# Laparoscopic One Anastomosis Gastric Bypass: History of the Procedure Surgical Technique and Outcomes

16

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**Chapter Objectives**

1. Familiarize the reader with the evolution of one anastomosis gastric bypass.
2. Present two common techniques described when performing one anastomosis gastric bypass.
3. The reader will understand the controversial issue of bile reflux as well as other complications, how to diagnosis these conditions, and therapeutic options for treatment.
4. Compare and understand the benefits of one anastomosis procedures versus two anastomosis bypass with Roux reconstruction.

## History

In 2001, an article was published in the journal *Obesity Surgery* reporting operative technique and outcomes in a series of 1274 cases utilizing a single anastomosis version of a gastric bypass [1]. The procedure described a simplified version of a traditional Roux-Y gastric bypass, avoided creation of a small gastric pouch or permanent gastric resection, and eliminated the second distal anastomosis which was required for the Roux-Y gastric bypass or duodenal switch. The concept of anastomosing a loop of jejunum to a long, narrow, gastric pouch created 2–3 cm below the crow's foot along the lesser curve was first introduced by Rutledge. Rutledge coined the phrase "mini gastric bypass" (MGB) and described a less complicated operative strategy that was easier to perform and eliminated the need for a Roux limb. It was hypothesized that a one anastomosis approach to gastric bypass could obtain similar results as the Roux-Y gastric bypass while also reducing the side effects and complications associated with the creation of the Roux limb necessary in RYGB and duodenal switch. Attempts at introducing a loop gastric bypass as a bariatric operation had been introduced by Mason 30 years earlier [2]. The "mini gastric bypass" operation introduced by Rutledge differed quite significantly from the original loop gastric bypass described by Mason. Mason's attempt to create a weight loss operation utilizing a horizontal gastroplasty and a simple loop jejunostomy was based very closely on the Billroth II gastrojejunostomy. Despite the simplicity of the operation, the initial loop gastric bypass created by Mason resulted in uncontrolled bile reflux and exposure of the distal esophagus to the deleterious effects of bile and acid. The controversy created by the esophageal complications following the introduction of the Mason loop gastric bypass has persisted over the two decades since the introduction of the "mini gastric bypass" by Rutledge. Mason's operation and the reflux producing side effects were quickly abandoned due to the severe and excessive presence of bile reflux on the distal esophagus. Subsequently, the potentially harmful effects of combining bile with acid and exposing the distal esophagus to this combination were well described by DeMeester [3, 4]. Fifty years after Mason first described his looped gastric bypass, the concerns that biliopancreatic reflux reaching the distal esophagus from the afferent limb of a loop gastrojejunostomy persist. Fear that bile induced esophageal inflammation, Barrett's changes, and esophageal cancer has limited adoption of one anastomosis gastric bypass (OAGB) in the United States. In the 20 years since the mini gastric bypass and OAGB procedures were described, there have been no publications definitively linking these single anastomosis procedures with the development of any cases of esophageal

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or gastric cancer. On the other hand, reflux secondary to sleeve gastrectomy may contribute to development of Barrett's esophagus in as much as 17% of patients undergoing vertical sleeve gastrectomy [5]. It has been hypothesized that the low-pressure environment of gastric bypass procedures and the longer length of the gastric pouch in OAGB operations may play a protective role in limiting reflux episodes from reaching the distal esophagus in patients undergoing OAGB.

While single anastomosis gastric bypass has been slow to gain traction in the United States, the opposite has been true in Europe, Asia, and the Middle East. Since 2001, over 16,000 patients have been reported in publications reporting OAGB outcomes [6]. The most comprehensive literature review identifying studies reporting outcomes following single anastomosis gastric bypass procedures was recently published as an IFSO position statement on March 29, 2018 [7, 8]. Included in the IFSO position statement was the recommendation that the "One Anastomosis Gastric Bypass is a recognized bariatric/metabolic procedure and should not be considered investigational." The IFSO Task force contributing to the review was composed of a multinational group of 22 recognized and accomplished bariatric surgeons. The United States was represented by two former ASMBS presidents. The task force reviewed, summarized, and correlated the findings of 52 studies reporting outcomes of 16,546 patients to report on the safety and efficacy of one anastomosis gastric bypass procedures.

## Introduction

One anastomosis gastric bypass (OAGB) is a technically easier operation than Roux-Y gastric bypass or biliopancreatic diversion with duodenal switch. The hallmark of the OAGB is the elimination of the Roux Limb. The well-recognized complications associated with the creation of the RYGB enteroenterostomy are eliminated. Morbidity and mortality rates are lower due to simplified operative dissection. Both the duodenal switch and the Roux-Y gastric bypass require the creation of a second enteroenterostomy. Well-known complications following RYGB can occur at the enteroenterostomy and include internal anastomotic staple line bleeding, intussusception, internal hernia, and leakage from a second anastomosis. These complications are avoided completely with the OAGB. OAGB offers reductions in operative time and less aggressive liver retraction. Division of small bowel mesentery is unnecessary in OAGB. The preservation of small bowel mesenteric blood flow may result in a decrease in the incidence of DVT, portal vein thrombosis, and bleeding. Large, super-morbidly obese patients whose BMIs exceed 50 can undergo OAGB without the need for a longer operation or one that would require a staged approach [9, 10]. Reversal of a single anastomosis gastric bypass is also relatively and technically easy should it be necessary in the future.

OAGB is a simpler, less costly operation to perform. Shorter operative times, less postoperative pain, decreased nausea and vomiting, early ambulation, and little more than an overnight hospitalization have been reported in comparative studies evaluating OAGB to RYGB [11]. The simplification in operative technique allows an inpatient hospitalization for RYGB to become an outpatient procedure for OAGB. The enteroenterostomy in RYGB can require up to four additional staple cartridges and closure of three mesenteric defects. OAGB is a procedure that can be offered by facilities at a significantly reduced overhead cost than that associated with gastric bypass. The improved economics associated with OAGB can significantly increase access to care for those patients who do not have the insurance coverage or economic means to afford more expensive procedures. The widespread adoption of this less expensive, less complex, and possibly safer alternative than RYGB has allowed bariatric surgery to be offered in large numbers to patients who might otherwise not have access to bariatric procedures across Asia, the Middle East, and Europe.

There is neither data nor established consensus as to an ideal or recommended operative technique. The initial operation described by Rutledge (MGB) and used in his 2001 series describes a gastric pouch based on the lesser curve of the stomach [12]. The initial staple line is created 1–2 cm below the crow's foot followed by a vertical extension along the body of the stomach and completing the pouch by staying just lateral to the angle of His as the stomach is transected. The anastomosis between the pouch and the jejunum is a wide, end to side anastomosis utilizing the entire length of a 45 mm stapler and is created between 180 and 220 cm distal to the ligament of Treitz. There is also no consensus on the optimal length of the afferent loop. Variations in the length of the afferent limb have been described for the elderly, vegetarian patients, and diabetics [13]. Fluctuations in the distance from the gastrojejunostomy to the ligament of Treitz have been reported from 180 to about 250 cm to greater than 300 cm depending on the age, eating habits, and comorbid conditions of the patient (Fig. 16.1).

An alteration to the original procedure described by Rutledge using a side-to-side (lateral to lateral) anastomosis between the jejunal loop and the gastric pouch was described by Carbajo in 2001 [14]. The modification was designed specifically to allow the afferent limb to experience less bile reflux into the gastric pouch. Carbajo and Caballero described the operation as a "one anastomosis gastric bypass" (OAGB). Their technique utilized this variation of the anastomosis described by Rutledge and lengthened the distance between ligament of Treitz and the gastrojejunostomy to between 250 and 350 cm (Fig. 16.2).

