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Revisions for Failed Weight Loss

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Abstract There is currently an increasing role for bariatric surgery in the treatment of obesity. However, not all patients experience a successful outcome in terms of weight loss achieved. Failure to attain sufficient weight loss or weight regain may be attributed to numerous factors. It is essential to adequately evaluate these patients to determine if they have behavioral issues that might be responsible for their weight loss failure. If a structural cause is identified it might be necessary to revise the primary operation with an aim to produce further weight loss.

Keywords Revisional surgery · Weight loss · Failed weight loss · Bariatric surgery · Gastric bypass · Biliopancreatic diversion · Duodenal switch · Gastric banding · Sleeve gastrectomy

Introduction

Current data shows the prevalence of obesity in adults in the US to be up to 35.5 % [1]. Though, this number has not changed significantly in the last 5–10 years, it remains a massive leap from the reported prevalence of 12.8 % in 1962 [2]. The obesity epidemic brought with it an increased need to develop the ideal bariatric surgical operation. Subsequently, numerous surgical procedures have been designed with a target to produce dietary restriction, malabsorption, hormonal manipulation or any combination of the above. The goal of every bariatric procedure is to produce adequate sustainable weight loss, and hence, remission of associated comorbidities.

Weight loss failure following a bariatric operation is said to occur when the excess weight loss is less than 50 %. This may occur either as a result of failure to lose adequate weight at the primary procedure or weight regain after an initial loss of sufficient weight [3]. Some authors may consider a postoperative body mass index (BMI) >40 or persistence of comorbidities as failure. When evaluating these patients it is important to understand the underlying etiology for their weight loss failure. It is essential to rule out the possibility of the patient's poor habits being responsible for weight recidivism. Patients who indulge in binge-eating and snack-eating patterns, or consume high caloric liquids may be at risk for weight loss failure [4]. The role of physical activity after bariatric surgery cannot be over-emphasized. In a systematic review of 13 studies, Livhits et al. [5] showed that exercise and physical activity were associated with a greater postoperative weight loss after bariatric surgery. Failure to comply with the follow-up schedule may equally put patients at risk for weight regain [4, 6]. Constant follow-up with the dietitian allows for close monitoring of weight changes and supervised dietary management.

The management of weight loss failure should assume a multidisciplinary approach. It is helpful if patients are being followed by their primary surgeon to allow continuity of care. However, in the event that a patient has been referred to a different bariatric surgeon, it is essential to conduct a detailed history and physical examination. A

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proper understanding of the preoperative care and operative details at the primary surgery should be sought. Details on the patient's follow-up care and progress should also be procured. It is also important to evaluate the anatomy of the patient's primary surgery prior to undertaking a revisional operation. Endoscopy and contrast study of the upper gastrointestinal tract will help elucidate the anatomy and effectively diagnose a structural cause of the weight loss failure. These studies are also helpful in ensuring efficient preoperative planning.

Revisions for Failed Roux-en-Y Gastric Bypass

Roux-en-Y gastric bypass remains the most commonly performed bariatric operation in the United States and worldwide [7]. It is estimated that 10–20 % of patients will require a revision for failed weight loss following a Roux-en-Y gastric bypass operation [8, 9•, 10]. Structural abnormalities that might be responsible for weight regain in these patients include presence of an enlarged gastric pouch, a dilated gastrojejunal anastomosis and presence of a gastro-gastric fistula. Yimcharoen et al. [10] conducted upper endoscopy on 205 patients who had regained weight following gastric bypass. Based on their endoscopy findings, a gastrojejunostomy was said to be enlarged if it had a diameter greater than 2 cm in any dimension. A gastric pouch was said to be enlarged if it was longer than 6 cm or wider than 5 cm. In a similar study, Heneghan et al. [11] found that the pouch length, pouch volume and stoma diameter were inversely related to excess weight loss. However, some other studies have failed to show a correlation between the immediate postoperative gastric pouch size and the eventual excess weight loss [12, 13].

