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Review article

## Systematic review on reoperative bariatric surgery *American Society for Metabolic and Bariatric Surgery Revision Task Force*

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**Abstract**

**Background:** Reoperative bariatric surgery has become a common practice in many bariatric surgery programs. There is currently little evidence-based guidance regarding specific indications and outcomes for reoperative bariatric surgery. A task force was convened to review the current evidence regarding reoperative bariatric surgery. The aim of the review was to identify procedure-specific indications and outcomes for reoperative procedures.

**Methods:** Literature search was conducted to identify studies reporting indications for and outcomes after reoperative bariatric surgery. Specifically, operations to treat complications, failed weight loss, and weight regain were evaluated. Abstract and manuscript reviews were completed by the task force members to identify, grade, and categorize relevant studies.

**Results:** A total of 819 articles were identified in the initial search. After review for inclusion criteria and data quality, 175 articles were included in the systematic review and analysis. The majority of published studies are single center retrospective reviews. The evidence supporting reoperative surgery for acute and chronic complications is described. The evidence regarding reoperative surgery for failed weight loss and weight regain generally demonstrates improved weight loss and co-morbidity reduction after reintervention. Procedure-specific outcomes are described. Complication rates are generally reported to be higher after reoperative surgery compared to primary surgery.

**Conclusion:** The indications and outcomes for reoperative bariatric surgery are procedure-specific but the current evidence does support additional treatment for persistent obesity, co-morbid disease,

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**Keywords:** Reoperative; Revisional; Bariatric; Weight regain; Complications

Morbid obesity is a chronic disease that requires lifetime treatment. While bariatric surgery is highly effective and durable therapy, as with many other chronic diseases requiring medical or surgical therapy, there will be patients who respond well to an initial therapy and others with only a partial response. There will also be a subset of patients who are nonresponders or have recurrent or persistent disease or complications of therapy; these patients may require escalation of therapy, a new treatment modality, or correction of complications [1].

The paradigm of revisional, adjuvant or escalation of therapy is well established in many medical and surgical specialties. For example, total joint arthroplasty for the treatment of chronic degenerative joint disease has an established early success rate. Patients receiving a successful joint replacement, though, will have varying degrees of functional recovery based on their underlying disease, technical aspects of the procedure, and their functional status before surgery. Over time, there is also a well-established revision rate [2–4] with joint replacement and, when this initial therapy fails, a revision, replacement, or conversion procedure is offered.

There are many other examples of surgical procedures with known long-term need for revision such as coronary artery bypass grafting, heart valve surgery, abdominal wall hernia repairs, and oncologic operations. In all of these cases, the necessity of reoperative procedures or the use of adjunctive therapy is clear and covered by payors. Review of several major nationwide health plans and plans for state employees in the United States found no limitation with regard to revisional surgery for orthopedics, cardiac surgery, or any other specialty except bariatric surgery [5]. The paradigm of chronic treatment for other diseases is applicable to the chronic disease of morbid obesity and its complications. Therefore, revisional or additional therapy is justified if a primary bariatric procedure does not sufficiently treat the disease of morbid obesity.

Many patients with morbid obesity are not provided insurance coverage for the treatment of this disease or are offered *only* 1 lifetime procedure to treat it or face near insurmountable barriers to access care. Patient selection for the initial procedure is often determined by the patient's and primary care physician's perspective of risk and benefits for their individual medical situation, insurance coverage, and their operative risk in consultation with their surgeon and bariatric program. Patients and surgeons in consultation often choose the operation that best fits their risk and benefit preferences. The opportunity to convert or revise a primary

operation that does not achieve adequate weight loss or comorbidity improvement is therefore necessary to provide effective therapy for these patients. As with other surgical specialties, reoperative bariatric surgery is more challenging than primary procedures and is associated with a higher rate of 30-day adverse events [6]. However, when reoperative surgery is performed by experienced surgeons who perform a variety of revisional procedures, risk and complication rates are acceptable [7–10].

The purpose of this systematic review is to provide a summary of the current evidence regarding reoperative bariatric surgery. Specific nomenclature has been developed to provide descriptive categories of revisional procedures.

## Methods

### *Evidence search strategy*

MEDLINE 1996–present was queried for the following terms: “bariatrics/ or \*bariatric surgery” OR “gastric bypass/ or gastroplasty/” OR “band/ banding” OR “anastomosis, roux-en-y/ or biliopancreatic diversion/ or gastrectomy/” AND “revis\$.mp” OR “conver\$.mp.” OR “revers\$.mp.” OR “fail\$.mp.” OR “Reoperation/ reop\$.mp.” OR “redo / redo” OR “regain.mp. or Weight Gain/”. The search was limited to articles in the English language with human patients.

A task force comprised of private practice and academic bariatric surgeons with expertise in reoperative bariatric surgery and critical evidence review was convened to review this topic. The ASMBS Insurance, Research, Clinical Issues, Quality Improvement, and Access to Care committees were represented on the task force. A medical researcher not affiliated with the ASMBS was contracted to perform the literature search and assist with evidence review. Members of the task force reviewed all citations and abstracts that met search criteria. The evidence was graded and sorted by procedure type and type of reoperation according to the nomenclature below. Secondary searches for specific procedures and topics were conducted by the task force based on key articles and bibliographies obtained in the primary search. A flow diagram of the citation selections process is shown in Fig. 1.

