Revisional Bariatric Surgery

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OVERVIEW

With the increasing number of bariatric procedures being performed annually, it is expected that the incidence of revisions will increase. The overall incidence of surgical revision after a primary bariatric operation is 5% to 50%. The lowest rate of revision is associated with the biliopancreatic diversion (BPD) with duodenal switch (BPD-DS) procedure and is 5%.\(^1,2\) The Roux-en-Y gastric bypass (RYGB) fails to produce adequate durable weight loss in 15% to 25%, with revision estimates of 10% to 20%.\(^3,4\) The incidence of revision after vertical banded gastroplasty (VBG) is 25% to 54%.\(^5–7\) The laparoscopic adjustable gastric band (AGB) has the highest rate of revision at 40% to 50%,\(^8\) although recent studies suggest that this rate is decreasing.\(^9–11\)

A distinction should be made between inadequate weight loss or weight regain and need for revision (ie, not all failures need to be revised). There are various indications for revising a primary bariatric operation. The most common indication is failure of the primary operation to provide adequate durable weight loss, which is generally defined as excess weight loss (EWL) of at least 50%. However, adequacy of weight loss must be judged in the context of the presence or absence of comorbid disease. Before considering whether a particular individual is a candidate for a revision of the primary operation, it is important to determine whether the operation failed the patient or whether the patient failed the operation; whether there is there an anatomic cause for the weight regain or the weight regain is primarily a result of behavioral discrepancies such as large portion sizes, high caloric foods, snacking between meals, and lack of exercise. It is imperative that these issues be determined before considering revisional surgery or there will be repeated failure of the operation to provide weight loss or to control weight regain. It should also be considered and accepted that, as with many other diseases, not everyone can be cured of their obesity; there is a group of nonresponders who are resistant to weight loss despite the surgeon’s best efforts.

In the early days of bariatric surgery, it was questioned whether the risk associated with revision of bariatric procedures was worth the benefit.\(^12,13\) There are now

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case-matched\textsuperscript{3} and case-controlled\textsuperscript{4} studies, as well as multiple retrospective series, that leave little doubt that revisions are effective and that there is a benefit in terms of both weight loss and overall health. As with reoperation in general, the associated morbidity and mortality are higher than with primary bariatric procedures, but are acceptably low if careful selection of patients is coupled with adequate surgeon experience and expertise.\textsuperscript{14} Nevertheless, although there are many reports in the literature evaluating outcomes after revision of primary bariatric surgical procedures and suggesting operative strategies for revision, there are no data-driven algorithms for surgical revisions based on randomized controlled trials.

**PREOPERATIVE EVALUATION AND TESTING**

The need for revision should be based on the suspected cause of the patient’s symptoms. Preoperative evaluation and anatomic studies need to be performed to help determine the root cause. Because bariatric procedures are not strictly standardized and there is some variation among surgeons, preoperative evaluation of the anatomy is imperative.

**Dietary Intake Diary and Nutrition Counseling**

When a patient reports the inability to eat appropriately in terms of food choices or adequate calories, or complains of persistent nausea and vomiting, this history must be verified before considering revision. Nutrition consultation, preferably with a bariatric-specialized registered dietician, is mandatory. A food diary listing the patient’s day-to-day dietary history should be kept and reported dietary behaviors investigated. For some patients with weight regain or even persistent nausea and vomiting, dietary modification alone can improve symptoms and correct weight regain. Appetite suppressant medications can be added to curb appetite and therefore augment behavior modification.

**Upper Endoscopy**

Inspection of the upper gastrointestinal (GI) tract should always be performed before revisional surgery. The usefulness is multiple. Endoscopic review of the anatomy can provide diagnostic information concerning the previous procedure should operative reports not be available. Inspection of the mucosa can determine the sequelae of acid or bile reflux, or the presence of stoma narrowing, marginal ulcers, bleeding, eroded foreign bodies, and other potential problems such as migrated sutures or the presence of a gastrogastric fistula.\textsuperscript{15}

**Contrast Upper GI Study**

A contrast upper GI study is essential. This study provides information that is useful for diagnosis and strategic preoperative planning by providing a road map for the surgeon contemplating revising the upper GI tract. A preoperative upper GI study also provides a comparison for any postoperative studies that may be needed. This study gives a more dynamic view of the upper GI tract and can identify functional narrowing, dilatation, gastrogastric fistula, and may help identify the original operation in cases in which the original operative note is unavailable and the patient cannot recall.

**Other Studies**

Esophageal manometry is occasionally warranted to determine whether esophageal peristalsis has been affected by the primary bariatric procedure, which can affect
the approach to revision, especially when the primary procedure was an AGB.\textsuperscript{16}
Gastric emptying studies can also be useful to identify functional abnormalities.

\textbf{Review of Operative Notes}

It is imperative that the operative notes from the primary bariatric operation be reviewed. Details of technique as well as reported anatomic variations can substantially affect operative strategy. Essential details include the lengths of bypassed intestines (such as Roux limb and biliopancreatic limb lengths after RYGB), estimates of pouch size, and whether a gastrostomy tube was placed. Important technical aspects to be considered include the details of any foreign body that was placed, for example, AGB type and size and VBG band type. Understanding the anastomotic technique used can guide dissection and potentially affect the operative plan. Anatomic variations deduced on primary operation can be anticipated on revision.