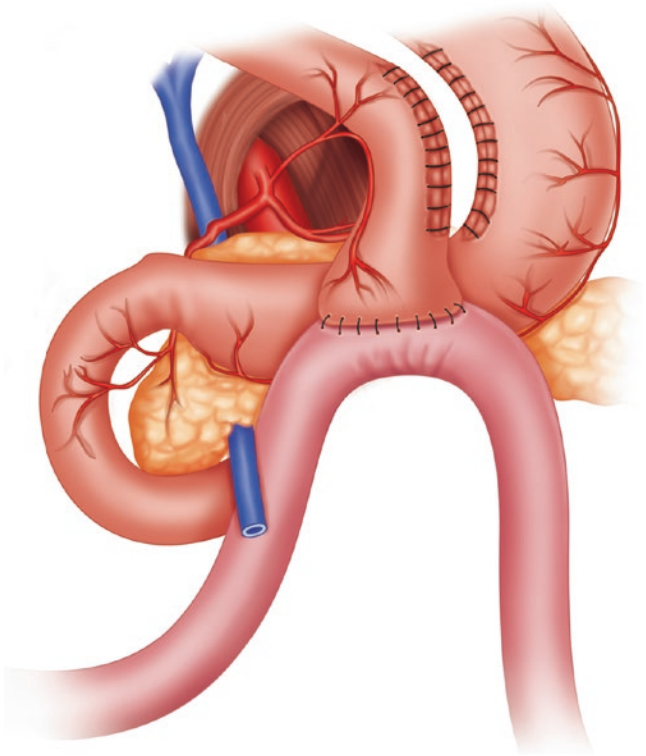

**Fig. 16.1** Technique of the "mini gastric bypass" as described by Rutledge consists of a long conduit from below the crow's foot extending up to the left of the angle of His. The operation has a wide gastrojejunal anastomosis to an anti-colic loop of jejunum 150–200 cm distal to the ligament of Treitz. The gastrojejunostomy between the posterior wall of the gastric pouch and the antimesenteric border of the jejunum is typically stapled using a 45 mm stapler in an end-to-side-type configuration

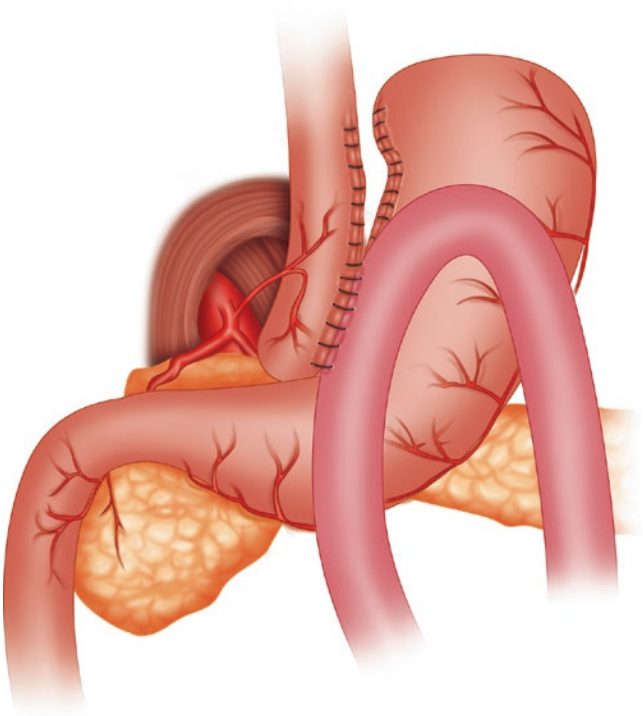

**Fig. 16.2** "One anastomosis gastric bypass" procedure as described by Carbajo [14] utilizes a side-to-side configuration and a 5–6-cm-long "anti-reflux" suture to approximate the mesenteric border of the jejunal loop to the lateral wall of the gastric pouch. Following this configuration, an enterotomy is made in the distal gastric pouch and the antimesenteric border of the jejunal loop. A stapled gastrojejunostomy in a side-to-side configuration completes the anastomosis

Since 2001, the variations in technique have resulted in multiple different versions of essentially the same operation [15]. These operations can be found in the medical literature described as:

1. Mini gastric bypass (MGB)
2. One anastomosis gastric bypass (OAGB)
3. Omega loop gastric bypass (OLGB)
4. Single anastomosis gastric bypass (SAGB)

This chapter will present the basic construction, operative technique complications, and outcomes we have employed and experienced with the introduction of OAGB into our practice. There is as yet no "gold standard" method with which to perform this procedure. Much of the operative techniques preferred by individual surgeons are based on opinions and personal experience. Anastomotic techniques vary between practices, and there are no comparative studies evaluating these differences in operative technique. Variations in technique regarding pouch size, bougie size, gastrojejunostomy technique, or afferent limb length among surgeons performing OAGB are common. The most common consensus agreement between various authors appears to be a long narrow gastric tube which extends to at or below the crow's foot of the lesser curve [16].

As surgical innovation continues, new operations that are cheaper, safe, and effective are the drivers that will improve access to bariatric surgery. Participation in national and international registries will allow for the collection of long-term data, outcome, and complication analysis. Analysis of the outcomes data is essential to the further advancement in the understanding of new and innovative metabolic and bariatric procedures. As we come to develop a consensus on procedures such as the OAGB, we can expect that future improvement in insurance coverage may ultimately benefit access to care nationally.

## Patient Selection and Preparation

The 1991 National Institutes of Health Consensus Development Conference Statement on Gastrointestinal Surgery for Severe Obesity established guidelines for identifying appropriate candidates for metabolic and bariatric sur-

gery operations [17]. Although these guidelines are more than 20 years old, they remain a foundation of bariatric surgery patient selection despite their likely outdated and historical significance. Evaluations of patients for possible MGB-OAGB, in our opinion, require utilization of a multidisciplinary team providing medical, surgical, psychiatric, and nutritional expertise. Evaluation of potential surgical candidates as per NIH guidelines is recommended and allows for appropriate discussions of both surgical and nonsurgical approaches to weight loss operations. In 2004, the American Society for Metabolic and Bariatric Surgery published a Consensus Conference statement on Bariatric Surgery for Morbid Obesity which discussed the expansion of available operative procedures, the growth in laparoscopic techniques, and the significant reductions in perioperative morbidity and mortality that have occurred since the 1991 NIH statement. In the years following the 2004 ASBS statement, societies including the American Society for Metabolic and Bariatric Surgery (ASMBS), the Obesity Society, the American Association of Clinical Endocrinologists (AACE), and the International Diabetes Federation (IDF) have endorsed consideration of lower BMI patients (30–34.9) for metabolic and bariatric operations [18].

## Surgical Technique

The introduction of one anastomosis gastric bypass into our practice evolved from our extensive experience with Roux-Y gastric bypass, handsewn and stapled anastomosis, and revisional procedures. Experience with laparoscopic anastomosis is essential when performing OAGB. Complications that can develop from a poorly done anastomosis can result in intractable reflux, outlet obstruction, afferent loop syndrome, and bile leakage. Surgeons whose experience is limited with respect to laparoscopic suturing of gastrojejunal anastomosis are encouraged to spend time improving their skills with respect to anastomotic technique. Advanced laparoscopic suturing skills are required to manage complications of these procedures. Surgeons with limited experience in performing laparoscopic suturing will find themselves at a disadvantage when performing the OAGB procedure or managing complications that may occur at the gastrojejunostomy. Educational courses featuring experts and faculty with extensive experience performing OAGB are becoming more widely available.

All patients receive a form of subcutaneous heparin and pneumatic compression devices to prevent DVT formation during the surgery. Patient positioning can either be via the French or split-leg positioning or standard supine position. We have performed our procedures using both techniques and find that either positioning is adequate, and there is relatively no advantage offered by one positioning technique over the other. Arm positioning is at 90° to the operating table, and padded straps to secure the lower extremities are used in all procedures as well as a foot rest to prevent patient movement and sliding during the procedure.