### *Nomenclature*

**Conversion.** Procedures that change from an index procedure to a different type of procedure.

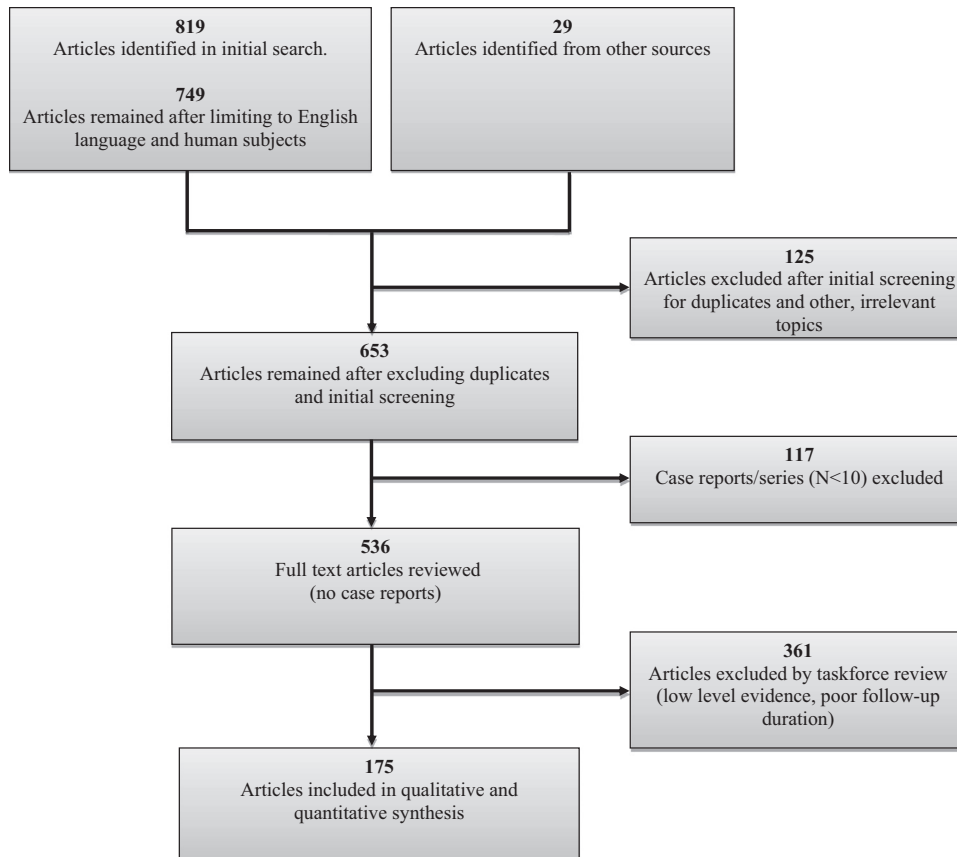


Fig. 1. Flow diagram of article selection process for systematic review.

Corrective. Procedures addressing complications or incomplete treatment effect of a previous bariatric operation.  
Reversal. Procedures that restore original anatomy.

### I. Treatment of insufficient weight loss or weight regain after bariatric surgery

While the majority of bariatric patients do achieve successful outcomes after their primary operation, the patients who present with insufficient weight loss, continued co-morbid disease, or weight regain after bariatric surgery represent a challenging population. This group of bariatric patients may benefit from additional surgical therapy to treat their obesity and should be thoroughly evaluated by a multidisciplinary program to determine the potential causes for their poor response. This evaluation may include nutritional and behavioral health assessment and anatomic evaluation based on the original procedure performed. The decision to proceed with additional medical or surgical therapy should be based on this multidisciplinary assessment and the patient's specific risk/benefit profile for a reoperative procedure [11].

#### *Roux-en-Y gastric bypass*

Indications for corrective procedures after gastric bypass are inadequate weight loss, weight regain, or recurrence of weight-

related co-morbid conditions. Since these options involve modifying a portion of the bypass anatomy or adding a component to the existing bypass anatomy, they are classified as corrective procedures rather than conversion based on the above nomenclature. The degree of weight regain that warrants a corrective procedure varies widely depending on the patient's original weight and co-morbidities. Mandatory waiting periods for insurance approval (6 mo of weight management or nutrition visits or documentation of prolonged disease burden, for example) are not indicated and are not supported by the evidence. Preoperative weight loss in specific patients may facilitate the laparoscopic approach or decrease technical difficulties of the operation and participation and duration of preoperative weight loss should be at the discretion of the surgeon and program managing the patient [12].

One type of corrective procedure is intended to increase or restore gastric restriction that contributed to the satiety sensation that assisted patients with their initial weight loss. Endoscopic therapy to reduce the pouch and gastrojejunal (GJ) stomal size has been shown to arrest weight gain [13] and achieve short-term weight loss with minimal risk [14–16], but most of the published studies are small non-controlled series and many of the devices reported in the literature are no longer commercially available. Surgical revision of the pouch and GJ may be indicated when there is significant pouch or stoma dilation that allows for a

significant reduction in size with surgical therapy or when there is a gastrogastric fistula with inadequate weight loss or a persistent marginal ulcer [17,18]. In some cases, additional therapy or anatomic change is reported to add to the existing Roux-en-Y gastric bypass (RYGB) anatomy that is intact. Reported options include placement of an adjustable or nonadjustable band around a gastric pouch to achieve additional gastric restriction [7,19,20], lengthening the biliopancreatic or Roux limb to increase the malabsorptive or bypass component of the operation, or conversion to duodenal switch (DS) [21]. All of these series report improved weight loss after salvage procedures, but the current evidence supporting these strategies is limited [22]. Complication rates of published studies evaluating procedures for weight gain after RYGB are shown in Table 1.

#### *Laparoscopic adjustable gastric banding*

Laparoscopic adjustable gastric banding (LAGB) is unique in that the device is placed without major anatomic alteration. The lack of anatomic alteration is thought to account for the significant lack of hormonal effect associated with LAGB. The average weight loss with LAGB is well documented to be lower than that of the other procedures mentioned. There is currently evidence that the LAGB can be converted to both RYGB, laparoscopic sleeve gastrectomy (SG), and DS to achieve additional weight loss [8,23–34].

Conversion procedures are intended for patients who experienced satisfactory weight loss and corresponding resolution of co-morbidity after LAGB and then experience subsequent weight gain and/or co-morbidity recurrence without a significant anatomic abnormality identified in the corrective surgery section below. Alternatively, some patients initially have insufficient weight loss to resolve their weight-related co-morbidity and do not achieve an acceptable degree of efficacy after band placement.

