

2. Laparoscopic Roux-en-Y Gastric Bypass: Techniques and Outcomes

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A. Introduction

The Roux-en-Y gastric bypass (RYGB) is the “gold standard” bariatric surgical procedure. According to the American Society for Metabolic and Bariatric Surgery, the RYGB is currently the most common bariatric procedure performed in the USA. The RYGB has both restrictive and malabsorptive properties due to the combination of a small gastric pouch and total bypass of the duodenum and the proximal jejunum. Today, over 90% of RYGB are performed laparoscopically. In this chapter, we highlight the history of the RYGB, operative indications, operative techniques, postoperative management, common complications and outcomes.

The RYGB has evolved significantly over the previous decades. Edward Mason was the first to describe the gastric bypass operation in 1967 as a treatment for morbid obesity. The stomach was divided creating a 100 mL horizontal, proximal gastric pouch to which a loop gastrojejunostomy was constructed. Later, Mason and colleagues reduced the pouch size to <50 mL to increase weight loss and reduce the frequency of anastomotic ulcer formation. Later in 1977, a horizontal stapled, undivided pouch was introduced by John Alden which was followed by the introduction of the Roux-en-Y reconstruction by Ward Griffen. This served to prevent alkaline reflux into the gastric pouch. The stomach was later divided from the pouch to reduce the incidence of gastrogastric fistula. Torres and Oca modified the Roux limb by lengthening it, a technique that was later popularized by Brolin and colleagues to augment weight loss. In 1994, Wittgrove and colleagues described the first laparoscopic RYGB with an end-to-end stapler technique. In 1999, Kelvin Higa described the first laparoscopic RYGB with a hand-sewn gastrojejunostomy.

B. Indications

1. Per the criteria set forth by the 1994 National Institute of Health Consensus Statement, bariatric surgery is indicated for patients with a body mass index (BMI) greater than or equal to 40 kg/m^2 or with a BMI greater than or equal to 35 kg/m^2 if one additional major comorbidity is present.
 - a. A major comorbidity could include type 2 diabetes, obstructive sleep apnea, or hypertension.
 - b. Since this statement was released, the profound effect of bariatric surgery on metabolic disease, particularly type 2 diabetes, has been thoroughly documented. Studies are currently underway to investigate the effect of the RYGB on patients with type 2 diabetes who have a BMI less than 35 kg/m^2 .

C. Preoperative Evaluation

Preoperative planning includes evaluations by the patient's primary care physician, a mental health professional, and a nutritionist. Commitment of the patient to attend several preoperative appointments serves as a litmus test for their ability to follow-up after surgery as well. In our practice, all patients are followed for a minimum of 3 months after referral before undergoing their procedure. At least 6 months of preparation with lifestyle and dietary modification is preferred.

1. A letter provided by the primary care physician upon referral should include previous weight loss strategies, such as exercise and dietary regimens as well as any previously attempted medical weight loss treatments. Also, a chronologic history of the patient's weight should be documented. Ultimately, surgery is only a tool and the long-term success of the operation is often determined by adherence to a diet and exercise plan postoperatively.
2. Polysomnography should be obtained when sleep apnea is suspected based on history, with the implementation of a continuous positive airway pressure (CPAP) device if warranted.
3. Referral to a cardiologist is recommended for patients over the age of 45 years with a diagnosis of type 2 diabetes or any patient older than 50 years with concomitant risk factors, such as a history of smoking, dyslipidemia, or hypertension. An echocardiogram

is recommended for patients with a history of fluramine and phentermine (Fen-Phen) use of 6 months duration.