Access to the peritoneum is performed using an optical 12 mm trocar technique at the umbilicus utilizing a paraumbilical crease for the access incision. Establishment of pneumoperitoneum is followed by placement of a right upper quadrant, subcostal 12 mm trocar. Two additional trocars are positioned slightly higher than utilized in traditional RYGB operations and include a 5 mm port in the left upper lateral abdomen and a 12 mm port in the left mid-abdomen lateral to the umbilicus. We prefer a 10 mm 30° operating laparoscope although surgeons preferring a 5 mm scope could utilize that and downsize the umbilical port to a 5 mm as per their preference.

If the patient is positioned supine, the surgeon is standing on the patient's right side. The majority of our patients have been placed on a 2-week liquid diet to facilitate reduction in the size of the liver. In most cases, the decrease in liver size will be sufficient so as to allow the use of internal liver retraction devices which typically suspend the liver using three hooks attached to suture technique. A deceased liver size avoids the deployment of external retraction devices such as the Nathanson hook which requires an additional incision and significant torque on the liver in order to provide exposure. We have also subjectively observed less congestion of the liver and less aggressive retraction using internal liver retraction.

## Creating the Gastric Pouch

Creation of the gastric pouch begins with a lesser curve dissection and identification of the crow's foot as the critical landmark to insure optimal pouch length in order to minimize any likelihood that refluxed biliopancreatic secretions could reach the esophagus (Fig. 16.3). The limitations of the Mason loop gastric bypass were largely due to the combination of a short pouch which was horizontal in nature with a loop reconstruction [19]. In order to perform a successful OAGB, and minimize any biliopancreatic reflux, the identification of the crow's foot of the lesser curve is the key to a successful operation. The majority of surgeons begin their perigastric dissection at the crow's foot although we prefer beginning our dissection 1–2 cm or so below the crow's foot (Fig. 16.4). Our preferred bougie is a 34 French oral gastric tube, but we have used 36 and even 40 French bougies when necessary. Unlike a sleeve gastrectomy, the goal when creating the gastric pouch is to avoid hugging the bougie and to create a pouch in which the stapler is positioned a bit wider and lateral to the bougie.

Once the perigastric dissection has been completed and the lesser sack has been entered, we position a 45 mm linear

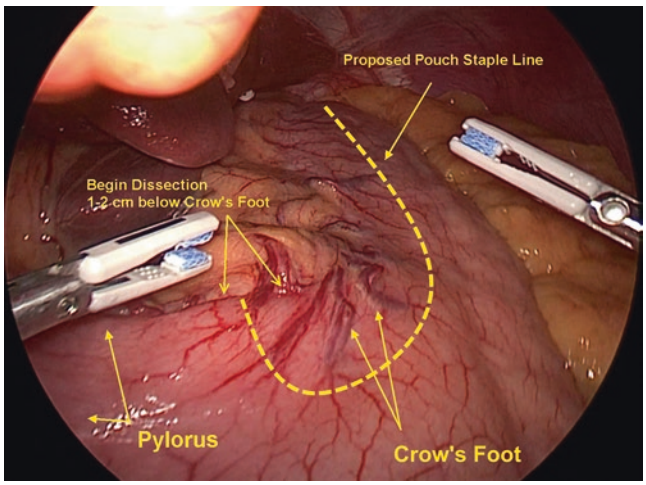


**Fig. 16.3** Operative inspection of the stomach. Key landmarks include the crow's foot and the planned path for stapling to create the gastric pouch as well as the pylorus

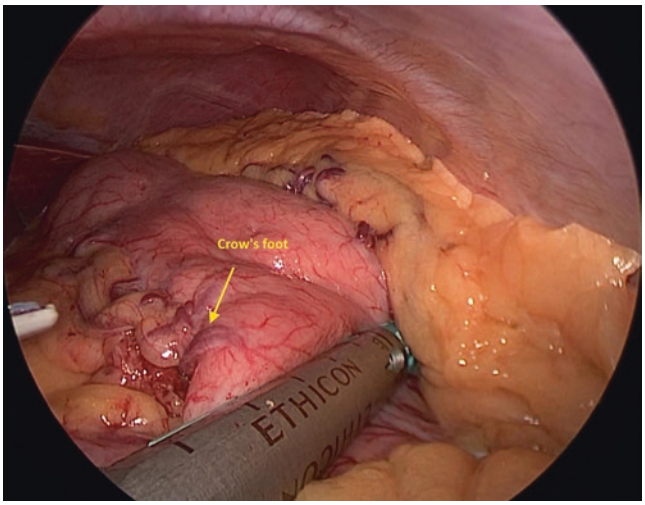


**Fig. 16.5** Initial positioning of the first staple cartridge 1–2 cm below the crow's foot for one anastomosis gastric bypass

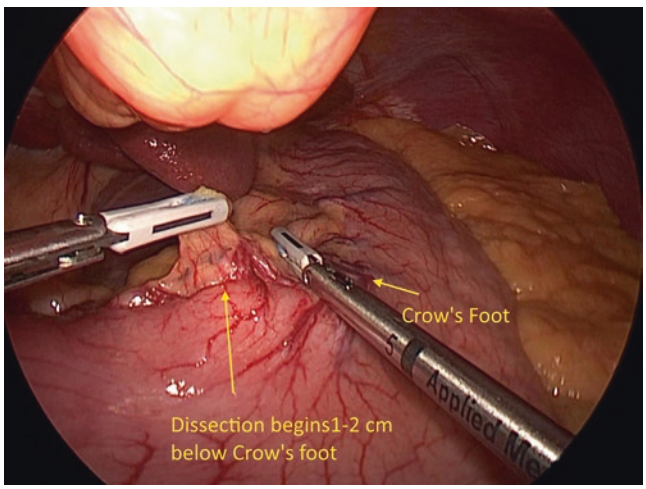


**Fig. 16.4** Dissection for the initial path of the stapler occurs 1–2 cm below the crow's foot along the lesser curve

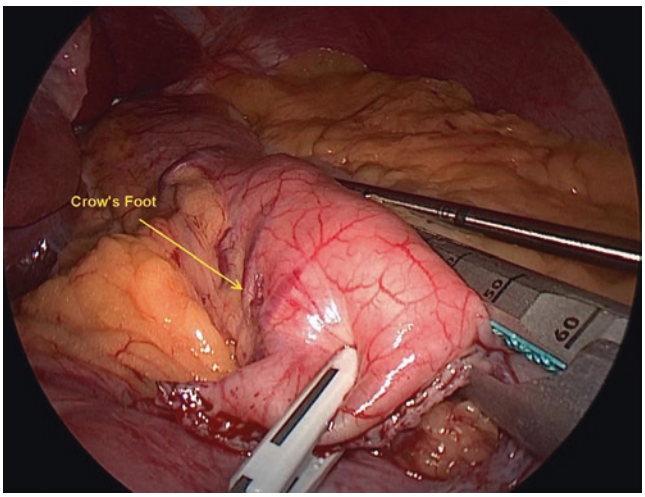


**Fig. 16.6** Positioning of the second staple firing for creation of the gastric pouch for one anastomosis gastric bypass

stapler via the left upper quadrant 12 mm port just below the crow's foot (1–2 cm) and perpendicular to the antrum (Fig. 16.5). The initial firing is with a cartridge used for the thickest tissue. Caution is taken so as to not transect the antrum or narrow the outflow of what will be the retained body and fundus of the bypassed portion of the stomach. A 60 cm linear stapler is then introduced through the left upper quadrant 12 mm port and positioned so as to create a staple line curving toward the angle of His while staying a bit lateral to the 34 French bougie and not hugging the bougie as is typically done with sleeve gastrectomy (Fig. 16.6). The initial firing is again with a cartridge used for the thickest tissue, and then adjustments in cartridge selection can occur based on the thickness of the tissue encountered. We consider bioabsorbable buttressing to limit staple line bleeding on all firings after the first 60 mm firing. Multiple 60 mm cartridges are deployed until the stomach is transected just lateral to the angle of His separating the long gastric pouch from the gastric remnant. It is essential to stay a bit wide of the bougie in order to insure that staple cartridges are positioned in the same horizontal plane and at the apex of each staple firing. This careful attention to detail is to prevent a spiral of the staple line which can result in a functional obstruction and severe reflux. We do not routinely oversew our staple lines and address any persistent bleeding with additional sutures or surgical clips.