\textbf{GENERAL OPERATIVE PRINCIPLES OF BARIATRIC REVISIONARY SURGERY}

\textbf{Adhesiolysis}

The surgeon should be prepared for challenging adhesiolysis, particularly if the primary operation was performed using an open approach. The need for extensive adhesiolysis is not a contraindication to the laparoscopic approach; magnification can provide an advantage and exposure is often superior. The most difficult adhesions are usually encountered at the gastric lesser curve where structures to be identified include the stomach, liver, pancreas, left gastric artery, and the inferior vena cava. At the angle of His, the proximity of the spleen to the gastric fundus can be challenging if dense adhesions are present in this region. Intraloop small bowel adhesions can be tedious to contend with laparoscopically but otherwise are not usually difficult to manage.

\textbf{Gastric Stapling}

For revision operations involving the stomach, transection of the stomach with linear staplers should always be performed with staple loads with a staple height of 4.5 mm or 4.8 mm because of the increased thickness of the tissues secondary to tissue fibrosis from scarring or chronic tissue inflammation with edema. All staple lines are oversewn using a similar rationale. For operations involving revision of a previously constructed gastrojejunostomy, Roux limb dissection should be completed before constructing the new gastrojejunostomy to ensure Roux limb viability. Whenever there is crossing of staple lines, this area should be carefully inspected and reinforced as needed.

\textbf{Leak Testing}

The anastomotic leak rate is increased when performing anastomoses of previously operated tissues.\textsuperscript{14} Therefore, the integrity of any high-risk anastomosis should be verified before concluding the operation. The 2 most common methods of leak testing are methylene blue instillation and gas insufflation, usually via an endoscope. The methylene blue test is usually performed by instilling dilute methylene blue (1 ampule in 250 mL of sterile water or saline) via a nasogastric tube in a carefully controlled volume adequate to distend the bowel with the bowel distal to the anastomosis occluded either digitally or using a bowel clamp. It is helpful to place a clean white sponge around the anastomosis to assist in detecting leakage. Leak testing using gas insufflation can also be performed via a nasogastric tube. However, this type of testing is best performed using an endoscope. In this technique, the bowel
is occluded just distal to the anastomosis. An endoscope is then placed transorally and carefully guided into position near the anastomosis. The anastomosis is flooded with irrigation until covered. Using the endoscope, air or CO₂ is injected, with careful inspection of the area for bubbling. If a leak is found, it is repaired and the leak test repeated. No patient should leave the operating room until the leak test is negative. Several studies have shown a benefit from intraoperative leak testing during primary RYGB, including decreased postoperative leak rates at the gastrojejunostomy anastomosis.17–19 One study found that the endoscopic leak test was superior to the orogastric tube technique.19

**Gastrostomy Tube**

As previously discussed, the risk of a gastrojejunal anastomotic leak is increased with revisional procedures. Therefore, placement of a gastrostomy tube with revision to RYGB should always be strongly considered and should always be placed when there is evidence of preoperative malnutrition or when extensive lysis of adhesions involving the gastric remnant is required, which may increase the risk of postoperative gastric remnant distention.

**Drains**

Intra-abdominal drains are used on a selective basis and should always be used in difficult anastomoses or when a repair is necessary because of a positive intraoperative leak test, which may also increase the likelihood of a controlled fistula if a leak were to develop. Drains are best placed in a dependent area in proximity to, but not in contact with, the at-risk anastomosis.

**LAPAROSCOPIC VERSUS OPEN APPROACH**

Most bariatric revision procedures involving the upper GI tract can be performed laparoscopically by a skilled and experienced laparoscopic bariatric surgeon even if the primary operation was performed using the open technique.20,21 The benefits of the laparoscopic approach are identical to those for a primary laparoscopic operation: fewer wound complications, less postoperative pain and narcotic requirement, shorter hospital stay, and earlier return to work.22 From a technical perspective, laparoscopy affords increased visibility and magnification of tissues. Although cost-effective as a primary procedure,23 to date, no data are available to determine whether revisions performed laparoscopically are cost-effective compared with the open approach.

Revisions involving the small bowel can be difficult after a primary open procedure because of multiple adhesions of the small bowel and mesentery that can severely limit its mobility. Although, with time and effort, nearly all cases can be completed laparoscopically, it needs to be decided whether the benefits outweigh an extreme effort. The decision whether to proceed with a laparoscopic or open approach should be made according to the skill and experience of the surgeon and good judgment on a case-by-case basis.

**REVISION OF RYGB**

**General Operative Strategy in Revisional Bariatric Surgery**

Whether performed open or laparoscopically, the operative strategy is the same. The first step is lysis of adhesions, which may be extensive. If the gastrojejunostomy is to be revised, the upper abdomen is entered. Adhesions of the greater omentum are typically encountered first. Also commonly encountered here is adhered transverse
colon and associated epiploic fat. After adhesions to the abdominal wall are taken
down in all directions, a retractor system is placed to provide exposure and thereby
allow further dissection in the upper abdominal compartment. The undersurface of
the left lateral segment of the liver will be adhered to the anterior surface of the
gastric pouch, and these structures should be separated. Complete dissection
and exposure of the gastric pouch and remnant is performed. Several variations in
the gastrojejunal arrangement are possible and nothing should be assumed if the
operative report is unavailable and findings on preoperative testing are ambiguous.
Possibilities include a loop gastric bypass, horizontally partitioned gastric pouch
with Roux-en-Y small bowel reconstruction, and vertical pouch with or without band-
ing. Patients are sometimes referred for revision with no records and only an under-
standing that they had a stomach stapling in the 1970s or 1980s. In the author’s
experience, this generic term does not suggest the likelihood of one procedure
type versus another.