4. A history of deep venous thrombosis or other clotting abnormality with unknown etiology triggers a hematology consultation.
5. The presence of severe pulmonary hypertension should prompt preoperative placement of a temporary inferior vena cava filter as a pulmonary embolism would be poorly tolerated in this patient population.
6. Physical medicine and rehabilitation is consulted if a patient has limited exercise ability due to neurologic, muscle, or joint disorders.
7. All patients should be screened for deficiencies in iron, vitamin B12, thiamine (B1), folate (B9), 25-hydroxy-vitamin D and calcium preoperatively.
8. Preoperative weight loss is a core component of preparation. The ability to accomplish this solidifies a patient's commitment to the weight loss process.
9. Documented smoking cessation is required for patients who smoke.
10. Exclusion criteria for RYGB include inflammatory bowel disease, ulcer diathesis, and those who are dependent on nonsteroidal anti-inflammatory medications.
11. A relative contraindication for a laparoscopic procedure includes a history of one or multiple previous intra-abdominal surgeries, where evaluation of the small bowel due to adhesions may be suboptimal. A previous colectomy may serve as a relative contraindication to a laparoscopic RYGB because distal adhesions may precipitate early postoperative bowel obstruction and increase the likelihood of an anastomotic leak. Thought should also be given to patients at increased risk for gastric cancer who would require frequent surveillance of their gastric remnant.
12. The use of esophagogastroduodenoscopy with *Helicobacter pylori* testing preoperatively remains controversial.

D. Operative Technique

In the preoperative area, all patients receive subcutaneous low-molecular weight heparin and sequential compression devices are applied as prophylaxis against deep venous thrombosis. Antibiotics (e.g. cefoxitin 2 g) are administered within 30 minutes of incision.

Ideally, the room should be equipped with an operating table capable of holding 1,000 pounds and providing at least 45° of reverse Trendelenburg position. The table should also have the ability to be fitted with extenders for length and width. A footboard is essential to prevent patient movement during manipulation of the operating table. Extra-long instruments may be necessary and should include toothed and atraumatic graspers, ultrasonic scissors, endoscopic staplers, liver retractors, and suction aspirators.

1. Position the patient supine position with arms out to the side and padding under both knees. Place a Foley catheter and secure the feet with tape and padding to the footboard. Place a safety strap just above the patient's knees.
2. The surgeon stands on the patient's right side with the assistant on the left. We operate with four ceiling-mounted monitors placed at shoulder level of both the surgeon and the assistant.
3. Establish pneumoperitoneum through a 15 cm Veress needle in the left upper quadrant at the junction of the mid-clavicular line just beneath the costal margin if no previous midline or left-sided incisions are present. Once pneumoperitoneum is established, place a 5-mm trocar at this site. Routinely, a total of five extra-long trocars are placed across the upper abdomen. An 11-mm trocar is placed approximately 15 cm below the xiphoid just to the left of midline under direct vision. A 10 mm, 45° laparoscope is then placed through the 11 mm port and the patient is placed in steep reverse Trendelenburg. Two ports are then placed along the patient's right side; one subcostal at the mid-clavicular line (5 mm) and the second (12 mm) is placed medial to the midclavicular line and just rostral to the camera port. A 5 mm trocar is placed in the right flank for liver retraction, and a sixth 5 mm working port can be placed in the patient's left flank for retraction when necessary (Fig. 2.1).
4. To create the gastric pouch, first divide the lesser omentum with a Harmonic scalpel. The left gastric artery should be easy to identify. Take care to avoid dividing a replaced or accessory left hepatic artery, if present.
5. Transect the neurovascular fat bundle along the lesser curve using a 6 cm linear endostapler with a vascular staple cartridge. Bovine pericardium or other staple-line reinforcement product reduces bleeding from staple lines.

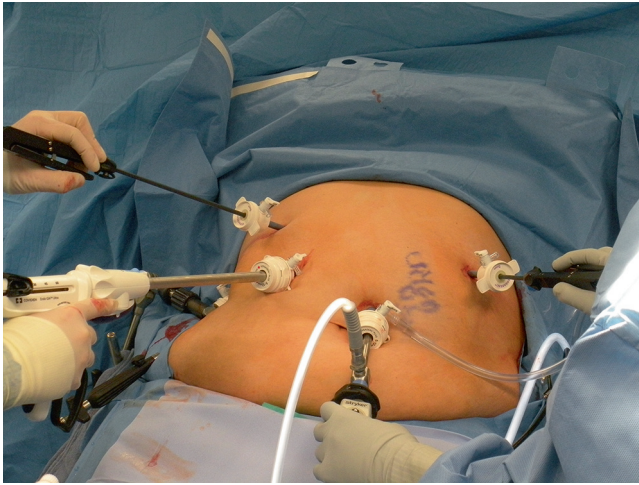


Fig. 2.1. Port placement. Five ports are routinely placed across the upper abdomen for maximum maneuverability and optimal exposure.