Other indications for conversion, as discussed below, include complications (slippage, dilation, migration, erosion, port/tube problems or band intolerance). There is some evidence to suggest that fewer complications occur when conversion to another procedure is performed in 2 stages (band removed with interval procedure 2–6 mo later to allow gastric tissue healing) [24,35–38]. Weight loss and co-morbidity outcomes of LAGB patients converted to RYGB, SG, biliopancreatic diversion (BPD), or DS have been reported and are similar to the outcomes for primary RYGB, SG, and BPD/DS [8,24–33,37–39]. Specific evidence to support the safety and efficacy of conversion procedures after LAGB is discussed below, and morbidity and mortality rates of conversion procedures are shown in Table 2.

#### *Conversion to RYGB*

Reported incidence of conversion from LAGB to RYGB is 2–28.8% [25–27,40]. Medium-term (up to 4 yr) weight loss

outcomes after conversion of LAGB to RYGB are comparable to primary RYGB outcomes [25,26,28,29,41,42], and complication rates are acceptable and most series report early adverse event rates similar to or slightly higher than primary RYGB complication rates [25,43–46]. A recent systematic review of 15 studies (588 patients) evaluating conversion of LAGB to RYGB reported an overall complication rate (major and minor) of 8.5% with anastomotic leak and bleeding rates of .9% and 1.8%, respectively. Excess weight loss was between 23% and 74% with follow-up periods ranging from 7–44 months. Decreases in body mass index (BMI) after conversion ranged from 6–12 points with the majority of studies reporting around a 10-point decrease [46].

#### *Conversion to SG*

Conversion of LAGB to SG is most commonly performed for inadequate weight loss [7,8,30–32,47–51]. Acceptable morbidity rates and short-term (up to 2 yr) weight loss improvement after conversion to SG has been demonstrated in published studies [46], but some series report higher leak rates than primary SG. This is postulated to be a result of the scar tissue at the angle of His that occurs after banding. A recent systematic review of 8 studies (286 patients) evaluating conversion of LAGB to SG reported an overall complication rate (major and minor) of 12.2% with staple line leak rate of 5.6%. Three leaks required reoperation. For studies that reported follow-up periods after revision (6–36 mo), the excess weight loss (EWL) ranged from 31–60% [46].

Removal of a LAGB with conversion to SG can be performed in a single-stage procedure or in 2 stages with band removal and interval conversion to SG. There is some evidence that the staged approach results in fewer leaks at the time of SG but the data are limited [52].

#### *Conversion to BPD/DS*

There is some evidence reporting outcomes after LAGB is converted to a malabsorptive procedure. These reports are limited to small case series with short-term follow-up [42,53]. Conversion to BPD or BPD/DS results in weight loss similar to a primary malabsorptive procedure with published complication rates that are higher than a primary BPD/DS [39].

#### *SG*

For patients who need additional therapy for weight loss or develop weight regain after SG, conversion to RYGB or BPD/DS is reported [7,54–56]. For high-risk or high BMI patients, utilizing the SG as the first stage of a planned staged approach is an established strategy [57–61]. In this patient group, the sleeve provides initial weight loss and co-morbidity reduction with improvement in functional status before the second-stage operation (RYGB or BPD/DS) that provides continued weight loss and co-morbidity reduction

Table 1  
Selected Papers Reporting Gastric Bypass Conversions

Author	Publication year	n	Primary procedure(s)	Revisional procedure(s)	Follow-up duration (range)	Complications	Leaks	30-d mortality	Preoperative BMI (at primary procedure)	Prerevision BMI	Prerevision weight loss	Postrevision weight loss	Interval from primary operation–revision	
Shimizu, et al. [7]	2013	154	RYGB, VBG or horizontal gastric bypass, SG, AGB, JIB, mini gastric bypass, BPD	RYGB, long limb RYGB, SG, rebanding, band over pouch, BPD reversal, RYGB reversal, redo GJ	2.4 ± 1.5 yr (n = 136)	Total 29.9% (n = 46); <grade 2 16.9% (n = 26); ≥ grade 3 13% (n = 20); early 20.8% (n = 32); late 9.1% (n = 14)	0, 1 late related to COPD	54.4 ± 13.8	44.0 ± 13.7	62.4 ± 24.1 for primary restrictive procedures	55.4 ± 24.8 for primary bypass procedures	53.7 ± 29.3 for primary restrictive procedure	37.6 ± 35.1 for primary bypass procedure	Interval 7.5 ± 9.6 yr
Khaitan, et al. [9]	2005	37	VBG, RYGB, JIB, LGB	RYGB	5 mo	33% overall 5 early complications, 9 late complications (5 leaks)	5	0 early, 1 late	NR	43.3 ± 9.9	NR	Postrevision BMI 37.4 ± 9.2	1–28 yr	
Hallowell, et al. [10]	2009	46	RYGB, VBG, JIB	RYGB	1 yr	2 (4.3%) strictures, 2 (4.3%) ulcers, 0 PE, 5 (11%) 11 (24%) 30-d readmissions	5	0	NR	45.4 ± 10.2	NR	Postrevision BMI 33.5 ± 5.6		
Thompson, et al. [13]	2013	TORe (n = 50) or sham procedure (n = 27)	RYGB	Endoscopic sutured TORe	6 mo	1 pulmonary edema immediately postprocedure	0			37.6 ± 4.9 in –TORe group	73.2 ± 20.5 in –TORe group (n = 50)	15.9 ± 20.90 in TORe group (n = 43)	58.8 ± 25.7 mo (n = 48) in TORe group	67.5 ± 24.5 (n = 27) in control group
Leitman, et al. [14]	2010	64	RYGB	EPRGP	5.8 (3–12) mo	2 (3%) intraoperative complications (equipment failure), 1 observed for bleed (no transfusion)	0	48.5	39.5	nadir BMI 31	7.3 kg (0–31)	5 yr		
Himpens, et al. [15]	2012	88	LRYGB (with and without prior VBG or AGB)	Distal RYGB, fobi ring around pouch, bypass reconstruction, LSG, plication	48 (18–122) mo	Overall reoperation rate: 7.3%, overall severe complication rate: 20.7%, overall leak rate 12.1%	0	42.7 ± 19.7 (33.0–56.6)	39.1 ± 11.3 (30.8–51.8)	12.4 ± 9.3% (–1.0–29.1)	Postrevision BMI 29.6 ± 12.4 (18.0–45.5)	3.0 yr (1.5–8.0)		
Irani, et al. [20]	2011	43	RYGB	Salvage banding	26 ± 14 (6–66) mo	12 adverse events: 1 enterotomy requiring band removal; 1 SBO, 1 GI bleed, 3 esophageal dilations resolved with band deflation, 1 minor port leak, 1 port flip, 1 band slip, 1 case of persistent dysphagia, and 2 cases of intragastric band migration	0	50.4 (35–60)	43.3 (34–60)	17% EWL	Post-LAGB BMI: 223 ± 154	33.8 (25–47); 38% EWL from LAGB; 55% cumulative (initial + revisional) EWL		

