the great vessels. Our present series demonstrates RYGB to be feasible laparoscopically or with robotic assistance when performed by an experienced team of foregut and bariatric surgeons. In 2012, the Da Vinci robot was incorporated into this practice and currently 44% of patients in this series had their procedure performed using robotic assistance. Robotic surgery may offer advantages during reoperative hiatal surgery [28, 29], as obliterated tissue planes may be better visualized using the robotic 3D camera and tremorless robotic arms facilitate fine manipulation, increased degrees of freedom, wrist articulation, and greater precision [28]. Some studies suggest fewer anastomotic complications with robotic assistance in creation of GJ anastomosis [30]. However, there is no consensus in the literature that robotic assistance supplies any significant outcome differences in primary RYGB [31]. In this series, there was no difference in complications, laparoscopic operations were faster, and there was a trend to improved long-term outcomes. Length of stay was 1 day less in the robotic-assisted cohort, but the robotic cases were performed later in the series when, overall, patients were sent home sooner.

The present study demonstrates that RYGB is appropriate in non-obese patients. Indeed, symptom control was excellent, with one non-obese patient having recurrence of symptoms following RYGB (3.7%). Akimoto et al., examined patterns of fundoplication failure and found that non-obese patients had unique risk factors for fundoplication failure with significantly more dysphagia as an indication for reoperative procedure, whereas obese patients had higher incidence of recurrent hiatal hernia and disrupted fundoplication [32]. In our series, dysphagia was the second most common presenting symptom, with reflux being first, however rates were equal between the obese and the non-obese. Given the possibility of impaired esophageal emptying following antireflux surgery [33], and the high prevalence of dysphagia in this failed fundoplication population, improved swallowing may be an additional benefit to RYGB creation over repeat fundoplication.

When performing RYGB in a non-obese patient, excess weight loss is a concern. The authors created a larger gastric pouch and a shorter Roux limb (60–100 cm) in an effort to

reduce restriction and malabsorption, and have not observed an incidence of problematic excess weight loss in our non-obese population. One non-obese patient did return with a BMI less than 18.5 kg/m² at one follow-up point, however at most recent follow-up had a BMI of 18.5 kg/m². Twenty-three of the 27 non-obese patients have returned in follow-up with normal BMIs. As after all RYGBP surgeries, patients are monitored for vitamin and mineral deficiencies, and are placed on necessary vitamin supplementation as needed.

Of the 11 patients who returned with recurrent symptoms, 5 have reported trouble adhering to a post-RYGB diet, resumption of smoking, or habitual NSAID use. This underlines the importance of preoperative education and dietary counseling. Patients are well counseled preoperatively on dietary changes and supplied nutritional education, however this information needs to be reiterated at each follow-up visit for continued success.

Regardless of the strong anatomical and physiologic rationale, as well as growing clinical data to support conversion of failed fundoplication to RYGB, insurance companies frequently deny this procedure, as they consider gastric bypass appropriate only for weight loss. This can be challenging for patients and surgeons alike, and may prevent patients from having disease RYGB. For patients who have failed prior antireflux surgery, regardless of BMI, this study supports the increasing evidence that RYGB is an effective alternative to redo fundoplication.

Limitations of the current study include the reliance on patient symptoms to define success after surgery rather than on objective reflux measure. Differences must be interpreted carefully as the comparison groups (laparoscopic vs. robotic, obese vs. non-obese) were not matched for comorbidities or prior surgical history. Further cost and outcome analysis is needed to better determine the role of robotic assistance in reoperative foregut surgery. Further follow-up is needed to assess the long-term nutritional effects of RYGB in the non-obese population.

Conclusion

When fundoplication fails, a RYGB can be accomplished safely, performed with acceptable perioperative morbidity, excellent symptom control, and the additional benefit of %EWL.

Compliance with ethical standards

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