6. Next, orient the endostapler transversely 2–3 cm distal to the gastroesophageal junction and just distal to the left gastric artery; and fire it to complete the transection of the neurovascular pedicle.
7. Create a 20–30 mL vertically oriented gastric pouch with the endostapler using 3.5 mm staples or a “blue” staple load. Sizing of the pouch with a balloon has proven not to be necessary. First, perform a transverse application of the stapler, with subsequent applications oriented toward the angle of His parallel to the lesser curve (Fig. 2.2). Apply Surgicel® as a topical hemostatic agent to control any oozing. Take care to avoid any incorporation of gastric fundus in the pouch. Repair any staple line defects in the pouch or gastric remnant with endo-suturing techniques. Alternative techniques include formation of the gastric pouch with the use of ring reinforcement and the micro-pouch technique.
8. We perform an antecolic, antegastric anastomosis. If a retrogastric anastomosis is planned or necessary due to a foreshortened mesentery, adhesions posterior to the remnant must be divided. Divide the greater omentum to improve reach of the Roux limb.

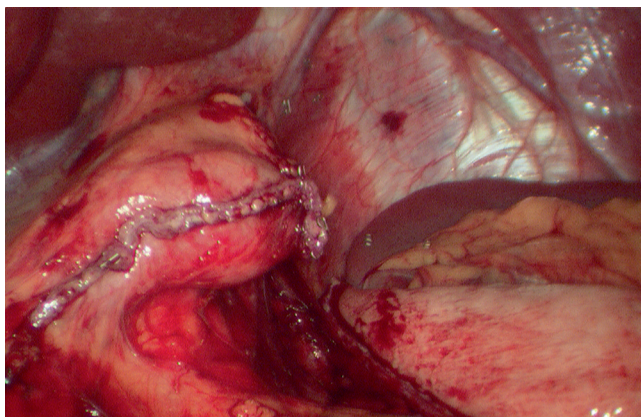


Fig. 2.2. Gastric pouch. The gastric pouch (*left*) following transection from gastric remnant (*right*).

9. Next, perform the gastrojejunostomy. Return the table to a neutral position and then identify the ligament of Treitz by lifting the transverse mesocolon rostrally. Measure out 100 cm of jejunum from the ligament of Treitz and a small defect is created in the mesentery. Pass a Penrose drain through. Rotate the proximal bowel one-half turn clockwise and bring the loop of jejunum up to the gastric pouch in an antecolic, antegastric fashion. At this time, the proximal Roux limb is to the patient's right and the biliopancreatic limb is to the patient's left.
10. Return the table to reverse Trendelenberg. Form the back row of the gastrojejunostomy anastomosis using an Endostitch™ (Covidien) with a 3–0 braided nylon running seromuscular suture beginning at the angle of His at the rostral aspect of the gastric pouch staple line. On the Roux limb, start the back row suture close to the mesentery.
11. At the right inferior portion of the pouch, create a gastrotomy with the Harmonic® scalpel (Ethicon Endo-Surgery). Similarly, create an enterotomy at a corresponding point on the Roux limb. Insert a blue staple load into the pouch and Roux limb to no more than 2.0 cm and fire it to create the gastrojejunostomy (Fig. 2.3).
12. Pass a 30-Fr endoscope through the mouth, into the pouch, through the anastomosis and into the Roux limb. Use an Endostitch™ to close the defect over the endoscope in two layers. Next, use a white load cartridge to divide the jejunum just