Table 1  
Continued.

Author	Publication year	n	Primary procedure(s)	Revisional procedure(s)	Follow-up duration (range)	Complications	Leaks	30-d mortality	Preoperative BMI (at primary procedure)	Prerevision BMI	Prerevision weight loss	Postrevision weight loss	Interval from primary operation–revision
Keshishian, et al. [21]	2004	47	VBG, RYGB, VBG converted to RYGB	DS	30 mo	1 (2.1%) SSI, 1 (2.1%) hernia	4 (8.5%)	0	53.2	47.3 (24.5–73.7)	70% (19–130) EWL	67% EWL; BMI 29.2	11.8 yr (2.7–23)
Rawlins, et al. [22]	2011	29	RYGB	Distal RYGB	1–5 yr	Short-term: 0 leaks, 4 DVTs, 10 SSIs Long-term: 1 partial SBO, 6 ventral incisional hernias, 9 w/albumin <3, 6 required TPN, 1 reversed	0	0	57.9 (38–81)	48.1 (35–67)	26.6% (0–46%) EWL	60.9% (39–83%) EWL at 1 yr; 68.8% (53–91%) EWL at 5 yr	
Greenbaum, et al. [82]	2011	41	RYGB, VBG, LAGB	DS with omentopexy and feeding jejunostomy	6 mo–2 yr	Overall major complication rate 13 (32%)	9 (22%)	0	NR	NR	48	EWL 54% (n = 31) at 6 mo 66% (n = 22) at 1 yr 75% (n = 9) at 2 yr	NR
Parikh, et al. [86]	2007	12	RYGB	BPD-DS	11 (2–37) mo	6 (4 strictures, 1 metabolic acidosis, 1 wound complication)	0	0	53.9 (40.7–66.0)	40.7 (33.2–46.0)	42% (8–63%) EWL; lowest BMI after primary RYGB: 31.6 (23.3–39.0)	62.7% (18.8–96.2%) EWL at 11 mo 79.4% (48.3–98.1%) overall	NR
Dapri, et al. [87]	2011	4	RYGB	LSG	11 ± 12.8 mo	1 GG fistula	NR	0	43.2 ± 8	37.3 ± 6.6	27.5 ± 11.8% EWL; 26.5 ± 12% EBMIL	59.3 ± 31.5% EWL; 42.3 ± 34.5% EBMIL	36.7 ± 15.6 mo

BMI = body mass index; RYGB = Roux-en-Y gastric bypass; VBG = vertical banded gastroplasty; SG = sleeve gastrectomy; AGB = adjustable gastric banding; JIB = jejunoileal bypass; BPD = biliopancreatic diversion; GJ = gastrojejunostomy; COPD = chronic obstructive pulmonary disease; LGB = loop gastric bypass; EPRGP = endoscopic plication and revision of the gastric pouch; LSG = laparoscopic sleeve gastrectomy; DS = duodenal switch; PE = pulmonary embolism; SBO = small bowel obstruction; GI = gastrointestinal; SSI = surgical site infection; DVT = deep venous thrombosis; TPN = total parenteral nutrition; GG = gastrogastric; NR = not reported; EWL = excess weight loss; EBMIL = excess body mass index loss