Surgical Management of the Enlarged Pouch

An enlarged gastric pouch may occur as a result of a technical failure while creating the pouch at the primary operation. This is more common in super-obese patients where there might be difficulty adequately exposing the angle of His [14]. There is also the tendency to fashion a larger pouch when revising a gastric band or a Nissen fundoplication to a Roux-en-Y gastric bypass. This occurs when the surgeon attempts to transect the stomach below previous scar tissue. Poor eating behavior may possibly play a role in eventual pouch enlargement. Muller et al. [14] described a series of five patients who underwent laparoscopic pouch resizing with a redo of the gastrojejunal anastomosis using a circular stapler technique. The median BMI at 12-month follow-up was 28 kg/m^2 compared to preoperative median BMI of 32 kg/m^2 at the primary operation.

Parikh et al. [15] described a technique in which they performed a resection of the dilated gastric pouch and the alimentary limb of jejunum along an orogastric tube in a longitudinal fashion, thereby downsizing the pouch. However, they were unable to show a significant difference in the pre- and post-revision BMI and excess weight loss. Similarly, a gastric plication technique has been described in a series of eight patients [16]. The plication was performed along the pouch, the gastrojejunostomy and the alimentary limb, around a 34-French orogastric tube using a non-absorbable suture material.

The placement of an adjustable gastric band around the pouch may add a further restrictive component to a failed Roux-en-Y gastric bypass [17–24]. This technique does not require the reconstruction of the gastric pouch or gastrojejunostomy. Hence, it is less technically demanding and obviates the possibility of an anastomotic or staple line leak. However, it retains the complications associated with placement of an adjustable gastric band. These complications include, band erosion [19], band slippage [19, 20], band leak, port flip [18], port infection [20], gastric volvulus and small bowel obstruction [20]. The approach to band placement has been described with both the open [17, 18, 20] or laparoscopic techniques [19–23]. Most authors describe dissecting the angle of His and utilizing the pars flaccida technique [20, 21] to introduce the band around the proximal aspect of the pouch. However, Heath et al. [22] utilized a perigastric approach to band placement with the band sitting in the more distal aspect of the pouch. The band may be secured in place by placing stitches between the fundus and anterior wall of the gastric remnant and the aspect of the pouch above the band [20, 21]. In larger pouches it may be possible to suture the superior aspect of the pouch to the part just inferior to the band [21]. Vijgen et al. [24], in a review of nine studies, reported that salvage banding for a failed Roux-en-Y gastric bypass produced further weight loss.

Surgical Treatment of a Gastro-Gastric Fistula

The incidence of a gastro-gastric fistula in the era of divided Roux-en-Y gastric bypass is 0.1–6 % [25–29]. The underlying etiology of a gastro-gastric fistula includes a non-divided gastric bypass [29] (Greenville gastric bypass operation) with staple line dehiscence, incomplete gastric transection, anastomotic leak, marginal ulceration, gastric tissue migration and Roux limb obstruction distal to the gastrojejunostomy [25, 30, 31]. Foreign body erosion has also been implicated in the etiology of gastro-gastric fistulas [25, 30, 31]. In addition to obtaining a history of weight regain, the mainstay of diagnosis involves obtaining an upper endoscopy and upper gastrointestinal contrast study [26]. Tucker et al. [27] described laparoscopic

remnant gastrectomy with gastro-gastric fistula excision with or without pouch trimming in 17 patients. In their series, 21 patients who had been treated with surgical and/or conservative means experienced a mean weight loss of 27 lbs at follow-up. Despite the potential role of endoscopic and surgical techniques in the management of gastro-gastric fistulas, conservative methods have been known to be effective as well. This involves the use of proton-pump inhibitors to decrease gastric acid secretion and effect fistula healing [31, 32].

Distalization of the Roux Limb

The Roux-en-Y gastric bypass operation produces weight loss by inducing restriction to dietary intake, malabsorption and hormonal manipulation. For patients who experience inadequate weight loss with no evidence of a dilated gastric pouch or gastrojejunostomy, the creation of a longer Roux limb or biliopancreatic limb might be a viable option [16, 33, 34]. This enhances the malabsorptive component of the operation, thereby producing further weight loss. Rawlings et al. [33] described the conversion of a 150 cm proximal Roux limb to a 100 cm distal common limb in a series of 29 patients. The Roux limb was transected at the jejunojejunal anastomosis and reconnected to the ileum, creating a long biliopancreatic limb. The mean excess weight loss was 26.6 % before revision and 68.8 % at 5 years after revision. Six patients developed protein calorie malnutrition requiring parenteral nutrition, with one patient undergoing a reversal. 79 % had complaints of diarrhea which was treated with opium or diphenoxylate/atropine.