Creation of the loop begins by revealing and exposing the ligament of Treitz. We use a 200 cm afferent limb for patients with a BMI under 50 and consider 250 cm afferent limb for patients with a BMI over 50. We utilize bowel graspers with

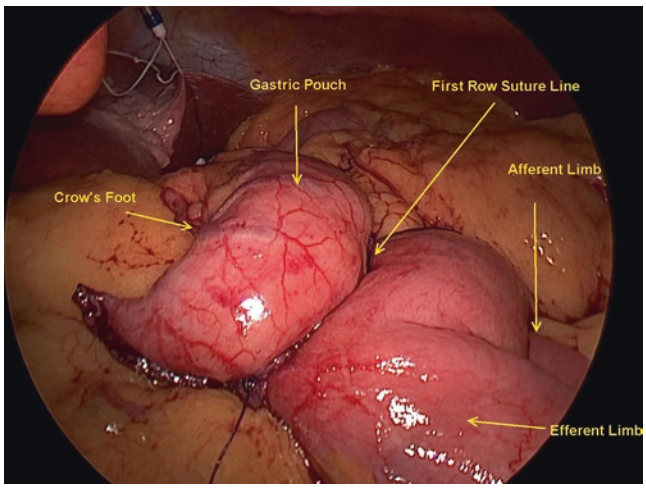


**Fig. 16.7** Completion of the initial suture line in preparation of a side-to-side linear stapled anastomosis for one anastomosis gastric bypass

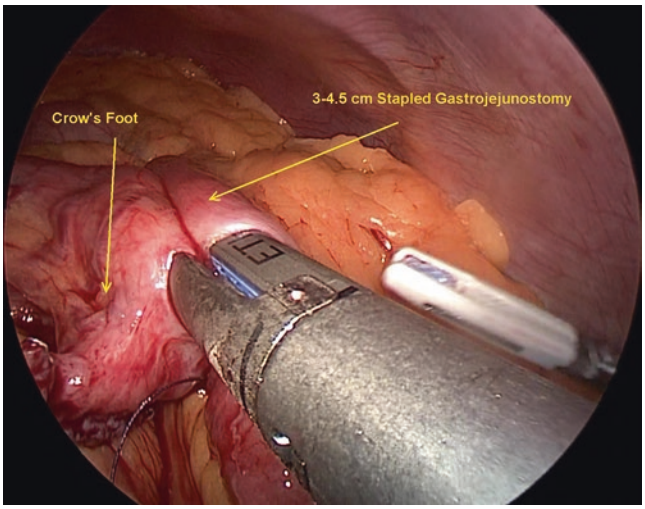


**Fig. 16.8** Intraluminal positioning of linear stapler for a side-to-side 2.5–4 cm stapled anastomosis one anastomosis gastric bypass

marks signifying 5 cm and 10 cm lengths to measure as precisely as possible, and we do not estimate the measurements via visual estimations. Once a 200 cm afferent limb has been measured, we favor the anti-reflux technique described by Cabajo and Caballero utilizing a side-to-side anastomosis of the afferent limb to the distal pouch. The gastric pouch which is typically 15–18 cm in length is positioned adjacent to the afferent limb to create a 200 cm biliopancreatic limb length. The site of the 200 cm measurement is marked with a stay suture, and measurements are continued distally to insure that there is at least 250–300 cm of small bowel distal to the proposed site of the gastrojejunostomy.

Once the site of the 200 cm afferent loop is confirmed, a posterior row of suture using 3–0 absorbable suture is placed to approximate the mesenteric serosa of the afferent limb to the lateral suture line of the distal pouch (Fig. 16.7). This suture line not only protects from leaks but also is essential in taking any unnecessary tension off the staple line. Once complete, an opening is made in the distal gastric pouch and the antimesenteric portion of the afferent limb so as to allow positioning of a 45 mm stapler to create a 3–4 cm gastrojejunal anastomosis. The stapler is positioned intraluminally in the gastric pouch and the afferent loop and then fired (Fig. 16.8). The 34 French bougie is advanced across the anastomosis and the remaining gastrojejunal defect is closed anteriorly with 3–0 absorbable suture followed by a second layer of 3–0 absorbable suture to oversew the anastomosis and approximate the serosa of the afferent limb to the serosa of the gastric pouch (Fig. 16.9). By utilizing this technique, the initial running suture line suspends the afferent limb above the anastomosis and secures the loop to the gastric pouch. We believe this technique not only will decrease the incidence of symptomatic bile reflux but will also decrease the possibility of developing an afferent loop syndrome postoperatively.

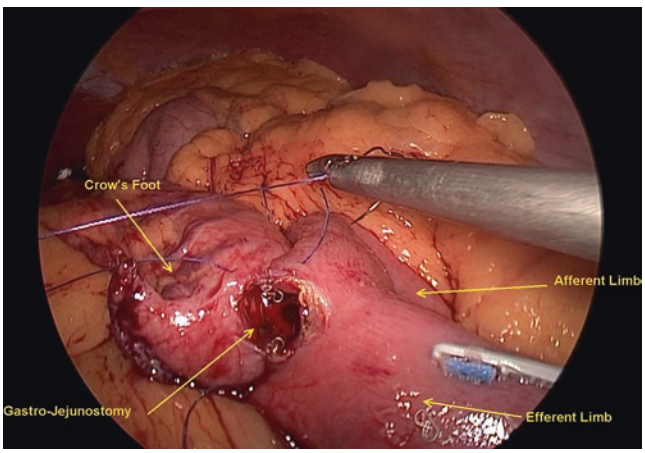


**Fig. 16.9** Handsewn closure of stapled side-to-side anastomosis, one anastomosis gastric bypass

The anastomosis and vertical staple line are tested for leaks by occluding both afferent and efferent limb and insufflating with oxygen or air under saline submergence. Any evidence of leak or visible air bubbles are addressed using intracorporeal suturing until there is no evidence of any air leak. Caution must be taken not to over-distend the pouch and afferent limb, and rarely do we need to insufflate with a pressure greater than 2 L per minute inflow. There must be excellent communication between the surgeon and the anesthesiologist during the leak test to avoid any rupture of the bowel or anastomosis due to over-distension. Alternatively, we have utilized the injection of methylene blue diluted into 1 L of saline as an alternative. Injection of 100–150 cc of diluted methylene blue is done by our anesthesiologist to accomplish distension of the gastric pouch as well as a short segment of the afferent and efferent limbs. Both limbs are