Table 2  
Selected Papers Reporting Gastric Band Conversions

Author	Publication year	Revisional surgery n	Primary procedure (s)	Revisional procedure(s)	Follow-up duration (range)	Complications	Leaks	30-day Mortality	Preoperative BMI (at primary procedure)	Prerevision BMI	Prerevision weight loss	Postrevision weight loss	Interval from primary operation to revision
Robert, et al. [24]	2011	85	LAGB	LRYGB	22 (3–72) mo	7% early morbidity rate: 2 reoperations (1 fistula, 1 small bowel injury) 1 liver abscess, 1 peritoneal abscess, 1 unexplained fever, 1 Rhabdomyolysis/bilateral brachial plexus. 4.7% delayed morbidity rate (GJ stenosis, incisional hernia)	0	0	47.2 (33–67)	32.9 (27–72)	Lowest BMI after LAGB: 35 (extremes 23–53.3)	Lowest BMI after revision: 34.8 (22–50); loss of 8.1 BMI points; overall (primary + conversion) 12.4 BMI points	6.2 yr (1–13)
Topart, et al. [25]	2009	58	LAGB	LRYGB	1 yr	5 (8.6%) in revisional group (3 wound abscesses, 1 atelectasis, 1 bowel obstruction, 0 leaks); 11 (5.5%) in primary group (4 leaks, 2 bleeds, 2 atelectasis, 1 dysphagia, 1 ARDS, 1 nausea)	0 in revisions, 4 in primary	0 in revisional group, 2 in primary RYGB group	46.3 ± 7.2	43.2 ± 7.0	Lowest BMI: 36.0 ± 7.8	66.1 ± 26.8% EWL at 1 year	46.1 ± 17.4 mo
Spivak, et al. [26]	2007	33	LAGB	LRYGB	15.7 mo (range, 12–26)	2 reoperations (1 splenectomy for bleeding, 1 repair of internal hernia at 1 year). No leaks	0	0 (NR?)	45.8 ± 3.4 (range 39.9–53.0)	42.8 ± 4.4 (range 33.1–50)	Lowest BMI achieved 39.7 ± 4.9 (range 30–49.2)	30.7 ± 5.3 (range 22–39.6)	28.2 ± 11.3 mo (range 11–46)
Ardestani, et al. [27]	2011	66	LAGB	RYGB, band revision (rebanding, band repositioning)	1–48 mo	4.3% in revision group (1 aspiration pneumonia and 1 acute renal failure/PE); 10.5% in conversion group (2 SSI).	0	NR	44.5 ± 5.2 in the revision group; 44.1 ± 5.7 in conversion group	NR	At 24 mo postband placement: 56.4 ± 19.6 (n = 19) in revision group; 17.8 ± 19.8 (n = 15) in conversion group	At 48 mo: 46.2 ± 23.3 (n = 17) %EBWL in revision group; 51.3 ± 30.9 (n = 7) %EBWL in conversion group	21.5 mo (range 0–49) for band revisions, 27.6 mo (range 11–48) for conversion to RYGB
Mognol, et al. [28]	2004	70	LAGB	LRYGB	7.3 mo (3–18)	Early complication rate: 14.3% (10/70). Reoperation rate was 5.7%. 3 bleeds, 1 pneumonia, 3 incisional abscesses, 3 fever. No leaks. Late major complications in 6 (8.6%) patients: 3 (4.3%) w/stenosis	0	0	46.9 ± 8.7 (range 38.6–74.5)	44.9 ± 10.8 (range 26.9–81)	NR	Median %EWL after 6, 12, and 18 mo was 50 ± 20%, 59 ± 18% and 70.2 ± 21%. Median BMI decreased to 34.5 ± 8.6, 33.9 ± 7.3, and 32.2 ± 6.3	42 (range 7–74) mo

Table 2  
Continued.

Author	Publication year	Revisional surgery n	Primary procedure (s)	Revisional procedure(s)	Follow-up duration (range)	Complications	Leaks	30-day Mortality	Preoperative BMI (at primary procedure)	Prerevision BMI	Prerevision weight loss	Postrevision weight loss	Interval from primary operation to revision
Langer, et al. [29]	2008	25	LAGB	LRYGB	3–12 mo	at the gastro-jejunosomy, 3 (4.3%) marginal ulcers. 4 major complications 0 - Early: 1 port-site hernia. Late complications: 1 port-site hernia, 1 GJ stricture 1 fistula.	0	NR	51.0 ± 8.1 (range 37.6–75.1)	47.6 ± 7.7 (range 37–70)	mean max %EWL = 39.9 ± 26.0% (range 0–97.8)	EWL of 28.3 ± 9.9%, 40.5 ± 12.3%, and 50.8 ± 15.2% at 3, 6, and 12 mo. BMI decreased to 35.4 ± 6.6 (range : 25–52) at 12 mo	53 (range 17–118) mo
Jacobs, et al. [30]	2011	32	LAGB, NAGB, VBG	LSG	26 mo (range 5–40)	2 reoperations (1 converted to RYGB, 1 revision of LAG); 1 leak	1	0	Mean 45.2	Mean 42.69	Mean 10% EWL	Mean EWL 60% (range 13.5–120%). Mean BMI postrevision 33.3 (range 23–50).	mean 67 mo (5.6 yr)
Acholonu, et al. [31]	2009	15	LAGB	LSG	6–24 mo	1 staple line leak, 1 acute gastric outlet obstruction	1	0	NR	38.66 (29.7–49.3)	NR	1 yr %EBMIL 65.7 (25.3–76.7)	34.7 mo (range 16–60)
Uglioni, et al. [32]	2009	29	LAGB	LSG	1–4 yr	Conversion group - Early complication rate: 11.4% (8/70) (1 dysphagia, 3 UTI). Midterm complication rate: 3 (10.3%) (1 leak, 1 hiatal herniation of sleeve, 1 trocar site hernia).	1	0	46.1 (38.8–58.1)	38.6 (25.1–52.7)	NR	EBMIL 65% (9–127%) at 1 yr, 63% (13–123%) at 2 yr, 60% (9–111%) at 3 yr, 122% in 1 patient after 4 yr	
Iannelli, et al. [33]	2009	41	VBG, gastric band	LSG	13.4 months (1–36)	5 (12.2%) complications (1 leak, 3 intra-abdominal collections, 1 incisional hernia)	1	0	53.1 ± 5.9 (range 35.9–63)	49.9 ± 5.9 (range 35.9–63)	NR	mean BMI, % EWL, and mean %EBL: 42.7, 42.7%, and 47.4%	
Khoursheed, et al. [34]	2013	95	LAGB	SG, RYGB	9.8 mo in SG group, 29.3 mo in RYGB group	Overall complication rate: 7.1 versus 20.8% in SG and RYGB groups. Reoperation rate: 0 in SG group, 3.8% in RYGB group. 1 (1.9%) leak in RYGB group. Bleeds in 1 (2.4%) in SG group, and 2 (3.8%) in RYGB group	1 (1.9%)	0		38.5 in SG group, 43.2 in RYGB group		%EWL 47.4 ± 21.6 in SG group, 45.6 ± 14.0 in RYGB group at 1 yr	