Himpens et al. [16] reported a morbidity rate of 21.1 %, while 10.5 % (2 out of 19) of their patient group required a reversal for cachexia and anorexia. In one other study [34], 49 patients underwent a distal modification of Roux-en-Y gastric bypass with a very long Roux limb and a 75 cm common channel. The mean excess weight loss was 48 %. Only 49 % of patients were able to achieve an excess weight loss of $\geq$50 % post-revision.

Conversion to Biliopancreatic Diversion with Duodenal Switch

Another option in the management of a failed Roux-en-Y gastric bypass is conversion to the biliopancreatic diversion with duodenal switch. This is a more malabsorptive procedure than the gastric bypass, and hence, produces greater weight loss [35, 36]. However, it is believed to produce a lesser degree of protein malnutrition when compared to distalization of the Roux limb [37].

Parikh et al. [38] described a laparoscopic approach to this procedure. This was done in one or two stages. It involved resection of the gastrojejunostomy with a linear stapler. A gastro-gastrostomy was performed between the gastric pouch and the remnant stomach using a circular stapler. A sleeve gastrectomy was then performed on the new stomach with sequential firings of a linear stapler. Subsequently, a duodenoileostomy and an ileoileostomy were performed. The prior jejunojejunostomy of the gastric bypass was divided, while intestinal continuity was reestablished by anastomosing the biliopancreatic limb to the proximal end of the Roux limb. Four of the 12 patients in this report had undergone prior revision surgery. Seven of the conversions were completed as a one-stage operation. The patients experienced a mean excess weight loss of 63 % and a BMI of 31 kg/m^2 at 11 months postoperatively.

Greenbaum et al. [39] reported a series of 32 patients who underwent conversion from a Roux-en-Y gastric bypass to a duodenal switch with omentopexy and a feeding jejunostomy tube placement. They reported an mean excess weight loss of 59 % in 15 patients at 1 year follow-up. There were eight proven or presumed leaks occurring at either the gastro-gastrostomy or the lateral gastrectomy site. These leaks were managed conservatively without surgical or radiologic intervention. There was no mortality.

Dapri et al. [40] described the laparoscopic conversion of a Roux-en-Y gastric bypass to a sleeve gastrectomy as a first step of duodenal switch in four patients. One patient eventually underwent the second step of the duodenal switch. The mean BMI and excess weight loss in all four patients were 30.3 kg/m^2 and 59.3 % respectively at a mean follow-up of 11 months.

Endoscopic Approach to Revision of Failed Roux-en-Y Gastric Bypass

Endoscopic techniques in current use for the management of a failed Roux-en-Y gastric bypass aim at producing further restriction. These different techniques address the possible etiologies such as a gastro-gastric fistula, dilatation of the gastric pouch and/or gastrojejunostomy. An endoscopic approach offers a potential solution to weight loss failure while avoiding the complications associated with surgical revision [41•].

One of these techniques involves the injection of a sclerosant in the tissue around the gastrojejunostomy. Loewen and Barba [42] reported a series of 71 patients who underwent injection of sodium morrhuate at the gastrojejunostomy; 73 % of these patients reported a subjective change in their ability to eat. The duration of increased restriction ranged from 1 week to 6 months; 72 % of patients maintained or lost weight during follow-up. In a more recent study, 231 patients underwent 575 sclerotherapy sessions [43]. The most common intraoperative

complication was bleeding (2.4 %). The post-procedure ulcer formation rate was 1 %. The mean weight loss at a mean follow-up of 6 months was 10 lbs.