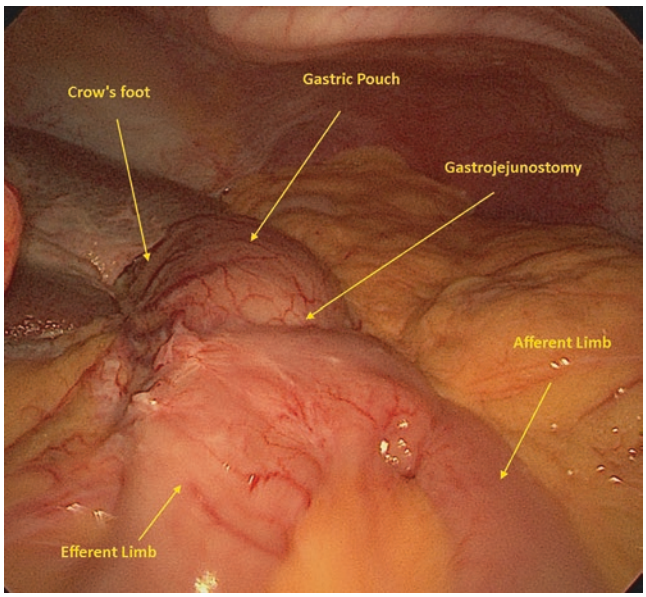


**Fig. 16.10** Same patient 1 year after one anastomosis gastric bypass. Visualized during laparoscopic cholecystectomy. The gastrojejunostomy is easily visualized below the liver and sits close to the transverse colon. The antrum and previous staple line are also visualized. EGD revealed no evidence of bile reflux, ulcer, or stricture. One year post-op, this patient has achieved a BMI of 25 and has no complaints

occluded by laparoscopic bowel clamps during the air insufflation or methylene blue tests.

Finally, we choose to close the mesenteric defect created by the afferent limb between the root of the mesentery of the afferent limb and the transverse mesocolon. Because the loop is an antecolic path the creation of a mesenteric defect between the mesentery of the loop and the transverse mesocolon is a recognized site of potential internal hernia. The defect is addressed using 3–0 nonabsorbable suture. The root of the mesentery of the loop is identified and sutured to the mesentery of the transverse colon until the mesenteric defect is closed. After completing a final secondary look for bleeding or leaks, the retractors are removed, and the 12 mm fascial defects are closed, and the procedure is completed (Fig. 16.10).

Our technique can be summarized by identifying several steps as all our OAGB procedures are done in the same manner:

1. Begin a perigastric dissection 1–2 cm distal to the crow's foot along the lesser curve.
2. Position a 45 mm stapler using a staple cartridge for thick tissue at the point of the perigastric dissection staying perpendicular to the lesser curve of the stomach.
3. Position a 34 French bougie intragastric followed by a 60 cm stapler just lateral to the bougie.
4. Transect just lateral to the angle of His to create a somewhat generous and straight gastric pouch.
5. Measure 200 cm distal to the ligament of Treitz, and anastomose the loop to the gastric pouch in a side-to-side fashion with the afferent limb superior and the efferent limb inferior.
6. Close the mesenteric defect.

Postoperative management is similar to traditional gastric bypass. We keep our patients overnight and start them immediately on a clear liquid diet. Almost all patients can be discharged postoperative day 1. We do not use routine upper GI swallows immediately post-op.

## Reversal of One Anastomosis Gastric Bypass

Postoperative complications following one anastomosis gastric bypass procedures are a rare but recognized reason for considering reversal of the procedure. Malnutrition, excessive weight loss, severe lower extremity edema, and motor deficits can present as a refractory malnutrition syndrome after any malabsorptive procedure. Genser et al. reported on a series of 2934 patients who had undergone mini gastric bypass over a 10-year period [20]. Of the 2934 patients, 26 were identified as having developed severe and refractory malnutrition syndrome which responded to reversal of MGB to normal anatomy.

Even with variations in surgical technique, reversal of a one anastomosis gastric bypass is straightforward allowing for complete restoration of normal anatomy. There are essentially three steps involved in reversing an OAGB operation:

1. Identification of the gastrojejunostomy
2. Resection of the gastrojejunostomy
3. Anastomosis of the gastric pouch to the body of the gastric remnant

Identification and dissection of the gastrojejunostomy away from adjacent structures allow for a straightforward transection of the distal gastric pouch disconnecting the stomach from the afferent limb. Following this, the gastrojejunostomy can be similarly removed from the afferent limb by careful placement of a 60 cm stapler along the antimesenteric border of the jejunum and then resecting the anastomosis off of the jejunum. Once the gastrojejunal anastomosis has been resected, all that remains is to reestablish continuity between the gastric pouch and the gastric remnant. We accomplish this by approximating the two stomachs using an absorbable 3–0 suture and then completing the anastomosis with a linear stapler followed by closure of the new anastomosis over a bougie using 3–0 absorbable suture in two layers. The anastomosis is tested for leaks using methylene blue or air insufflation and the reversal is completed. Patients are started on clear liquids postoperatively and are discharged after an overnight stay.

## Benefits of a Single Anastomosis Procedure

### Mesenteric Defects

Mesenteric defects created by RYGB are a potential source of internal hernia, bleeding, and bowel obstruction. Obstruction from internal hernia following Roux-Y gastric bypass is relatively common. Internal hernia as the primary cause of obstruction following gastric bypass represents up to 41% of cases presenting with intestinal obstruction [21]. Roux-Y gastric bypass requires the creation of a gastrojejunostomy and a second enteroenterostomy. Depending on whether an antecolic approach or a retrocolic approach is undertaken, there can be up to 3 potential spaces where internal herniation can occur. OAGB eliminates the need for the enteroenterostomy created when a RYGB is performed. The second anastomosis which is created between the biliopancreatic limb and the alimentary limb is unique to RYGB and creates a potential site for internal hernia that does not exist in an OAGB operation. The herniation of bowel through this kind of defect creates a surgical emergency that must be evaluated quickly to avoid bowel ischemia and infarction. Closure of mesenteric defects can reduce the risk of internal hernia from 3.3% to 1.2% but cannot eliminate the risk [22]. If a retrocolic passage of the Roux limb to gain access to the gastric pouch is used, a third potential site of herniation through the mesenteric defect is created which also must be closed. The simplicity of the OAGB eliminated two of these three potential sites of internal herniation. As a result, the potential for internal hernia is lower in OAGB than in RYGB. Internal hernia following OAGB is a rare complication [23, 24].

The benefit of decreasing the potential defects associated with internal hernia following gastric bypass is not new. The modification of the retrocolic gastric bypass to the antecolic technique of passage of the Roux limb from the midgut to the foregut eliminated one of the three potential sites of internal hernia [25, 26]. As a result, the risk of internal hernia through the mesentery of the transverse colon was eliminated, reducing morbidity and mortality from internal herniation [27, 28]. OAGB has the benefit of decreasing morbidity and mortality further by eliminating one of the two remaining sites of potential internal herniation that exist in RYGB.

Internal hernia rates following RYGB have been reported. Iannelli et al. reported findings of 11,918 patients following RYGB. Internal herniation was discovered in 300 patients for an internal hernia rate of 2.51% [29]. Internal herniation occurred at the level of the transverse colon in 69% of cases, at the level of the Peterson's defect in 18% of cases, and at the level of enteroenterostomy in 13% of cases. OAGB creates no defect at the level of the transverse colon or at the enteroenterostomy. Eighty-two percent of the cases of internal hernias reported in RYGB are associated with these two defects. Internal hernia reported with OAGB are relatively rare compared to the incidence reported with RYGB [30].