Suter, et al. [36]	2004	24	LAGB, SAGB	RYGB	2 mo–4 yr	1 leak, 4 wound infections	1	NR	45.9	33.4	52.9% EWL	Mean %EWL (based on preband weight) 65.1% (range 9.2–105%)	Band erosion was diagnosed after a mean of 22.5 mo (3–51)
Van Nieuwenhove et al. [37]	2011	37	LAGB	LRYGB	10 (range 4–23) mo in single stage group, 9 (range 3–21) mo in 2 stage group	5 complications (1 PE, 0 1 bleed, 3 late stenosis of GJ anastomosis)	0	NR	41.9 ± 6.1 for single stage group, 45.0 ± 6.7 in 2 stage group	41.4 ± 6.7 in single stage group, 43.8 ± 5.8 in 2 stage group	%Weight loss 1.54 ± 10.64 in single stage group, 2.12 ± 8.21 in 2 stage group	26 .5 ± 5.5% EWL in single stage group, 35.4 ± 13 .2% EWL in 2 stage group. BMI after conversion: 28.7 ± 10.8 in single stage group, 35.3 ± 7.55 in 2 stage group	90 (40–144) mo in single stage group, 80 (28–120) in 2 stage group
Topart, et al. [39]	2010	53	LAGB	RYGB, BPD-DS	18 mo	1 bleed, 8 wound/port 2 site abscesses, 1 abdominal abscess, 1 bowel obstruction, 1 pneumonia, 1 stricture.	0	0	49.6 ± 5.2 for those converted to BPD-DS, 45.8 ± 6.4 for those converted to RYGB	46.0 ± 5.5 for those converted to BPD-DS; 43.1 ± 6.4 for those converted to RYGB	Lowest BMI achieved with LAGB: 39.3 ± 6.0 for those converted to BPD-DS; 36.0 ± 6.9 for those converted to RYGB	Mean EWL was 73% after BPD-DS, 61.8% after RYGB (cumulative); 66.2% after BPD-DS and 58.8% after RYGB based on prerevision weight	33.4 ± 17.8 mo in BPD-DS conversions; 42.5 ± 14.1 mo for RYGB conversions
Rogers, et al. [40]	2010	15	LAGB	RYGB	6–8 wk	1 splenectomy for hemorrhage (6.6%); 2 anastomotic strictures (13.3%)	1 (6.6%)	0	NR	NR	NR	NR	Mean 21.3 mo (range 5.5–46.6)
Muller, et al. [41]	2008	74	LAGB	Rebanding, LRYGB	Median 36 mo (range 24–60)	26 overall; 4 slippage, 2 penetration, 1 infection, 1 dissatisfaction, 8 insufficient weight loss, 6 esophageal dysmotility with weight regain, 1 SBO, 1 pouch diverticula/blind loop syndrome	2 in rebanding group	NR	46.1	41.9 in RYGB conversions; 35.9 in rebanding	NR	Mean decrease of 6.1 BMI points after RYGB conversion, mean increase of 1.5 BMI points after rebanding	NR
Steffen, et al. [42]	2009	91	LAGB	RYGB	7 yr	Mean total of 18.4% complications in those converted to RYGB over 4 yr of f/u (anastomosis stenosis) with endoscopic dilation (mean 7.5%), internal hernia (mean 2.8%), incisional hernia (mean 8%),	20/292 LAGB (6.8%)	0	43.7 ± 5 (35–55)	NR	NR	For ALL 388 patients (revisions and nonrevisions) mean EWL 61% at yr 7, decrease of 12 BMI units	3.6 ± .2 yr to conversion to RYGB

Table 2  
Continued.

Author	Publication year	Revisional surgery n	Primary procedure (s)	Revisional procedure(s)	Follow-up duration (range)	Complications	Leaks	30-day Mortality	Preoperative BMI (at primary procedure)	Prerevision BMI	Prerevision weight loss	Postrevision weight loss	Interval from primary operation to revision
						anastomotic ulcer without stenosis (mean 18.4%). 44 reoperations in those that maintained LAGB for slippage/pouch dilation (n = 22), leakage (n = 20), or migration (n = 2). Early complication rate (within 30 days) was 2.6% (CO2 embolus, band infection, wound dehiscence, port infection, intraperitoneal bleeding, and pneumonia)							
Worni, et al. [43]	2013	3433 (NIS data)	Gastric band, RYGB	RYGB, Band-related reoperation		30.2% (n = 91/301) overall postoperative complication rate in those converted from band to RYGB; 4.9% (n = 3096/63,171) for primary RYGB	Not specified	80 (0.1) for primary RYGB; 1 (0.3) for band converted to RYGB	NR	NR	NR	NR	NR
Moore, et al. [44]	2009	26	LAGB	RYGB	18 mo	11% overall complication rate (1 leak, 1 anastomotic stricture)	1		45	40	Mean 23% EWL	%EBWL at 6 and 12 mo was 51% and 56% based on pre-LAGB weight	Mean 29 mo
te Riele, et al. [45]	2008	55	LAGB	RYGB	12.8 (3–37.2) mo	Overall 29.6% in primary RYGB group, 30.9% in LAGB converted to RYGB. Early–11 (13.6%) in primary RYGB and 8 (14.5%) in LAGB conversions to RYGB. Late–13 (16.0%) in primary RYGB and 9 (16.4%) in LAGB conversions to RYGB	5 (6.2%) in primary RYGB; 2 (3.6%) in LAGB converted to RYGB	0	52.3 ± 7.2 (range 40.6–84.6) for primary RYGB group; 50.1 ± 6.5 (range 42.1–71.7) for conversion group	47.7 ± 7.4 (range 33.2–68.1)		Mean BMI at 2 yr: 33.3 ± 7.5 (range 24.3–50.5) for primary RYGB and 35.6 ± 5.7 (range 27.5–48.0) for LAGB conversions to RYGB	Median 66.2 mo (range 12.7–120.0)