The StomaphyX endoluminal device (EndoGastric Solutions, Redmond, WA) utilizes 7-mm, 3-0 polypropylene H-fasteners to create full-thickness, serosal-to-serosal tissue approximation in the GI tract [41•, 44]. This serves to reduce the pouch volume, thereby producing some restriction. Mikami et al. [44] reported a series of 39 patients who underwent the StomaphyX procedure. The average excess weight loss at 1 month was 10.6 %, and 13.1 % at 3 months ($n = 15$). In another study, [45] endogastric plication using the StomaphyX device resulted in a median percentage of effective weight loss of ≤47 % at 6-month follow-up. At 12-month follow-up ($n = 14$), 86 % had regained weight after achieving their lowest weight after endogastric plication.

The incisionless operating platform™ (IOP) with the tissue anchoring system (USGI Medical, San Clemente, CA, USA) is another endoscopic technique utilized in revision of a dilated gastric pouch or stoma. It facilitates the placement of tissue plications circumferentially around the stoma and also within the gastric pouch. Borao et al. [46] described a series of 20 patients who successfully underwent the IOP procedure. Stomal diameter was reduced, on average, by 53 %, with pouch reduction averaging 41 %. Mean percentage excess weight loss at 6 months was 18 %, while the mean weight loss at 6 months was 17.3 ± 15 lbs.

The Bard EndoCinch Suturing System™ (C.R. Bard, Inc., Murray Hill, NJ) allows for tissue suction and subsequent suturing. This device is used to revise a dilated gastrojejunostomy. In a multi-center, randomized, double blinded trial, endoluminal suturing was compared to sham endoscopy for the management of failed weight loss following Roux-en-Y gastric bypass [47]. Seventy-seven patients with a BMI of 30–50 kg/m^2 who were ≥6 months post-Roux-en-Y gastric bypass with inadequate weight loss and/or weight regain and a gastrojejunostomy diameter >2 cm were randomized 2:1 to endoluminal suturing or sham control. A reduction of the gastrojejunostomy to ≤10 mm (technical success) was achieved in 89 % of cases. The mean 6-month absolute weight loss using an intent-to-treat analysis was 4.5 ± 5.78 kg ($n = 43$) and 1.8 ± 5.33 kg ($n = 26$) ($P = 0.063$). The sutured group was also shown to have a trend towards improvement in metabolic indices as well.

Heylen et al. [48] described the use of an over-the-scope clip [OTSC(R); Ovesco Endoscopy AG, Tubingen, Germany] in 94 patients who had experienced weight gain of 10 % or more 2 years after gastric bypass. This a nitinol clip deployed from an applicator situated at the endoscope tip. When properly applied it serves to narrow the gastrojejunostomy. The mean BMI at 1 year post-intervention dropped from 32.8 ± 1.9 to 27.4 ± 3.8 kg/m^2.

Revisions for Failed Adjustable Gastric Banding

Laparoscopic adjustable gastric banding is the second most common bariatric operation in the United States after the Roux-en-Y gastric bypass [49]. It offers a lower morbidity profile when compared to the other bariatric procedures. However, failure rates have been reported to be about 40–50 % at 5 years. Revision rates have also been reported to be as high as 20–30 % [49–52]. The initial approach in the management of patients who have weight loss failure following a laparoscopic adjustable gastric band is to determine the functionality of the device. An attempt should be made to aspirate fluid from the port and hence rule out the possibility of a leak in the system. At the same time a detailed evaluation of the patient's eating habits should be conducted in a multi-disciplinary manner with due involvement of the nutritionist, psychologist and surgeon. Failure to achieve weight loss following this conservative measure may indicate a failure of the operation and a potential need for surgical revision.

The laparoscopic adjustable gastric band operation is often considered the least invasive of all the bariatric operations due to minimal distortion of the patient's anatomy. Hence, most revisions can be performed with lower risks when compared to revisions for other bariatric operations. However, meticulous application of good surgical technique remains essential in performing these revisions. Care must be taken to deal with scar tissue around the band, the left lobe of the liver and the spleen. A dilated, thinned out pouch or a fibrotic stomach have the potential for an unrecognized gastric perforation or increased risk for anastomotic dehiscence. The approach to surgical revision of a failed adjustable gastric band entails re-banding or conversion to another bariatric operation.