With revision of the gastrojejunostomy, the entire Roux limb (or jejunal loop in the
case of a loop gastric bypass) must be exposed, freed of adhesions, and the gastro-
jejunalostomy skeletonized. To provide adequate Roux limb length, the Roux limb
mesentery must be carefully dissected to avoid injury and consequent Roux limb
ischemia. If the gastrojejunostomy is to be revised, available gastric pouch tissue is
limited, and the indication for revision does not include abnormalities at the gastroje-
junostomy (eg, marginal ulcers or stricture), it is then feasible to resect the jejunum off
the stomach with a linear cutting stapler without resecting gastric tissue. However, in
most cases, the gastric pouch is enlarged and the previous gastrojejunal anastomosis
is resected with pouch revision by downsizing.

Construction of the gastrojejunal anastomosis should proceed as per the surgeon’s
preferred technique. The author prefers a partially linearly stapled, partially hand-sewn
technique using a 10-mm endoscope as a stent during construction. With revisions,
care should be taken to avoid a particularly small stoma, because increased edema
and fibrosis can occur, thereby potentially increasing the risk of short-term and
long-term stricture. In the case of a loop gastric bypass, continuity of the alimentary
limb can be reestablished with an end-to-end anastomosis, and a Roux-en-Y small
bowel reconstruction is then performed with a biliopancreatic limb length of at least
40 cm and a Roux limb length of 75 cm to 150 cm.24

CONVERSION OF LOOP GASTRIC BYPASS TO ROUX-EN-Y

Indications

At present, gastric bypass for morbid obesity is universally performed using Roux-en-Y
small bowel reconstruction. However, this was not always the case. The loop gastric
bypass was typically constructed with a large gastric pouch constructed by a horizon-
tally stapled partition, which can be an important factor in weight regain. Moreover,
patients with loop gastrojejunostomy anatomy are at increased risk for developing
several issues including marginal ulcerations, stricture of the gastrojejunal stoma,
poor gastric pouch emptying, and bile reflux. When symptomatic, any of these condi-
tions is an indication for conversion to RYGB.

Management Options and Outcomes

The entire jejunal loop must be exposed and the gastrojejunostomy skeletonized. The
gastrojejunal anastomosis is resected with revision of the gastric pouch. If the bili-
pancreatic limb has adequate length, a jejunojejunostomy can be constructed directly
with the distal end. Alternatively, continuity of the jejunum can be reestablished with an
end-to-end anastomosis, and a Roux-en-Y small bowel reconstruction is then per-
formed with a biliopancreatic limb length of at least 40 cm (to prevent bile reflux)
and a Roux limb length of 75 cm to 150 cm. The gastric pouch is divided to create
a new, smaller 15-mL to 30-mL lesser curvature-based pouch. As discussed earlier,
this should be done using 4.5-mm or 4.8-mm staple loads and all staple lines over-
sewn. A proximal gastric resection may be necessary if it appears on inspection
that this portion of the stomach has become devascularized or if it simply appears
unhealthy and potentially compromised. Potential pitfalls include devascularization
of the Roux limb during dissection and adhesiolysis; construction of a Roux limb
that is too short, resulting in bile reflux; and leaving a pouch that is too large to provide
additional weight loss and that could result in symptoms of gastroesophageal reflux
disease (GERD).

Few studies have been performed evaluating outcome after conversion of a loop
gastric bypass to a RYGB. Weight loss is expected, particularly if the gastric pouch
size has been substantially reduced. Marginal ulcers can recur, especially if preoper-
ative risk factors have not been eliminated. The Roux-en-Y reconstruction eliminates
bile reflux in nearly all cases.25

REVISION OF PROXIMAL RYGB

Indications

The incidence of weight regain or failure to lose adequate weight after a primary prox-
imal RYGB is about 15% to 25%.26–28 When a patient presents with weight gain after
a proximal RYGB the cause of failure must be determined. Patients in whom an
anatomic cause for the weight gain is identified are generally candidates for revision.
Exceptions may be patients with a strong behavioral component to the weight gain
that contributed significantly to the anatomic changes.

Management Options and Outcomes

Adding restriction

It remains controversial whether increasing restriction is appropriate for patients with
inadequate initial weight loss or weight regain after initial RYGB. Changes in the upper
GI anatomy can occur that suggest a benefit from alteration through revision. A gastro-
gastric fistula after gastric partitioning is an anatomic finding that can result in weight
regain as well as severe GERD; in this case, repair is indicated and is performed by
dividing the stomach just proximal to the previous staple line. Care should be taken
not to cross staple lines or create a gastric chamber that cannot drain.