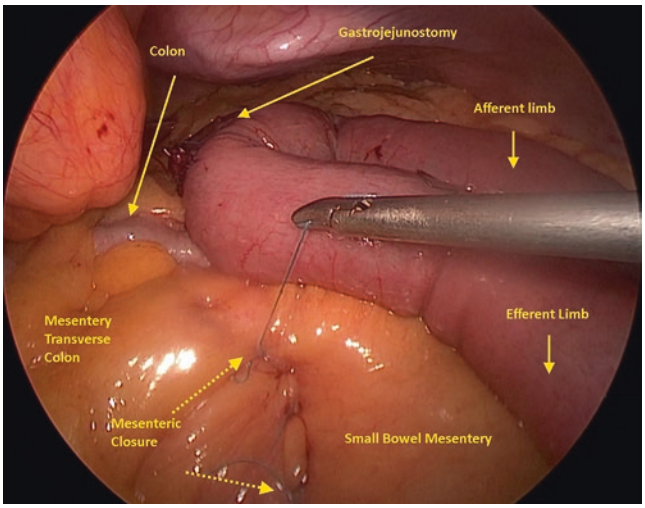


**Fig. 16.11** Closure of the only mesenteric defect in one anastomosis gastric bypass is accomplished by closing the defect between the efferent limb and the mesentery to the transverse colon. Nonabsorbable suture is used to close the defect beginning at the root of the mesentery and approximating it to the transverse mesocolon until the lower border of the colon is reached

The OAGB utilizes a single gastrojejunal anastomosis with a single mesenteric Peterson hernia defect created by the loop anastomosis of jejunum to gastric pouch. Closure of this mesenteric defect is relatively easy and is associated with significant decrease in the rate of internal hernia from this single remaining site (Fig. 16.11).

### Intussusception

Jejuno-jejunal intussusception is a known complication following RYGB. Obstruction, bowel ischemia, and bowel necrosis are potential sequela following development of intussusception. The rate of intussusception following RYGB at the level of the enteroenterostomy occurs at less than 1% (0.4%) [31]. Diagnosis can be difficult as symptoms are generally nonspecific. Both operative and nonoperative approaches to the treatment of intussusception do not reliably prevent recurrence of the problem. The single anastomosis OAGB eliminates the potential of intussusception of the enteroenterostomy further decreasing postoperative morbidity and mortality from RYGB-related complications.

### Simplified Reversal/Revision

Reversal of OAGB can be accomplished via two approaches. Complete anatomic reversal requires simple transection of the gastrojejunostomy on the jejunal side of the anastomosis followed by creation of a gastro-gastrostomy between the gastric pouch and the gastric remnant. Alternatively, func-

tional reversal of the OAGB can be accomplished by simply reconnecting the stomach to the gastric remnant.

### Conversion to Roux-Y Configuration

In the rare event that bile reflux is suspected, diversion of the bile away from the gastrojejunostomy can be accomplished by simply transecting the afferent limb at the level of the gastrojejunostomy and diverting the flow at least 50–70 cm below the gastrojejunostomy utilizing a new enteroenterostomy.

## Complications

### Bile Reflux

Perhaps the most contentious, widely discussed topic surrounding one anastomosis gastric bypass has been the issue of potential bile reflux (Figs. 16.12 and 16.13). The topic remains controversial with potential concerns regarding Barrett's esophagus and possible esophageal cancer persisting although no reported cases of esophageal cancer appear in peer reviewed publications. Despite the large number of publications and low incidence of reflux-related revisions, this controversy continues to persist and has resulted in a delay of acceptance of the procedure particularly in the United States. Most authors report an improvement in GERD symptoms following OAGB [32]; however, some authors report reflux symptoms that have required revision to either RYGB or implementation of Braun's anastomosis distal to the gastrojejunostomy of the single anastomosis of the gastrojejunostomy [33]. The incidence of symptomatic acid reflux in our patients that have undergone OAGB procedures is higher than what we have experienced in our RYGB patients. The majority of these patients are easily treated with once-a-day PPI therapy, and many reflux symptoms dissipate over time. The few patients that have had significant reflux symptoms following OAGB have been successfully revised to a Roux-Y gastric bypass with complete resolution of their symptoms. Many surgeons have reported an incidence of symptomatic reflux following one anastomosis gastric bypass at less than 0.5%.

Despite positive effect in terms of weight loss and improvement of obesity-related comorbidities, there still exist concerns about symptomatic biliary reflux gastritis and esophagitis requiring revision surgery following OAGB procedures [34]. Concerns regarding the risk of esophageal cancer with this procedure because of chronic biliary reflux persist [35]. There is no prospective data to suggest there is a legitimate concern for gastroesophageal reflux following OAGB to progress to Barrett's esophagus or cancer.

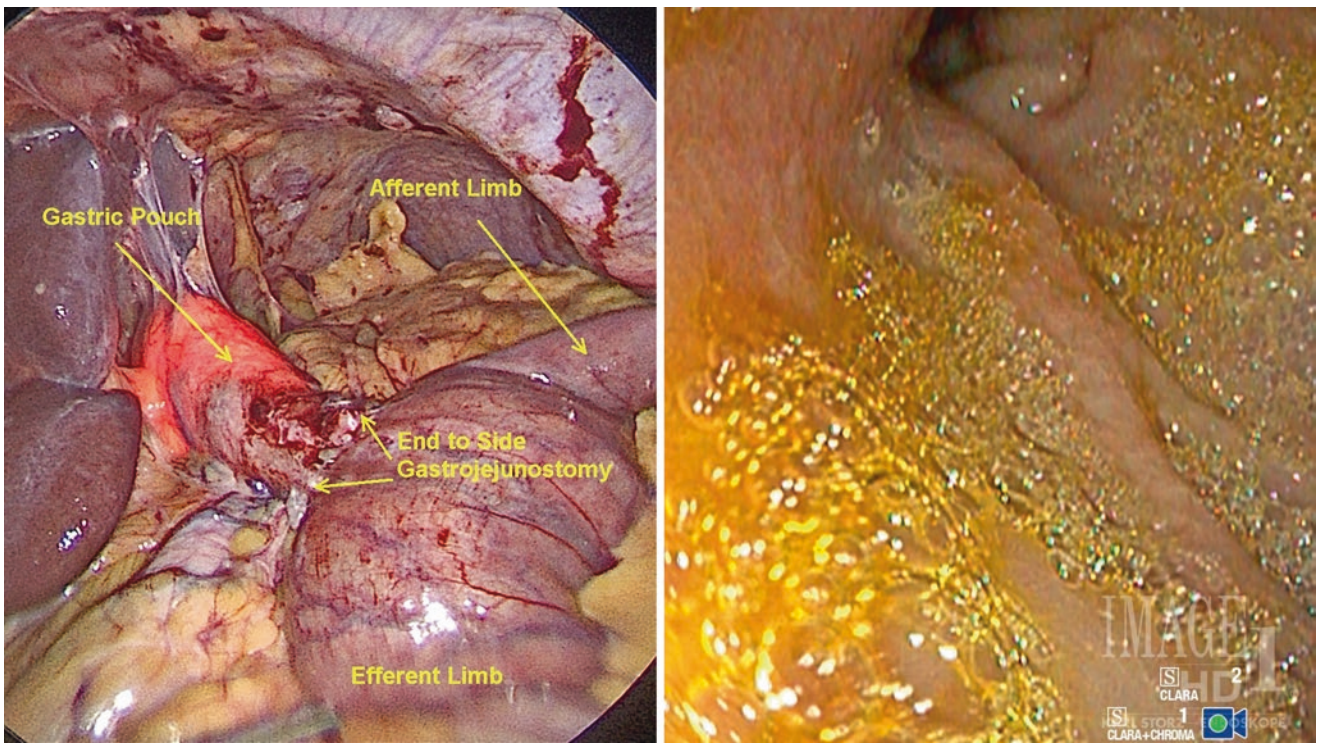


**Fig. 16.12** Classic bile reflux following mini gastric bypass performed as described by Rutledge in a patient with previous repair of a large para esophageal hiatal hernia and poorly functioning lower esophageal sphincter