Replacement of the Laparoscopic Adjustable Gastric Band

Most surgeons advocate band replacement or repositioning for complications such as band prolapse or erosion [49, 51, 53, 54]. The utilization of re-banding in patients who have failed to achieve weight loss is generally frowned upon [54–56]. Muller et al. [56] described a series of 74 consecutive patients who underwent a rescue operation for a failed gastric banding. Forty-four patients underwent a re-banding operation, while 30 patients were converted to a Roux-en-Y gastric bypass; 45 % of the re-banded patients

required further operative revision. In addition, patients who underwent a Roux-en-Y gastric bypass achieved significantly greater weight loss when compared to the re-banding group.

Conversion of the Adjustable Gastric Band to a Roux-en-Y Gastric Bypass

The addition of a malabsorptive procedure to a purely restrictive operation may facilitate achieving further weight loss. There are currently no randomized trials comparing the outcomes of a band replacement or repositioning to a conversion to a Roux-en-Y gastric bypass. However, several reports suggest the superiority of the latter in patients who have not been able to achieve sufficient weight loss following an adjustable gastric band [56–58]. van Wageningen et al. [58] described a series of 47 patients who failed primary laparoscopic adjustable gastric band and underwent a subsequent conversion to a Roux-en-Y gastric bypass. Twenty-six of these conversions were performed laparoscopically while 21 were achieved via an open approach. The indication for conversion was insufficient weight loss in 62 % of these patients. The mean BMI was decreased from 45.8 ± 8.9 to 37.7 ± 8.7 kg/m^2 following revision.

In a series of 86 patients who had a failed adjustable gastric band, Apers et al. [59] described conversion to a Roux-en-Y gastric bypass in a single-stage procedure in 59 %. Of these cases, 41 % were performed as a delayed two-step procedure a few months after removal of the gastric band. In the single-stage group, 12 % of the patients developed major early complications. No patient in the two-stage group had a major early complication. However, this difference was not statistically significant.

Another feasible approach in the management of failed adjustable gastric bands is to convert them to a Roux-en-Y gastric bypass while leaving the band in place. It is thought that the presence of the band adds extra restriction to the pouch size after a Roux-en-Y gastric bypass has been performed. Some authors have similarly described placing a band on the gastric pouch in a failed Roux-en-Y gastric bypass with favorable results [17–24]. Meesters et al. [60] reported a series of 12 patients with a failed adjustable gastric band who were converted to a Roux-en-Y gastric bypass with the band in place. Their technique consisted of opening the band to allow removal of the fibrotic ring and then repositioning it close to the gastroesophageal junction. They created a longer gastric pouch than usual, to allow a significant distance between the gastrojejunostomy and the band, and also to avoid creating a staple row in the fibrotic ring. The median weight loss was 23 kg in a median period of 16 months. One patient in the series experienced band slippage requiring repositioning.

Conversion of the Adjustable Gastric Band to a Sleeve Gastrectomy

The laparoscopic sleeve gastrectomy is largely considered superior to the laparoscopic adjustable gastric banding operation in terms of weight loss and resolution of comorbidities [61–63]. Hence, one viable option in the treatment of patients who have failed to lose weight following an adjustable gastric banding is to convert them to a sleeve gastrectomy.

Acholonu et al. [64] described the conversion of a laparoscopic adjustable gastric band to a laparoscopic sleeve gastrectomy in 15 patients. The indication for conversion was weight regain or poor weight loss in 60 % of these patients. Thirteen patients had the procedure done as a single-stage operation while two patients required a two-stage procedure to accomplish the conversion. The first stage consisted of band removal in one patient and subsequent conversion to a sleeve gastrectomy after a 1 year delay. One patient developed a staple line leak requiring laparoscopic exploration and repair on postoperative day 3. The mean weight loss was 48.3 and 57.2 lbs at 6-month and 1-year follow-up, respectively.

In another report [65], 36 patients had a failed gastric band converted to a laparoscopic sleeve gastrectomy. The operation was performed in two stages with band removal in the first stage. The sleeve gastrectomy was then performed 3 months later. The purpose of this approach was to reduce the chronic inflammatory response around the stomach that might be responsible for incomplete stapling of the stomach. Despite this, the authors reported the occurrence of a leak in one patient, while three patients developed deep intra-abdominal fluid collections. The mean excess weight loss was 42.7 % at a mean follow-up of 13.4 months.