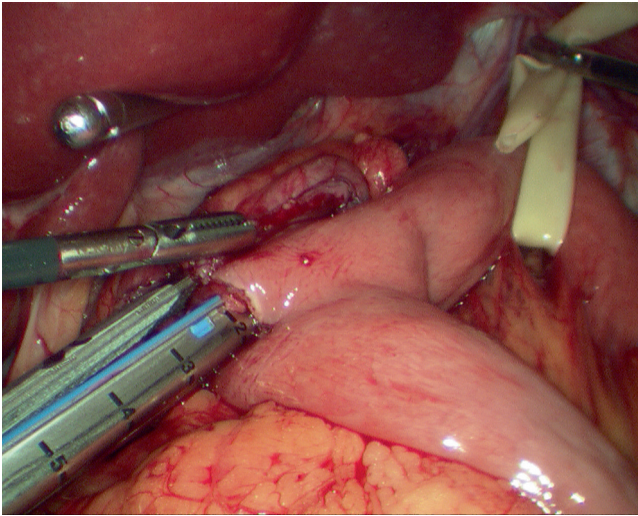


Fig. 2.3. Gastrojejunostomy. Following suturing of the back wall of the anastomosis a blue load endostapler is used to create the gastrojejunostomy. The Penrose drain in the background marks 100 cm from the ligament of Treitz and is the future site of division of the jejunum.

to the left of the gastrojejunal anastomosis. If the small bowel is unusually thick, consider a blue load to divide the small bowel. Remove the Penrose drain from the abdomen.

13. To test the anastomosis, place a bowel clamp 5 cm distal to the gastrojejunostomy and submerge the site of anastomosis in saline irrigation. Insufflate air through the endoscope with monitoring for bubbles. Oversee any areas suspected of leaking and then repeat the insufflation process. Drains at the site of the gastrojejunostomy are rarely used.
14. A 150 cm Roux limb is standard. It is measured from the gastrojejunostomy.
15. Sew the distal biliopancreatic limb, the stapled end created in step 11 above, to the Roux limb at their antimesenteric borders in preparation for a functional side-to-side stapled anastomosis. Take extra care to be certain that the mesenteries are properly aligned and no twists are present.
16. Make enterotomies in the Roux limb and biliopancreatic limb with a Harmonic® scalpel. Insert a 6 cm white cartridge load to its full length in each limb to create the anastomosis. Place a single suture to secure the heel of the anastomosis (Fig. 2.4a).