In theory, a large pouch or large stoma could be responsible for weight regain after
RYGB. When a loss of satiety is reported and a large pouch with a large gastrojejunal
stoma is found on preoperative work-up, revision of the pouch and gastrojejunostomy
is a reasonable surgical option. If the gastric pouch and stoma have enlarged substan-
tially, the entire gastrojejunostomy complex can be revised, effectively decreasing the
size of both. Other strategies include gastrojejunostomy revision with banding of the
pouch near the stoma, which is also referred to as pouch stabilization (ie, the Fobi
pouch). Placement of an AGB around the pouch has the advantage of providing addi-
tional adjustable gastric restriction without the added risk associated with revision of
the anastomosis. When placing an AGB after divided RYGB, gastrogastric fixation of
the AGB using the gastric remnant is the general technique adopted to prevent post-
operative slippage.29

Historically, there has been little direct evidence that RYGB revision involving
various strategies of adding gastric restriction results in superior weight loss.12,13,30
Moreover, MacLean and colleagues\textsuperscript{31} showed that stoma size does not necessarily correlate with initial weight loss or weight regain. However, more recently, others have reported long-term data that support gastric pouch stabilization as a technique to improve weight loss with RYGB.\textsuperscript{32,33}

Parikh and colleagues\textsuperscript{34} recently published short-term data on revising patients with suboptimal weight loss after RYGB by adding restriction through performing a laparoscopic sleeve resection of the gastrojejunal complex with a bougie in place. At an average follow-up of 12 months, there was no difference in preoperative and postoperative body mass index (BMI) or EWL in patients undergoing sleeve resection with or without added malabsorption by lengthening the Roux limb, although the extent of added malabsorption by Roux limb lengthening was not reported.\textsuperscript{34}

Although not extensively studied, RYGB failure treated by AGB placement has had promising initial results. The largest series to date was reported by Bessler and colleagues\textsuperscript{29} and consisted of 22 patients with follow-up of up to 5 years. Beginning with a mean BMI at revision of 44.8 (± 6.34) kg/m\textsuperscript{2}, patients experienced a loss of 27\%, 47.3\%, 42.3\%, 43\%, and 47\% of their excess weight at 1, 2, 3, 4, and 5 years following AGB placement, respectively. Three major complications occurred requiring reoperation. No band erosions were documented. The next largest study assessing AGB placement after RYGB consisted of 11 patients with a mean EWL after RYGB of 38\% (± 9\%) and mean BMI of 43.4 kg/m\textsuperscript{2}. The average follow-up after laparoscopic AGB placement was 13 months (range 2–32 months). Postrevision mean BMI was 37.1 kg/m\textsuperscript{2} and these patients undergoing laparoscopic AGB after failed RYGB had an additional mean 20.8\% EWL leading to an overall EWL of 59\% for both procedures. Thirty-day morbidity and mortality were nil.\textsuperscript{35}

**ADDING MALABSORPTION**

**Conversion to Distal RYGB**

Malabsorption can be added to a proximal RYGB by increasing the length of either the Roux or biliopancreatic limb. In a patient with weight gain after having undergone a proximal or short Roux limb (<150 cm) gastric bypass who, on work-up, has normal gastric bypass gastrojejunostomy anatomy (ie, a gastric pouch estimated to be less than 30 mL and a stoma less than 15 mm), conversion to a distal (long-limb) RYGB can be considered. From a technical perspective, this procedure is usually straightforward because the more difficult dissection in the upper abdomen is unnecessary. The length of the Roux limb is measured to ensure that it correlates with the operative note. The biliopancreatic limb is measured from the ligament of Treitz. The end-to-side jejunoojejunostomy is skeletonized so that all staple or suture lines are clearly visible. At this point, there are 2 possible ways to proceed. The biliopancreatic limb can be removed from the Roux limb without compromising the Roux limb by using a linear cutting stapler placed just adjacent to the previous staple or suture line. Any tissue that would be rendered nonviable is left on the end of the biliopancreatic limb and can be removed with a second firing before constructing the jejunojejunostomy. It should be verified that the Roux limb lumen is not compromised after this maneuver. The benefit of this operative technique is that only 1 anastomosis needs to be constructed as opposed to 2. Alternatively, the distal Roux limb, distal biliopancreatic limb, and proximal common channel at the jejunojejunostomy can each be transected, which then requires construction of a functional end-to-end jejunojejunostomy to restore continuity of the alimentary limb.

Although the approaches vary, construction of a distal RYGB in general requires measuring the common channel distally to proximally, beginning at the ileocecal valve.
The common channel length is critical; typically this length is 75 to 150 cm. A length less than 75 cm has an unacceptably high risk of protein malnutrition. An ileojejunostomy is then constructed; the author prefers a side-to-side functional end-to-side linearly stapled technique.

In one of the first published studies examining the effect of converting a failed proximal RYGB to a distal RYGB, Sugerman and colleagues examined the records of 27 patients in whom the Roux limb was lengthened from 40 cm to 145 cm with a common channel length of 50 cm in the first 5 patients and 150 cm in the last 22 patients. The biliopancreatic limb was not measured and the gastrojejunostomy was not revised. All 5 patients with a 50-cm common channel developed severe nutritional deficiencies including protein-calorie malnutrition that required revision. Two of these patients died of liver failure. Of the 22 patients with a 150-cm common channel, 3 required common channel lengthening because of malnutrition. All patients had at least 1 nutrition-related blood test abnormality and 4 (18%) required either total parenteral nutrition (TPN) or percutaneous enteric feeding. The EWL was 69% at 5 years after adding malabsorption, with nearly universal resolution of comorbid disease after the first year.