Conversion of the Adjustable Gastric Band to Duodenal Switch

The biliopancreatic diversion with duodenal switch produces the greatest weight loss amongst the currently existing bariatric operations [35]. Conversion of a failed laparoscopic adjustable gastric band to the duodenal switch has been shown to be feasible. In one retrospective study [66], the outcomes of a conversion to a biliopancreatic diversion with duodenal switch (21 patients) were compared to conversion to a Roux-en-Y gastric bypass (32 patients). There were significantly more complications with biliopancreatic diversion with duodenal switch (62 %) than with a Roux-en-Y gastric bypass (12.5 %). However, there was no statistically significant difference in the excess weight loss achieved between the two groups at 18-month follow-up.

In a more recent retrospective review, Dapri et al. [67] reported the laparoscopic conversion of 31 failed adjustable gastric bands to the duodenal switch operation. One patient died of sudden death syndrome on postoperative day 3. The major complication rate was 6.4 % with one leak at the ileoileostomy and one hemoperitoneum. The mean excess weight loss was 78.4 % at a mean follow-up of 28 months.

Revisions for Failed Laparoscopic Sleeve Gastrectomy

The laparoscopic sleeve gastrectomy has steadily gained in popularity. It is currently the third most common bariatric operation in the United States and the second most common worldwide [7]. The laparoscopic sleeve gastrectomy has been shown to have a shorter operating time, fewer early minor complications [68, 69] and favorable weight loss [69, 70] when compared to the laparoscopic Roux-en-Y gastric bypass. The increasing popularity of laparoscopic sleeve gastrectomy has led to more available data regarding revisional surgery for weight loss failures. The strategies for revision of a failed sleeve gastrectomy include resizing the sleeve, further sleeve restriction with a band or conversion to another bariatric operation.

Resizing the Sleeve Gastrectomy

Weiner et al. [71] were able to show that there was a correlation between a large sleeve size and eventual weight regain or weight loss failure. In their prospective study of 101 patients who underwent the laparoscopic sleeve gastrectomy, those who had a calibrated sleeve prior to resection had better weight loss than those who did not. A repeat sleeve gastrectomy is not a purely restrictive operation. Further resection may remove ghrelin-producing areas of the stomach and hence diminish appetite in these patients [72].

Iannelli et al. [73] reported a series of 13 patients who underwent a re-sleeve gastrectomy for weight loss failure. These patients were found to have a persistent gastric fundus on upper gastrointestinal series. The sleeve gastrectomy was performed over a 34-Fr bougie with a mean operative time of 43 min. The mean excess weight loss was 50.3 and 71.4 % at 1-month and 12-month follow-up respectively.

Placement of an Adjustable Gastric Band on a Sleeve

The role of band application at a primary sleeve gastrectomy has been investigated. In one study, a piece of Alloderm® (LifeCell Corporation, Branchburg, NJ, USA) was wrapped around the proximal aspect of the sleeve gastrectomy in 27 patients [74]. This served to restrict dilatation of the sleeve and eventual weight regain. The decrease in excess BMI observed at 6- and 12-month follow-up was 53.2 and 73.1 % respectively. This was comparable to results obtained in 54 matched controls that had undergone a Roux-en-Y gastric bypass (58.5 and 75.7 %, respectively).

The use of an adjustable gastric band as revisional surgery for a failed sleeve gastrectomy is not widely practiced. Greenstein and Jacob [75] reported the placement of a VG-size Lap-Band System (Allergan, Irvine, CA, USA) in a patient who had achieved an excess weight loss of 16 % after a primary sleeve gastrectomy. There were no postoperative complications. The excess weight loss at 9-month follow-up was 57 % from the initial pre-sleeve weight.

Conversion to a Roux-en-Y Gastric Bypass

The addition of a malabsorptive procedure to a failed sleeve gastrectomy may facilitate further weight loss. This approach may also be indicated in patients who have persistent type 2 diabetes mellitus or severe reflux [76, 77]. In one retrospective study [76], eight patients required a conversion from a sleeve gastrectomy to a Roux-en-Y gastric bypass after a median interval of 33 months. There was one leak at the gastrojejunostomy which was successfully treated with a temporary stent placement. The mean weight reduction was 15.2 ± 8.0 kg within a follow-up from 1 to 52 months.