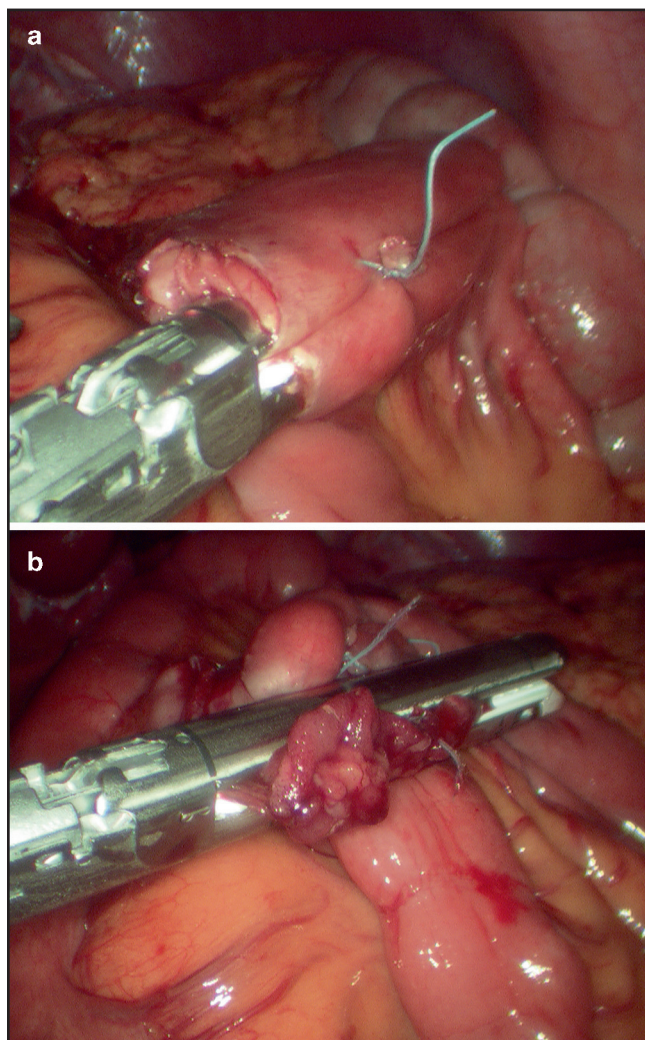


Fig. 2.4. Jejunojejunostomy. A side-to-side functional anastomosis is formed between the two enterotomies with an endostapler (a) and the common enterotomy is closed with an endostapler as well (b). An anti-obstruction stitch is placed to aid in preventing future kinking of the anastomosis (c). (Part c Reprinted with permission has been granted from J Gastrointest Surg. 2007;11:217–28, for Fig. 2.4).

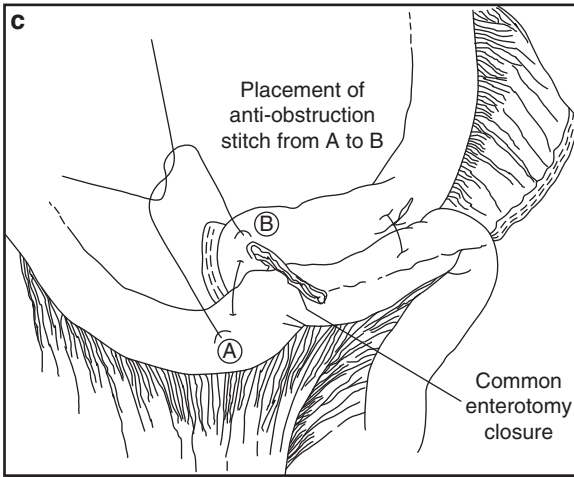


Fig. 2.4. (continued)

17. Approximate the edges of the common enterotomy with an Endostitch™, and close the enterotomy with an additional firing of a white load with the 6 cm endostapler (Fig. 2.4b). Approximate any areas of separated serosa with Lembert sutures.
18. Place an “anti-obstruction stitch” from the Roux limb to the biliopancreatic limb to prevent kinking (Fig. 2.4c). Close the small mesenteric defect with a running suture (Fig. 2.5). Apply fibrin glue to the staple line to reduce adhesions and bleeding.
19. Close Peterson’s defect with a purse-string suture (Fig. 2.6).
20. Remove trocars and close all skin incisions with staples. These can be removed and replaced with Steri-Strips™ (3M Corporation) on postoperative day 2.

E. Postoperative Management

Postoperative management is directed toward avoidance and early detection of complications. Nasogastric tubes are not routinely left in place. On postoperative day 1 an upper gastrointestinal contrast study is obtained to look for evidence of an anastomotic leak or a Roux limb

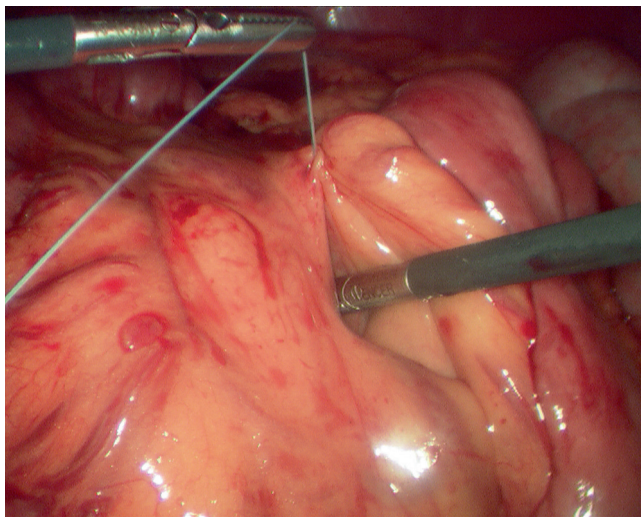


Fig. 2.5. Mesenteric defect. A short running suture is used to close the short mesenteric defect after creation of the jejunojunctionostomy.