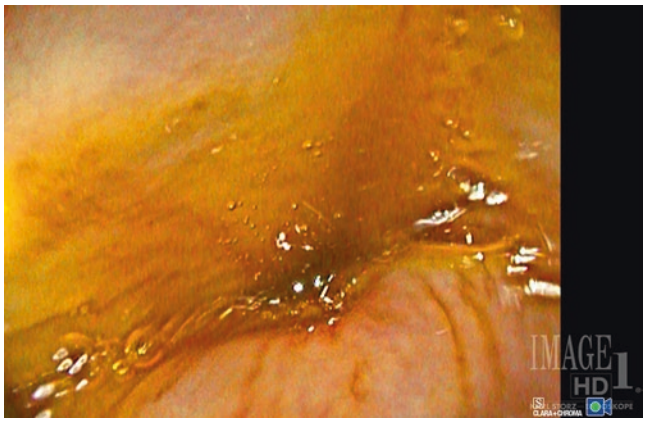


**Fig. 16.13** Esophageal view, bile reflux following mini gastric bypass. Same patient as Fig. 16.12

Tolone et al. evaluated 15 patients (5 males/10 females), with a mean age of 38 years, a median preoperative weight of 141.1 kg (121–174), and a mean BMI of 46.4 (38–60) kg/m$^2$, who had undergone OAGB [36]. At the 1-year postoperative follow-up, the median weight was 81.2 kg (72–111), the median BMI was 31 kg/m$^2$ (28–42), and the excess weight loss (EWL, %) was 63 (56–69). The OAGB was compared to a control group consisting of 25 adult patients who underwent sleeve gastrectomy. The sleeve gastrectomy group was age- and sex-matched with patients who underwent OAGB. Their median preoperative weight was 130.8 kg (119–156), and median BMI was 46.1 (38–58); 1-year postoperative median weight was 98 kg (72–110), and median BMI was 34.7 (28–46), with 56% excess weight loss. In this study, the OAGB group (15 patients) reported no symptoms of reflux prior to surgery. Following OAGB, none of the 15 patients reported reflux/GERD symptoms, and there was no esophagitis on endoscopic examination.

Using high-resolution impedance manometry and 24-h pH-impedance monitoring, Tolone discovered a significant reduction in esophageal acid exposure as well as reflux episodes in all patients undergoing OAGB. The control group of patients undergoing sleeve gastrectomy developed an increase in both esophageal acid exposure and reflux episodes.

They concluded that patients undergoing OAGB developed no changes in esophageal gastric junction function or motility patterns in obese patients without preoperative GERD or large hiatal hernia 12 months after surgery. In contrast to patients having undergone sleeve gastrectomy, those who had undergone OAGB demonstrated diminished esophageal acid exposure and total number of reflux. Although this study reports a rather small patient population, it remains perhaps the most elegant and complete study exploring the function of the esophageal gastric junction following OAGB operations.

Our experience with bile reflux following OAGB has been similar to many published studies with virtually no complaints of reflux occurring in patients having had no history of hiatal hernia or reflux symptoms prior to surgery. Our only two findings of significant reflux have occurred in two patients both of whom had significant abnormalities of the distal esophagus and esophagogastric junction prior to their OAGB. It has been our experience that patients with symptomatic bile reflux can be confirmed on endoscopic examination and can be successfully treated with revision to a Roux-Y configuration if necessary with complete resolution of symptoms [37].

## Bile Scintigraphy

Bile scintigraphy has been published and is a possible modality to assess the presence of bile reflux in patients following mini gastric bypass [38] (Fig. 16.14). In this study, nine consecutive patients who underwent OAGB underwent hepatobiliary scintigraphy and a reflux questionnaire 8–13 months after their operations. In addition, every patient with a positive bile scintigraphy scan underwent gastroscopy with biopsies. Five of the nine patients demonstrated positive reflux into the gastric tube; however, bile reflux was not present in the esophagus of any of the nine patients. The findings demonstrated that transient bile reflux was common after MGB but only in the gastric tube and not in the esophagus. The clinical relevance of bile reflux and loop bariatric procedures has not been adequately studied. The debate regarding OABG procedures and the clinical significance of reflux following these procedures will continue, and further prospective studies both short-term and long-term are necessary to further define the clinical relevance of bile reflux.

## Malabsorption

Multiple studies have confirmed that malabsorption can occur following OAGB, and careful postoperative monitoring of nutritional status is recommended following this procedure [39]. Unlike Roux-Y gastric bypass where no standardization of the alimentary, biliopancreatic, and common limb lengths has been defined, OAGB procedures typically describe a biliopancreatic alimentary limb length of between 150 and 200 cm. Nutritional outcomes utilizing these limb lengths have been extensively reported [40, 41]. One hundred fifty centimeters of limb length has been proven to be effective in patients with class II obesity. Regardless of the method used to determine if the limb length should be 150 cm or 200 cm, a risk of revisional surgery for excess weight loss was reported by Noun to be 0.4% [42]. Lee reported a 1.0% and Musella et al. [43] reported an incidence of excess weight loss at 0.2%. Authors who have used a fixed 200 cm biliopancreatic loop in the creation of a one anasto-