Fobi and colleagues retrospectively reported a series of 65 patients who failed proximal banded RYGB and who were revised to distal RYGB. Indications for revision included failure to lose more than 40% EWL with the primary procedure (21%), BMI greater than 35 kg/m² (23%), weight regain of at least 14 kg (21%), patient request for revision during another concomitant operation to maximize weight loss even though BMI was less than 35 kg/m² (24%), and band removal required (9%). The strategy used for enhancing the malabsorptive component of the RYGB was to move the Roux limb distally halfway down the common channel, effectively reducing the alimentary limb length by 50%. Three percent of patients developed intractable diarrhea. Fifteen patients (23%) developed protein malnutrition as defined by a serum albumin less than 3 g/dL. All protein-malnourished patients were treated with oral supplements and nutrition counseling. In addition, 8 required percutaneous gastrostomy feedings, 6 required TPN, and 6 patients (9.2%) required reoperation to lengthen the common channel. After revision, the mean weight and BMI loss were 20 kg and 7 kg/m². The final mean BMI was 34.6 kg/m² for the group.

Brolin and Cody converted 54 patients to a long-limb RYGB who had inadequate weight loss after short-limb RYGB or gastric restrictive operation using an open approach. In each case of RYGB revision, the gastrojejunostomy was revised to enhance gastric restriction. The Roux limb was reanastomosed to the distal ileum at a point 75 to 100 cm from the ileocecal valve. Perioperative complications occurred in 18.5%. There were 9 nonmetabolic late complications and there was a high incidence of anemia in these patients. Metabolic sequelae of conversion to distal RYGB included macronutrient and micronutrient deficiencies; protein malnutrition was present in 7.4%. Mean weight/BMI losses were 37 kg and 13.1 kg/m² respectively, with 47.9% of patients losing at least 50% of their excess weight at 1 year after surgery. There was no difference in percent EWL between patients who had revisions of purely restrictive operations and those who had revision of gastric bypass.

**Conversion of RYGB to BPD-DS**

When gastric bypass fails, some clinicians advocate conversion to duodenal switch. In theory, this conversion should provide an additional 15% to 20% EWL even in the case of a successful RYGB. Revision to BPD-DS is a complicated procedure that requires 3 or 4 bowel anastomoses: gastrogastrosomy, duodenoileostomy, ileoileostomy (a jejunoileostomy is also necessary to reconnect the alimentary limb if the
RYGB jejunojejunostomy was completely resected). Technically challenging in any case, this procedure can be done open or laparoscopically in 1 or 2 stages.

A controversial indication for conversion of RYGB to BPD-DS is reactive hypoglycemia. If compliance with a low-carbohydrate diet is not successful, this procedure can be considered because it reestablishes the pylorus and thus slows the emptying of carbohydrates into the small bowel, resulting in amelioration of the reactive hypoglycemic response.40

Only 3 studies have been published on conversion of RYGB to BPD-DS. In a recently reported study, 41 patients underwent open conversion of their original bariatric operation to a duodenal switch with omentopexy and feeding jejunostomy, including 32 patients who originally underwent RYGB. The average EWL following surgical reinter-vention was 54% in 25 patients at 6 months, 59% in 15 patients at 1 year, and 77% in 5 patients at 2 years. The incidence of major complications was 32%, including a gastrogastrostomy leak rate of 20%. There were no deaths.41

One of the first reports of RYGB conversion to BPD-DS included 47 patients who underwent open revisions to BPD-DS (26 primary RYGB and 5 patients who had initial VBG later revised to a RYGB) and were presenting for their second revision. Three-fourths of patients underwent revision to BPD-DS for either weight regain or inadequate loss (46%) or significant dumping syndrome (28%). The postoperative leak rate was 8.5% and half of these occurred in patients who had first undergone VBG followed by RYGB, with BPD-DS as a second revision. One-half of the leaks occurred at the gastrogastrostomy and one-half were located at the site of the sleeve gastrectomy (SG) proximal to the gastrogastrostomy. At an average follow-up of 30 months, the average BMI decreased from 48.9 to 29.2 kg/m² with an EWL of 67% and an average weight loss of 48 kg. All patients had resolution of the primary problem that led to revision.42

To date, the largest reported series of laparoscopic conversion of RYGB to BPD-DS comes from Gagner and associates.43 They reported data for 12 patients who experienced weight regain or inadequate weight loss, 4 of whom had undergone a revision before conversion. The average BMI before conversion was 41 kg/m². Seven (58%) underwent conversion to BPD-DS in 1 stage. A circular stapler was used for the gastrogastrostomy in most cases. At 11 months after surgery, average BMI decreased by 10 kg/m² and EWL was 63% with resolution of comorbid disease in all cases. One-third developed strictures at the gastrogastrostomy site. There were no leaks or deaths.

REVISION AFTER FAILED RESTRICTIVE PROCEDURES

Revision of VBG

Indications
The main issues that develop after VBG that require considering surgical revision are weight regain secondary to maladaptive eating or weight gain caused by staple line breakdown with or without the development of severe GERD and esophagitis.44

A thorough dietary history often reveals the same story from patient to patient; those with maladaptive eating prefer foods that disintegrate easily. For example, in his practice, the author has noted that Cheetos is a food nearly universally consumed by these patients. Healthy foods such as fresh vegetables, fruits, and meats are not well tolerated and therefore have been slowly eliminated from the diet. Malnutrition can ensue. Upper endoscopy can be diagnostic, showing esophagitis, a dilated esophagus, and a gastrogastric fistula to the lower stomach. Contrast upper GI study verifies the presence of a gastrogastric fistula and dilated
esophagus and can provide direct evidence of delayed pouch emptying and esophageal reflux. On distention with contrast, relative pouch size can be estimated and this information used for operative planning.