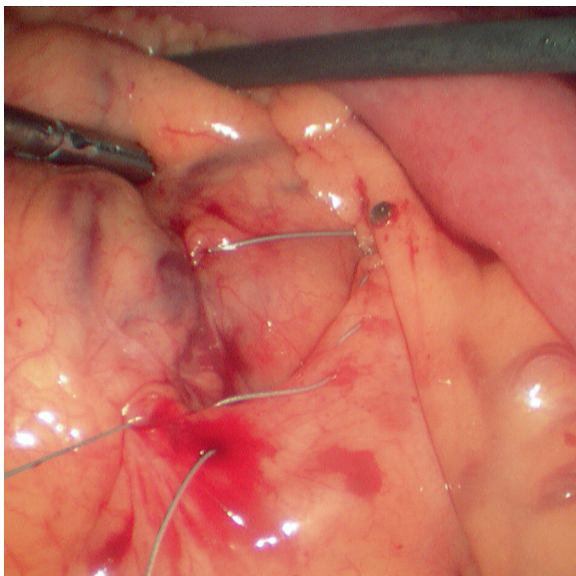


Fig. 2.6. Peterson's defect. Peterson's defect is closed with a purse string suture to reduce the likelihood of future internal hernia formation.

obstruction. If negative, patients are started on clear liquids that morning. Typically, patients are discharged home on postoperative day 2 with follow-up in bariatric surgery clinic at 1 week and at 1, 3, 6, 9, and 12 months.

F. Complications

Complications can be divided into two groups: non-technical and technical.

Non-technical complications include nausea and vomiting, deep venous thrombosis, and pulmonary embolism. Technical complications include anastomotic leak, stricture, bowel obstruction, and hemorrhage.

1. A leak rate of <1% is anticipated.
2. A rate of deep venous thrombosis of <1% is expected.
3. A stricture rate of 5–8% is appropriate.
4. The rate of internal hernias is between 1 and 3%.
5. Marginal ulcer rate is anywhere from 1 to 10%.
6. An overall 30-day mortality rate of 0.2% has been reported.

G. Outcomes of RYGB

1. In a study published by Adams et al., with a mean follow-up of 7.1 years, the mortality rate for patients who underwent RYGB was 2.7% versus 4.1% in BMI-matched controls. Disease-specific mortality was reduced by 56%, 92%, and 60% for coronary artery disease, diabetes, and cancer, respectively.
2. Major adverse events are predicted by a history of deep venous thrombosis or pulmonary embolism, a history of obstructive sleep apnea and impaired functional status. Major complications have also been shown to be predicted by male gender, higher BMI, advancing age and preoperative presence of bleeding disorders.
3. 90-day readmission rate following laparoscopic gastric bypass is between 6 and 7% with the most common complications resulting in readmission being nausea/vomiting/dehydration and stricture.

4. Weight loss at 1 year on average equals 70% of excess weight.
5. Twenty to thirty percent total weight loss at 10 years has been reported.
6. Failure rate, defined as a follow-up BMI ≥ 35 kg/m² for morbidly obese or ≥ 40 kg/m² for super obese, is 35% at 10 years overall with 58% failure rate among the super obese.
7. The effect of RYGB on comorbid illnesses is profound. A large meta-analysis by Buchwald et al. demonstrated that RYGB resulted in 84% resolution of type 2 diabetes, 94% of patients experienced improvement in hyperlipidemia, and 75% demonstrated resolution of their hypertension.

H. Summary

1. The laparoscopic RYGB is the most commonly performed bariatric procedure in the USA today.
2. Preoperative evaluation and appropriate patient selection are key factors for a successful weight loss operation.
3. The effect of the RYGB on metabolic disease is profound, and studies are currently underway to explore the utility of the RYGB outside the current BMI guidelines making the RYGB a metabolic operation as well as a weight loss operation.

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