Tran, et al. [47]	2013	109	LAGB	LRYGB, LSG, Reoperation for LAGB complications	54.3 (47–62) mo in conversion group; 42.2 (25–54) mo in LAGB reoperation group	Early (n = 11), late (n = 12) in conversion group	4	1 in conversion group	45.4 ± 6 in conversion group; 44.8 ± 7 in LAGB reoperation group	42.9 ± 6 in conversion group; 38.1 ± 7 in LAGB reoperation group	12.4 ± 22 % EBWL in conversion group; 28.5 ± 24 % EBWL in LAGB reoperation group	53.7 ± 27 % EBWL in conversion group; 28.2 ± 28 % EBWL in LAGB reoperation group	36.3 (25–45) mo
Stefanidis, et al. [48]	2013	102	LAGB, VBG, RYGB, LSG, Fundoplication	RYGB, LSG, LL-RYGB, pouch revision of RYGB, GJ revision of RYGB, GG fistula takedown after RYGB, reversal of RYGB	30 d	18% LAGB to LSG; 20% LAGB to RYGB; 25% other revisions; 40% fundoplication to RYGB	4% in other revisions, 3.4% for fundoplication to RYGB	0	NR	39.7 for LAGB to LSG; 40 for LAGB to RYGB; 42.5 for other revisions; 34 for fundoplication to RYGB	NR	NR	NR
Goitein, et al. [49]	2011	46	LAGB	LSG	Mean 17 (range 1–39) mo	3 (6%) overall (2 leaks, 1 bleeding)	2	0	NR	43.1 (range, 29–57)	NR	%EWL at 2, 6, 12, 24, and 36 mo was 24, 37, 53, 51, and 48%	Median 2 yr (range 2 mo–9 yr)
Kasza, et al. [50]	2011	26	LAGB	LSG, band removal, laparoscopic exploration for SBO, exploration for stoma obstruction, re-exploration for reconnection of the tubing, band replacement due to a perforated balloon, surgery for slippage, reoperation for leak	16 mo overall (reoperation + nonreoperation group)		1	0	45.6 ± 6.1	NR	NR	Overall mean EWL 20% ± 14% (primary + reoperations)	29.4 mo
Bhasker, et al. [51]	2011	41	LAGB	LRYGB, LSG, band removal	6 mo	NR	0	NR	NR	Median 39 (range 33.4–53)	NR	Median 6 mo. weight loss: 15.5 kg (range 10.4–24) for conversion to LSG; 14 kg (range 12–19) for conversions to LRYGB	NR
Stroh, et al. [52]	2013	174	LAGB	LSG	NR	Overall, 6.6% for 1 step conversion to SG; 5.4% for 2 step conversion to SG	4.40%	0	NR	Mean 45.4 (range 20.6–82.0) for 1 step conversion to SG; 46.9 (range 25.4–			

Table 2  
Continued.

Author	Publication year	Revisional surgery n	Primary procedure (s)	Revisional procedure(s)	Follow-up duration (range)	Complications	Leaks	30-day Mortality	Preoperative BMI (at primary procedure)	Prerevision BMI	Prerevision weight loss	Postrevision weight loss	Interval from primary operation to revision
Schouten, et al. [53]	2006	33	LAGB	Band refixation, BPD-DS, RYGB	34 ± 19 mo	4 (12%) overall (2 SSI, 1 severe diarrhea, 1 malnutrition requiring TPN 10 mo after conversion to BPD). 3 patients requiring second reoperation after refixation (1 band leak, 2 slippage)		0	44.6 ± 5.8 (37.0–55.6)	72.6 for 2 step conversion to SG 37.5 ± 6.4 NR		Postrevision BMI: 28.1 ± 17.6 mo 33 ± 7	

BMI = body mass index; LAGB = laparoscopic adjustable gastric banding; LRYGB = laparoscopic Roux-en-Y gastric bypass; GJ = gastrojejunostomy; ARDS = adult respiratory distress syndrome; EWL = excess weight loss; NR = not reported; PE = pulmonary embolism; SSI = surgical site infection; NAGB = non-adjustable gastric band; VGB = vertical banded gastroplasty; LSG = laparoscopic sleeve gastrectomy; EBMI = excess body mass index loss; UTI = urinary tract infection; SG = sleeve gastrectomy; SAGB = silastic adjustable gastric band; BPD-DS = biliopancreatic diversion-duodenal switch; f/u = follow up; LL-RYGB = long-limb Roux-en-Y gastric bypass; TPN = total parenteral nutrition; BPD = biliopancreatic diversion

[62,63]. Occasionally, very high BMI patients are able to achieve satisfactory weight loss with the first stage only [64], but the option to proceed with the second-stage bypass procedure is available based on the patient’s weight, comorbidities, and risk [57].

*Vertical banded gastroplasty*

Vertical banded gastroplasty (VBG) was described by Mason [65] in 1982 as a simplified bariatric operation to provide lasting results due to reduced stomach capacity and delayed emptying from a fixed outlet at the distal end of the pouch. The original procedure consisted of creating a 50-mL pouch around a 32-French Ewald tube with a non-divided vertical staple line. The outlet of the vertical pouch was then reinforced with a permanent piece of banding material (Marlex mesh, polypropylene, or silastic ring). This procedure gained popularity due to initial weight loss and fewer nutritional side effects than RYGB [65].

Early reported weight loss after VBG was acceptable [66]; however, VBG patients often displayed maladaptive eating behaviors due to solid food intolerance and were unable to either achieve or sustain adequate weight loss in the long term. (5.0–61%) [33,67–72]. Reoperations for VBG most often include conversion to another bariatric procedure, most often RYGB, with appropriate postconversion weight loss.

Conversions to RYGB have been reported in up to 25–65% of patients after VBG [67,73], though others report lower conversion rates ranging from 4.4–8.0% [74,75]. The perioperative complication and mortality rates among patients who underwent conversion of VBG to RYGB ranged from 8.9–21.0% [69,75–77], and 0–2% [69,75–78], respectively. EWL at 31 months after conversion to RYGB has been reported to be 47% [74]. Mean preconversion BMIs ranged from 34.0–46.0 kg/m<sup>2</sup>, and postconversion BMIs ranged from 28.0–35.0 kg/m<sup>2</sup> [69,75–77,79,80]. In comparing patients who underwent corrective revision of VBG to those who had conversion of VBG to RYGB, subsequent further revisional procedures were observed in 32.2–68.0% of patients who underwent revision versus 0% in those converted to RYGB [67,81].