**Management options and operative strategies**

**VBG band removal with or without gastrogastrostomy** In a patient with maladaptive eating caused by pouch outlet narrowing or partial obstruction who has not regained significant weight or who requests a reversal of the VBG, simple ring removal is generally sufficient to resolve these symptoms; without the ring in place, the opening from the pouch to the lower stomach quickly dilates and, although rarely required, postoperative endoscopic dilation is effective without the ring in place. If persistent and severe vomiting from pouch outlet obstruction is a key symptom and preoperative studies support the diagnosis of gastric outlet obstruction, a gastrogastrostomy should be strongly considered. The need for gastrogastrostomy can be assessed using intraoperative upper endoscopy. If the area where the ring was located is very narrow and fibrotic, then gastrogastrostomy is recommended. All patients undergoing simple band removal with or without gastrogastrostomy should be advised that any lost weight will almost certainly be regained.

**Conversion of VBG to RYGB** Most cases of VBG conversion to RYGB can be handled laparoscopically by an appropriately skilled surgeon. Five ports are generally needed to complete the operation laparoscopically. After abdominal entry, lysis of adhesions is performed throughout the abdomen. Most of the adhesions will be located in the upper abdomen. Omentum and transverse colon can be adhered to the anterior abdominal wall in the region of the patient’s previous incision. When these have been lysed, attention is turned to the adhesions of the undersurface of the left lateral segment of the liver and the stomach lesser curvature. The caudate lobe of the liver is an important landmark and is identified early. The position of the left gastric artery is noted. A gastroscope is often helpful in guiding dissection of the stomach and verifying the location of the band, staple line, and gastroesophageal junction.

The location of the gastroplasty band is often revealed by the presence of dense adhesions in this area. Silastic bands can generally be visualized or are palpable and can be fairly easily removed by incising the overlying peritonealized tissue, lifting the band off the stomach, and incising the associated suture. Complete band removal should be verified by measuring the removed segments. Polypropylene bands are incorporated to a large extent into the gastric tissue and therefore are much more difficult to remove. In this case, the options are (1) removal and oversewing of the gastric tissue, (2) leaving the band in place, and (3) removing the band and associated portion of the stomach en bloc.

The anterior surface of the stomach is cleared of adhered tissues until the gastroplasty staple line is identified. This usually appears as a clef in the gastric surface extending from the position of the ring to the angle of His. The staple line is skeletonized to precisely determine its position. A retrogastric tunnel is made proximal to the gastroplasty staple line; this may be made easier by mobilizing the greater curvature of the stomach by dividing several proximal short gastric vessels. Once this tunnel is made, a gastric pouch can be constructed using multiple firings of a triple linear cutting stapler with staples that are at least 4.5 mm in staple height. Ideally, the new staple line should be placed just proximal and adjacent to the gastroplasty staple line. If this will result in a pouch that is too large (>30 mL), then the pouch is made to be the appropriate size with resection of the proximal gastric remnant to include
the VBG staple line because 2 parallel staple lines separated by a gap of tissue can result in ischemia of this intervening tissue or a chamber with no outlet.

The jejunojejunostomy can be performed before or after completion of the gastrojejunostomy. If a VBG is the only previous abdominal operation, there will be few adhesions involving the inframesocolic abdomen. The jejunojejunostomy is then constructed as in a primary RYGB.24

An antecolic or retrocolic Roux limb gastrojejunostomy is then constructed. The surgeon should be aware that, depending on the indication for revision, the gastric tissues are often inflamed, edematous, and fibrotic compared with a primary RYGB, and, on this basis, adjustments in technique need to be considered. All staple lines are oversewn. A remnant gastrostomy tube and intraperitoneal drain should always be considered and is used on a selective basis by the author.

Endoscopic removal has been reported in cases in which the band has eroded into the gastric lumen, although the risk of leak with this approach may be substantial.45

**VBG revision outcomes**

There have been multiple retrospective reviews of both open and laparoscopic approaches that provide evidence for outcome analysis. As with other revisional procedures, the morbidity and mortality with revision of VBG are higher than after primary procedures.13,46–50 VBG revision has more associated morbidity than conversion to RYGB. Complication rates are in the range of 10% to 40%, with mortality typically 2% or less.51–55 More recent studies have confirmed these findings and have also shown that conversion of VBG to RYGB resulted in better weight loss than revision of the gastroplasty.56 Sugerman and colleagues57 showed that, 1 year after VBG conversion to RYGB, the percentage of EWL was no different from that of a primary RYGB.

Most patients undergoing VBG revision have resolution of VBG-related symptoms, including open reversal of VBG by gastrogastrostomy, which resulted in 89% symptom improvement58 and conversion of VBG to RYGB, which was associated with 100% symptom improvement.59

There is some evidence that weight loss after VBG conversion to RYGB depends on the indication for revision. In a study of 101 patients, Schouten and colleagues59 found that patients undergoing revision for the indication of recurrent obesity had a significant decrease in BMI after conversion of VBG to RYGB. Patients with excessive weight loss after VBG experienced a slight weight gain, whereas those undergoing revision strictly for maladaptive eating were weight stable after conversion.