In a more recent report, 18 patients who had undergone a primary sleeve gastrectomy were converted to a Roux-en-Y gastric bypass [77]. The indication for conversion was insufficient weight loss in 50 % of the patients. The complication rate was 5.5 %. The mean excess weight loss after conversion was 61.7 % at a mean follow-up of 15.5 months.

Completion of a Sleeve Gastrectomy to a Duodenal Switch

The sleeve gastrectomy was historically a first stage procedure for the duodenal switch. Subsequently, it was developed and accepted as an isolated bariatric operation. The conversion of a failed sleeve gastrectomy to a duodenal switch procedure has been shown to be a reasonable treatment approach. The addition of a malabsorptive component facilitates further weight loss.

Dapri et al. [78] compared the outcomes of a repeat sleeve gastrectomy to the addition of a duodenal switch for weight loss failure following a primary laparoscopic sleeve gastrectomy. In their study, patients who exhibited volume eating (hyperphagia) were treated with a repeat sleeve gastrectomy, while those who ate too frequently

(polyphagia) were treated with the duodenal switch. The mean operative time for the duodenal switch group was 15 min longer. One patient in the repeat sleeve gastrectomy group developed a leak at the angle of His. The duodenal switch group had one patient with bleeding, one with a duodenoileostomy leak and another with a duodenoileostomy stenosis. Patients in the repeat sleeve gastrectomy group achieved a mean excess weight loss of 43.7 % at a mean follow-up of 23.2 months. Patients who had a duodenal switch operation achieved a mean excess weight loss of 73.7 % at a mean follow-up of 24.9 months.

Revision for Failed Vertical Banded Gastroplasty

The vertical banded gastroplasty has largely fallen out of favor and has almost completely been abandoned. It has been associated with revision rates of about 20–55 % [79]. The mechanisms of failure may be attributed to maladaptive eating habits, staple line breakdown [80], enlargement of the gastric pouch, or stoma. As with failures in other bariatric operations, these patients need to be adequately evaluated with regards to their eating habits. A preoperative upper endoscopy and upper gastrointestinal series will aid surgical planning. Strategies for revision entail conversion to another restrictive procedure or conversion to an operation that offers malabsorption.

Conversion to a Laparoscopic Adjustable Gastric Band

The conversion of failed vertical banded gastroplasty to an adjustable gastric banding operation has been shown to be feasible. It can be accomplished laparoscopically in most cases, but occasionally, a laparotomy may be required. The pars flaccida technique is the preferred approach. However, when the right crus is not adequately visualized, a perigastric approach may be utilized [81]. In one study 40 patients underwent a laparoscopic adjustable gastric banding as a revisional operation for a failed vertical banded gastroplasty [81]. There were three conversions from laparoscopy to laparotomy. The minor morbidity rate was 12.5 %, while the major complication rate was 5 %. The mean BMI dropped from 38.9 kg/m^2 before revision to 30.7 kg/m^2 at a mean postoperative follow-up of 18 months.

Conversion to a Sleeve Gastrectomy

There are few reports in the literature regarding the conversion of a failed vertical banded gastroplasty to a sleeve gastrectomy. One of the largest series comprised 23 patients [82]. In this study, 19 patients had a successful laparoscopic conversion to a sleeve gastrectomy. The leak rate was identified as 8.6 %. The weight loss outcomes were not specified. In another small study [83], six patients who had undergone conversion to a sleeve gastrectomy were compared to another six patients who had revision of their vertical banded gastroplasty to a Roux-en-Y gastric bypass. The sleeve gastrectomy group had a shorter mean operative time than the gastric bypass group. However, the total morbidity rate was higher with the sleeve gastrectomies (83 vs 33 %).