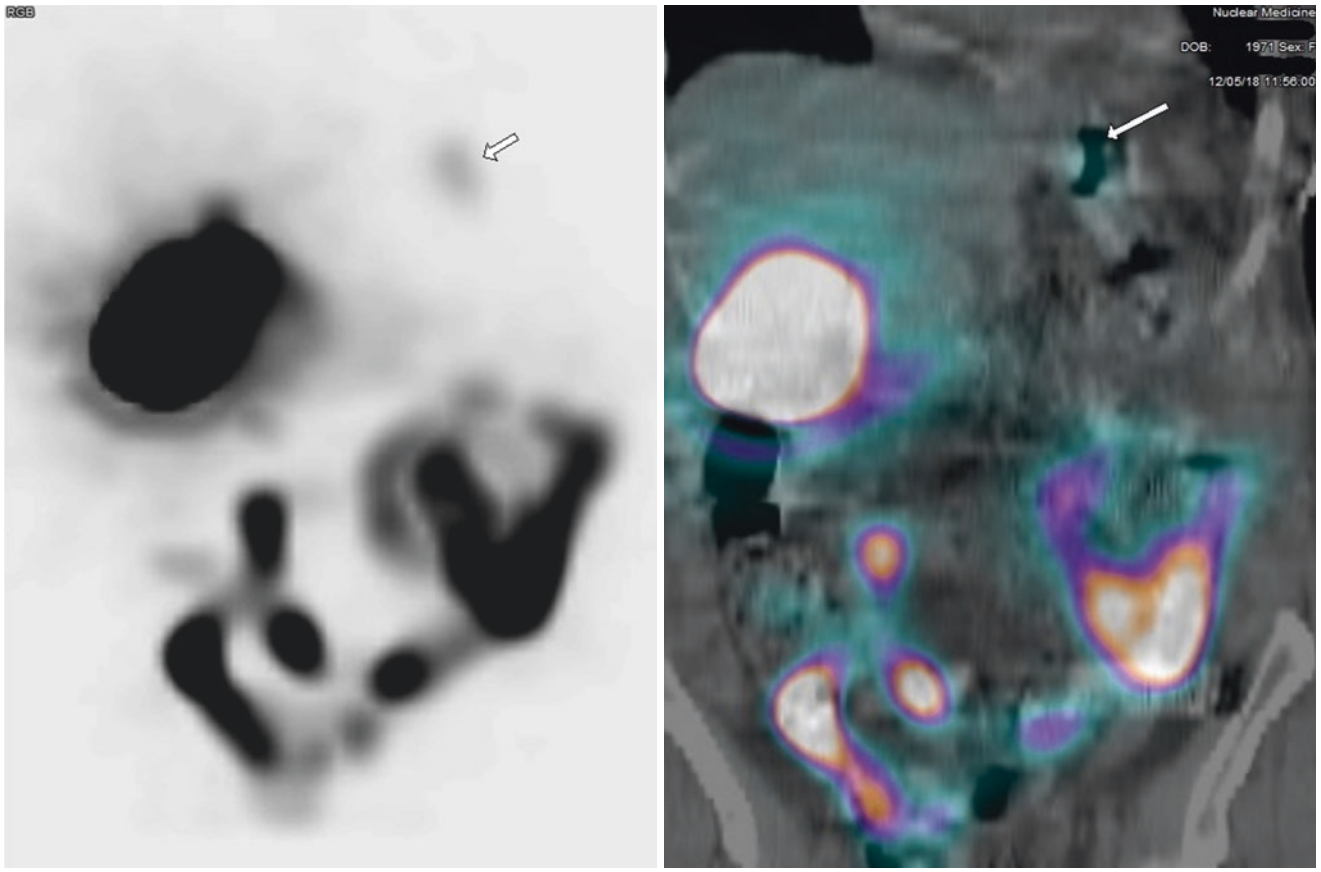


**Fig. 16.14** Nuclear medicine bile scintigraphy following one anastomosis gastric bypass demonstrates no significant bile reflux. The scan correlates with the endoscopic findings which were devoid of any bile reflux in the gastric pouch or esophagus. Arrow depicts very small uptake in the gastric pouch but below the diaphragm which may represent trace amounts of bile reflux but no significant reflux entering the distal esophagus

mosis gastric bypass report a much lower rate of malnutrition of 0.05% and 0.1% by Chevallier and Kular [44].

## Resolution of Comorbidities and Nutritional Complications

The major comorbid conditions commonly associated with one anastomosis gastric bypass which include diabetes, hypertension, obstructive sleep apnea, hyperlipidemia, and joint pain all show significant improvement after 5 years of follow-up. Bruzzi et al. published a series of 126 patients with 72% follow-up at 5 years [46]. No mortalities were reported, and percent excess body mass index lost was an impressive 71%. Complete remission of type 2 diabetes occurred in 82% of patients. Fifty-two percent of patients with hypertension and 81% of patients with hyperlipidemia were able to stop medications at 5 years follow-up. Sleep apnea resolved in 50% of patients.

The largest UK study showing safety and acceptable results for metabolic syndrome and obesity comorbid conditions following OAGB/MGB was published in 2019. In it, type 2 diabetes mellitus remission rate was 83% and 70% at 1 and 3 years, respectively. Hypertension resolution was 61%, 58%, and 58% at 1, 2, and 3 years post-op. Ninety-nine percent of sleep apnea patients improved symptomatically and went off their CPAP machines. The study reported on outcomes of 527 OAGB patients. Mean follow-up was 2.5 years and the mortality was zero. Multiple additional authors report similar results with comorbidity resolution following laparoscopic OAGB and similar procedures [42, 45–50].

## Outcome Comparison Roux-Y Gastric Bypass vs Sleeve Gastrectomy vs One Anastomosis Gastric Bypass

The most recent prospective randomized series comparing long-term results between Roux-Y gastric bypass versus sleeve gastrectomy versus one anastomosis gastric bypass was recently published by Ruiz-Tovar et al. [51]. In this

study, 600 patients undergoing primary bariatric surgery were prospectively randomized into a clinical trial consisting of three groups. Patients were randomized into those undergoing sleeve gastrectomy (SG), Roux-Y gastric bypass (RYGB), and one anastomosis gastric bypass (OAGB). The study reports on the long-term findings with respect to BMI, excess BMI loss, remission of type 2 diabetes, hypertension, and dyslipidemia.

Six hundred patients were randomized into three groups, 200 patients in each group. The authors achieved 91% follow-up at 5 years in the SG group, 90% follow-up in the OAGB group, and 92% follow-up in the RYGB group. The study reports significantly greater excess BMI loss in the OAGB group versus that achieved in the SG and RYGB group at 5 years follow-up. Similarly the OAGB group achieved greater remission of type 2 diabetes, hypertension, and dyslipidemia than RYGB or SG. The results build upon findings observed with previous studies and continue to confirm the findings that OAGB is a safe and efficacious operation. Prospective randomized studies continue to confirm short-term and long-term outcomes that meet or exceed those of SG and RYGB. The importance of these studies in contributing to the worldwide adoption of the OAGB as an acceptable, safe, and effective primary bariatric operation cannot be underestimated.

## Insurance Coverage USA

Insurance coverage for one anastomosis gastric bypass procedures has been slow to obtain adoption by commercial insurance companies in the United States. At the current time, there are no know commercial payers in the United States who have included MGB, OAGB, or single anastomosis gastric bypass as a covered benefit for bariatric surgery. In our review of over 20 different benefits of coverage policies for virtually every major insurance company in the United States, we were unable to find a single policy which did not specifically exclude these procedures, and in every instance they were identified as being investigational. In every policy reviewed, the OAGB procedures, procedures using a loop gastrojejunostomy or Billroth II-type anastomosis, or procedures described as mini gastric bypass, for the purpose of weight loss, were specifically identified as procedures which were not a covered benefit of the insurance plan with respect to the surgical treatment of morbid obesity.

## Summary

One anastomosis gastric bypass/mini gastric bypass is clearly a promising bariatric operation, one that still continues to polarize bariatric surgeons. Despite the many thousands of procedures published in the world literature, there remain objections to the one anastomosis procedures. These objections have led to a slow, almost insignificant adoption of the procedure in the United States as the concern regarding symptomatic bile reflux, malnutrition, and risk of esophageal cancer remains the most common objections voiced by those surgeons reluctant to perform this operation. Those surgeons having demonstrated significant expertise with the one anastomosis approach to gastric bypass report favorable outcomes with excellent resolution of comorbid conditions and low complication rates. In addition, the technical simplicity of the operation and short learning curve, standardized approach, and relative ease with which the operation can be reversed or revised lead many surgeons to advocate for a more widespread proliferation of this operation as a preferred operation for the treatment of obesity.

Multiple publications including prospective and randomized trials have demonstrated that OAGB/mini gastric bypass is at least comparable to Roux-Y gastric bypass in the treatment of obesity. Our personal experience with OAGB exceeds 5 years, and thus far we have experienced results similar to that described in the world's body of published literature. The single anastomosis approach to gastric bypass can be performed in less time than a Roux-Y gastric bypass, utilizes less resources, and has a very low complication rate. Time will tell over the next few years if this procedure develops more widespread adoption among American surgeons and if the major insurance plans in the United States will begin to recognize this approach as an effective alternative.

## Question Section

1. One anastomosis gastric bypass
   A. Consists of a short gastric tube similar to a RYGB.
   B. Consists of a long gastric tube created below the crow's foot of the lesser curve.
   C. Must consist of a tight narrow gastric tube to avoid weight regain.
   D. A 40 French Bougie is to be avoided.
2. Malnutrition associated with one anastomosis gastric bypass
   A. Increases as the afferent biliopancreatic limb exceeds 250–300 cm
   B. Can be avoided by insuring that there are at least 250–300 cm of bowel distal to the loop gastrojejunostomy
   C. Can be improved by revision of the biliopancreatic loop to a 150–200 cm length
   D. All of the above
3. Reversal of one anastomosis gastric bypass
   A. Requires small bowel resection and reconstruction into a Roux-Y configuration

   B. Can be accomplished without resection of the gastrojejunostomy
   C. Leads to intractable bile reflux
   D. Discovery of Barret's esophagus postoperatively is the primary indication for reversal
4. Bile reflux following one anastomosis gastric bypass
   A. Is a common complication leading to Barrett's esophagus and early esophageal cancer
   B. Can be prevented by the administration of double dose PPI therapy
   C. Can be eliminated by revision to a Roux-Y configuration
   D. Is difficult to detect without annual endoscopy and distal esophageal biopsies

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