Many small reports in the literature address laparoscopic conversion of VBG to RYGB and echo the findings of the open literature. To date, the largest published report is a retrospective analysis of 105 patients laparoscopically converted from VBG to RYGB. The overall (both early and late) complication rate was 38%. With an average follow-up of 31 months, the median EWL was 47% and median decrease in BMI was 8 kg/m². Patient symptoms including GERD improved or completely resolved in 95% and all patients had resolution or improvement in dysphagia. Patient comorbid disease, including type 2 diabetes mellitus, obstructive sleep apnea, and hypertension, all improved substantially and similarly to improvements seen with primary RYGB.60

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**Revision After AGB**

**Indications**

Failure of adequate weight loss after adjustable gastric banding has been reported to occur in 40% to 50% of patients in the United States.8,61 AGB failure can have several
different causes and the indication for revision dictates the approach to revision. Patients with failure caused by purely technical problems with the band, including hardware failure or slippage, may benefit from simple band replacement, especially if the original band can be replaced with a next-generation band. However, if the indication is a esophageal motility issue, inadequate weight loss, GERD, or psychological band intolerance, patients are generally better served by conversion to another weight loss procedure.62–64

When considering failed AGB, the question of which revision procedure to perform in what circumstances has not been clearly answered; much conjecture is present in the literature but no hard data. However, for patients with inadequate weight loss, there are several studies suggesting that conversion to RYGB is superior to rebanding.63,65–67

**Management options and operative strategies**

**AGB removal** Simple AGB removal technically is the easiest of the procedures. However, this intervention invariably leads to weight regain and return of obesity.62,63 The band tubing is followed to the stomach to identify the band. Once the AGB is identified, the overlying peritonealized tissue is incised, which directly exposes the band. The AGB is dissected free, elevated, and transected with either laparoscopic scissors or the ultrasonic shears. Once divided, it is generally easy to pull the AGB off the stomach. Although isolated AGB removal can be performed, in general, it is preferable to restore normal upper gastric anatomy by taking down the gastrogastric sutures and associated adhesions. A safe way to accomplish this is to follow the tract formed by the chronic tissue reaction to the band, using it as a guide to take down the gastrogastroptic sutures. It has been shown that AGB that have eroded can be safely removed endoscopically, although this practice is not yet universal.68

**AGB replacement** Replacement of the AGB is a reasonable option if the patient has had a good result with the AGB and is being considered for revision based on considerations other than inadequate weight loss or complications of the AGB that would preclude AGB replacement, such as recurrent prolapsed, erosion, or general intolerance with insolvable nausea and vomiting. Careful patient selection is imperative to avoid recurrent complications or recurrent weight loss failure.64 Substantial additional weight loss should not be expected with AGB replacement.63 Some clinicians recommend replacing the band by forming a de novo retrogastroesophageal tunnel either above or below the previously placed tract.69 This approach avoids adhesions and, if there was an element of prolapse or slippage, this approach can serve to better secure the newly placed band and avoid this complication in the future. Although there are exceptions depending on the indication for replacement, it is generally preferable that normal anatomy be restored before replacing the band to ensure that pouch volume, precise positioning, and band fixation are optimized.

**AGB conversion to SG** Conversion to SG, another restrictive procedure, is a reasonable choice if the patient has had a reasonable weight loss with the AGB and requires revision for other considerations. Other factors that can affect this decision include persistent technical failures, patient compliance issues with adjustments, and anatomic changes that preclude AGB replacement.

It is imperative that normal anatomy be restored before SG. Once this has been accomplished, the stomach is laid out in its normal position. In performing an SG, larger linear staple height loads (eg, 4.5 mm or 4.8 mm) should be considered for the sleeve resection because of increased thickness of the normally thinner tissue of the gastric fundus.
A few small retrospective studies have examined short-term outcomes after AGB conversion to SG. The largest series examined the short-term outcome of 41 patients. The complication rate was 19.5% and included a gastric leak rate of 5.7%. There was 1 death. EWL was 41.6% at 2 years. Two patients required conversion to BPD-DS for poor weight loss. Another study retrospectively examined 36 patients, all revised to SG for insufficient weight loss. The complication rate for this series was 12.2% and included 1 leak. At a mean follow-up of 13.4 months, EWL was 42.7%. Six patients required eventual conversion to BPD-DS, BPD, or RYGB.

**AGB conversion to RYGB**

AGB conversion to RYGB is appropriate for patients with inadequate weight loss, GERD, esophageal dysmotility, and possibly psychological band intolerance (although these patients must be approached with caution). As with other AGB revisions, normal gastric anatomy should be restored before constructing the gastric pouch to ensure that the gastric pouch size is optimized. It is usually prudent to modify the lesser curve and retrocardia dissection to avoid AGB-related fibrotic tissues. Cautious dissection at the angle of His is necessary because adhesions in this area cannot be avoided.

In an analysis of several studies that examined revision of AGB to RYGB, either open or laparoscopically, it was concluded that the operative times are longer than for primary RYGB and even longer with the laparoscopic approach. It was also noted that adhesions and fibrosis led to increased complications including anastomotic leaks. EWL was higher and, in some cases, approached that of a primary RYGB.

One recent study retrospectively analyzed 66 patients who had AGB placed as a primary bariatric procedure. Of these, 47 (71.2%) underwent revision of the AGB and 19 (28.8%) underwent conversion to RYGB. Demographics were similar between the 2 groups. However, patients in the revision group had adequate weight loss with the AGB, whereas those in the conversion group did not. Patients converted to RYGB had an average EWL of 48%, whereas those undergoing AGB revision maintained their weight.