Conversion to Roux-en-Y Gastric Bypass

The conversion of a vertical banded gastroplasty to a laparoscopic Roux-en-Y gastric bypass is a technically challenging procedure. Special care must be taken to perform a meticulous adhesiolysis. The gastric pouch typically is performed proximal to the band and the vertical staple line [80]. Silastic bands may be removed while marlex meshes may be left in place [80, 84, 85]. In addition, in certain situations, the anatomy may be unfavorable requiring division of the esophagus above the gastroesophageal junction, and hence creation of an esophago-jejunostomy. In one of the largest studies to date, 203 patients underwent a laparoscopic Roux-en-Y gastric bypass for revision of a vertical banded gastroplasty [85]. The indication for surgery was weight regain or insufficient weight loss in 63.1 and 5.5 % of patients, respectively. The complication rate was 11.8 % with a mortality rate of 0.5 %. The mean BMI before revisional surgery was 37.4 kg/m^2. The mean BMI postoperatively after 1, 3 and 5 years was 29.1, 28.8 and 28.7 kg/m^2, respectively.

Conversion to a Duodenal Switch

The conversion of a failed vertical banded gastroplasty to a duodenal switch has also been described in the literature [67, 86, 87]. In one of the larger series [67], 12 patients underwent conversion at a mean interval of 172.2 months. The mean excess weight loss prior to conversion was 20.8 %. The major complication rate was 50 % with a mean hospital stay of 34.5 days. There was a 25 % mortality rate within the first 8 months after revision. The mean excess weight loss in the surviving patients was 85.1 %.

Revisional Surgery for a Failed Biliopancreatic Diversion with Duodenal Switch

The biliopancreatic diversion with duodenal switch offers one of the best weight loss results amongst the current bariatric operations [35, 88]. Weight loss failure occurring following this operation is relatively uncommon but there

is a greater tendency for malnutrition. Revisional surgery for weight regain or insufficient weight loss may be required in less than 5 % of cases [89]. The options for revisional surgery entail re-sizing the sleeve or shortening of the common channel.

A laparoscopic re-sleeve gastrectomy would be a viable option in patients who have radiological evidence of an enlarged gastric sleeve in the setting of weight loss failure [90]. The procedure entails downsizing the stomach over a large bougie inserted along the lesser curvature. Care must be taken to ensure preservation of the blood supply of the lesser curve as this reduces the risk of staple line ischemia and consequent leak [89]. Additional measures that may be utilized to reduce the risk of a staple line leak are use of staple line reinforcement materials or oversewing of the staple line.

The length of the common channel plays a significant role in the amount of weight loss achieved with a duodenal switch operation [91]. A shorter common channel or a greater length of bypassed small bowel induces more malabsorption, and hence greater weight loss [92]. This option, however, may potentially induce severe protein and nutrient deficiencies in a patient who is already at risk.

Conclusions

Bariatric surgery has been shown to be the most effective treatment modality for achieving sustainable weight loss in the severely obese. The success of any bariatric operation is based on its ability to produce sufficient weight loss without weight regain and at the same time induce resolution of associated comorbidities. In this context, it may be difficult to categorically state that a patient has failed a bariatric operation without considering the impact it has made on their general health status and comorbidities. Most authors will define weight loss failure as inability to achieve an excess weight loss of greater than 50 %. However, there are other recognized definitions of this concept in the literature. There is a definite need to standardize this definition.

The different bariatric operations have been shown to produce varying degrees of weight loss. Some are superior to others in this regard. There are varying factors that determine what bariatric operation is offered to a specific patient. The key to ensuring successful weight loss lies in paying particular attention to the preoperative and postoperative management of these patients. A good follow-up program is essential. Weight loss failure may occur as a result of poor patient compliance. It may also occur as a result of an anatomical or structural problem with the surgical procedure that might require surgical correction. Another approach would be conversion to another operation that offers superior weight loss. The choice of a specific revisional bariatric operation should be determined by the primary operation.

Revisional bariatric surgery is generally fraught with higher morbidity when compared to the primary operation [16, 18–20, 33, 39, 59, 60, 64, 65, 67, 76, 78, 83]. The complexity of these operations requires an experienced and skilled bariatric surgeon. It is important that patients are made to understand the potential problems associated with revisions. There is also the potential for the operation not to produce the desired weight loss [15, 34, 45, 93].

In conclusion, the decision to pursue a revisional bariatric surgical procedure must weigh the risks and benefits of such an intervention, with clear expectations on the patient's part and endorsement by a multidisciplinary team.

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