Another early study retrospectively analyzed 70 patients with a median BMI of 45 (± 11) kg/m² who underwent attempted conversion of AGB to RYGB. Indications for conversion were inadequate weight loss or weight regain after band deflation for gastric pouch dilatation, inadequate weight loss, symptomatic proximal gastric pouch dilatation, intragastric band migration, and psychological band intolerance. Mean operative time was 240 (± 40) minutes (range, 210–280 minutes). Mean hospital length of stay was 7.2 days. The early complication rate was 14.3%. Late major complication rate was 8.6%. There was no mortality. Median EWL was 70% (± 20%), and 60% of patients achieved a BMI of less than 33 kg/m² with mean follow-up of 18 months.

**AGB conversion to BPD-DS**

Another choice of revisional procedure when AGB fails to provide adequate weight loss or is associated with complications is conversion to BPD-DS. In theory, this procedure should result in superior weight loss compared with conversion to either another restrictive procedure or to RYGB. As with most revisions after AGB, and as previously discussed, normal gastric anatomy is restored before SG. The lower gastric and inframesocolic portions of the BPD-DS proceed in the usual manner as in a primary BPD-DS.

There are few studies in the literature reporting on conversion of AGB to BPD-DS. The largest study is a retrospective review of 53 patients who failed to lose adequate weight after AGB. Thirty-two patients underwent laparoscopic conversion to RYGB for a BMI of 43.1 kg/m² and 21 underwent conversion to BPD-DS for a BMI of 46.0 kg/m². Operative times were an average of 105 minutes longer for BPD-DS and had
significantly more associated complications (62%) compared with the RYGB group (12.5%). There were no deaths. At 12 and 18 months after revision, the 2 groups had similar BMIs and the EWL was greater after BPD-DS than after RYGB compared with prerevision weight (66.2% vs 58.8%) and initial weight (73% vs 61.8%), although this difference was not statistically significant.

**REVISION AFTER MALABSORPTIVE PROCEDURES**

**Revision after Biliopancreatic Diversion with Duodenal Switch**

**Indications**
As with all bariatric procedures, the 2 main indications for revision of a malabsorptive operation such as the long-limb gastric bypass or BPD-DS are complications or weight regain/failure to lose adequate weight. The complication requiring revision that is most often associated with malabsorptive procedures is micronutrient and macronutrient deficiency with malnutrition. Weight regain or failure to lose adequate weight is less common with the BPD-DS. Overall, the incidence of BPD-DS revision is reported to be about 5%. However, it is unclear whether this lower incidence is secondary to a lack of indication or surgeon reluctance because of the technical demands of the procedure.

**Management options and operative strategy**

**Revision of the sleeve** In patients having BPD-DS with weight regain or inadequate weight loss, an enlarged stomach, particularly the fundus, is often present because of inadequate resection or stretching. A preoperative contrast upper GI study is mandatory and helps determine the degree of excess gastric tissue present. Thus, the first approach to BPD-DS revision should be re-SG. Dissection of the stomach from its adhesive attachments is performed with care not to compromise the lesser curvature blood supply. A 60-Fr bougie is passed transorally along the lesser curvature of the stomach. Using 4.8-mm staple loads, the bougie is followed proximally with transition to 3.5-mm staple loads if the more proximal gastric tissue becomes thinner. Staple line reinforcement by oversewing is recommended with care taken to avoid stricture by incorporating excessive gastric tissue.

**Modifications of common channel length** Occasionally performed to convert a proximal RYGB to a distal RYGB, shortening of the common channel is less commonly indicated after BPD-DS because the degree of malabsorption, by definition, is already maximized or nearly maximized. Further shortening of the common channel to less than 75 cm can lead to severe vitamin, mineral, and protein deficiencies. However, approximately 5% of patients with BPD-DS require lengthening of the common channel to reverse the complications of excessive malabsorption, including severe malnutrition.

Elongation of the common channel can be performed at the expense of the biliopancreatic limb length by disconnecting the alimentary limb at the ileoileostomy, followed by construction of a side-to-side functional end-to-side ileojejunostomy proximally to increase the common channel length to 250 cm. Alternatively, a simple side-to-side anastomosis is constructed between the biliopancreatic limb and the alimentary limb 100 cm proximal to the ileoileostomy without division of the alimentary limb.

**Outcomes**
There are few outcomes data addressing revision of BPD-DS. In the single study that has reported on outcomes, revision was performed a median of 17 months after BPD-DS. Indications for revision included protein malnutrition in 20 patients, diarrhea in 9 patients, metabolic abnormalities in 5 patients, and liver disease in 2 patients. At
revision, the median BMI was 28 kg/m². Median serum albumin increased significantly from 3.6 g/dL preoperatively to 4.0 g/dL. The complication rate was 15%. There was no perioperative mortality. The median weight gain was 8.2 kg during a median follow-up of 39 months.1

SUMMARY

The need for revisional bariatric operations is certain to increase as the number of primary bariatric procedures increases. To formulate a successful revision strategy, it is essential to perform a thorough preoperative work-up that includes imaging, behavioral and dietary assessment, and review of the primary operative report. Outcomes vary according to the primary operation and chosen approach to revision. Initially, revisions of primary bariatric operations had a high morbidity; however, more recent studies have shown acceptably low complication rates and good weight loss with the associated health benefits. Although there is no direct evidence in the form of randomized studies indicating which patients with inadequate weight loss or weight regain will benefit most from revision or supporting one particular revision approach rather than another, based on the available studies it is possible to develop general, effective strategies.

REFERENCES