When converting VBG to SG, a leak rate of 14% has been reported, and the leak rate is 22% for patients undergoing VBG conversion to BPD/DS [8,82]. Conversions to open BPD [83,84] or open BPD/DS [21] have had mixed results. Laparoscopic conversions to BPD/DS have been performed only rarely after VBG [85]. The current evidence suggests that conversion of VBG to SG or BPD/DS should be approached with caution due to high complication rates.

**II. Treatment of acute and chronic complications after bariatric surgery**

*RYGB*

Conversion. Indications for conversion of RYGB to another procedure are primarily related to weight regain

or recurrence of co-morbid disease, but rare metabolic derangements of the primary operation (refractory neuroglycopenia, recalcitrant hypocalcemia with associated hypoparathyroidism, and severe malnutrition) may require conversion of RYGB to SG or BPD/DS, or original anatomy [86,87]. These reports demonstrate technical feasibility and short-term results of these 1- or 2-stage conversion procedures.

#### *Corrective treatment of acute complications*

**Gastrointestinal leak.** The incidence of anastomotic leak is 0–5.6% [88–92]. Anastomotic leaks most commonly occur at the gastrojejunostomy and often occur within the first 5 days after surgery [88]. Causes of leaks can be multifactorial [93]. Gastrojejunal leaks are most commonly detected with imaging studies such as an upper gastrointestinal contrast study or computed tomographic (CT) scan. Management of leaks includes fluid resuscitation and intensive care unit admission in the septic patient, antibiotics, operative management with control of the leak and drainage of infected fluid collections. There is a role for nonoperative management with percutaneous drainage (if needed), antibiotics, and nutritional support in a clinically stable patient [88,92]. Endoscopic therapy (stenting) is appropriate to facilitate closure of the leak after appropriate control of sepsis has been obtained [94,95]. Leaks at the jejunojunostomy (JJ), gastric remnant, or other bowel typically present later or have a delayed time to recognition [88]. Treatment is surgical management to close or control the leak with wide drainage.

**Obstruction/stricture.** Early postoperative bowel obstruction (<30 d after surgery) occurs in 0–1.2% of patients after RYGB [7,96]. Early postoperative bowel obstructions after RYGB usually result from a mechanical obstruction that requires reoperation [96,97]. Kinking of the bowel, intraluminal clots or distal adhesions can cause an early small bowel obstruction and jeopardize the integrity of the newly constructed GJ and JJ anastomoses. A dilated biliopancreatic limb or gastric remnant adds to the urgency of operative repair to identify the source of obstruction and decompress the biliopancreatic limb and gastric remnant. Obstruction at the JJ with decompressed biliopancreatic limb can be treated with construction of another JJ between the Roux limb and the common channel. Management of small bowel obstruction in a patient with history of gastric bypass differs from the typical management of adhesive small bowel obstruction. Because internal hernias and closed loop obstructions occur more commonly after RYGB compared to the general surgery patient and post-RYGB have a biliopancreatic limb and gastric remnant that cannot be decompressed with a nasogastric tube, nonoperative management can lead to bowel ischemia, perforation, and poor clinical outcomes. A low threshold to operate must be maintained in a post-RYGB with severe abdominal pain or

imaging suggesting an obstruction, regardless of the time interval since their gastric bypass.

There is wide variability in the reported incidence of anastomotic strictures, ranging from 1.4–23.0% of patients [98–104]. Strictures can be associated with anastomotic ulceration, nonsteroidal anti-inflammatory drug (NSAID) use, and smoking [105–107]. Anastomotic strictures typically occur within the first 3 months after surgery and are effectively treated with 1–3 sessions of endoscopic balloon dilation. Strictures that occur late (>6 mo) are more refractory to endoscopic therapy and may require surgical revision if they are unresponsive to endoscopic therapy [17].

**Bleeding.** Bleeding requiring transfusion or reoperation occurs in 1–4% of patients after RYGB [89,108–112]. Bleeding can be intra-abdominal or arise within the gastrointestinal tract from an anastomosis or staple line. Treatment of intra-abdominal bleeding in an unstable patient is laparoscopic or open re-exploration and control of the bleeding source. In a stable patient, fluid resuscitation and transfusion with blood products and close clinical observation are appropriate [113]. Gastrointestinal bleeding can present as hematemesis or hematochezia [114]. Treatments of gastrointestinal bleeding often require combined endoscopic and surgical approaches [113,114].

#### *Corrective treatment of chronic complications*

**Ulcer.** Ulcers at the GJ, also referred to as marginal ulcers, occur 1.0–16% of the time after RYGB [115–121]. Early causes include ischemia or tension at the anastomosis. Other associated factors include smoking, NSAID, and steroid use, *Helicobacter pylori* infection, large pouch or a gastrogastic fistula [120]. Symptoms include epigastric pain, nausea, and vomiting. Patients who develop these symptoms or gastrointestinal bleeding after RYGB should have an upper endoscopy performed to evaluate for marginal ulcer. Although rare, ulcers can also occur in other segments of the gastrointestinal tract. Initial treatment is with medical therapy including acid suppression, sucralfate, and elimination of modifiable risk factors such as use of NSAIDs, steroids, tobacco, and caffeine products. Ulcers that are causing severe chronic pain, malnutrition, or bleeding may require surgical resection and revision of the GJ or closure of a gastrogastic fistula if present. Perforation of a marginal ulcer requires urgent surgical treatment [121].

**Fistula.** Fistulas can occur between the gastric pouch and the gastric remnant (gastrogastic fistula) in 1–2.6% of cases [122]. Gastrogastic fistulas may need to be surgically corrected if they are large enough to contribute to weight gain, associated with ulcers, gastroesophageal reflux disease (GERD), or pain [123]. Other gastric or enteric fistulas that do not close with bowel rest and nutritional support will require surgical management [124].

**Obstructions.** Late small bowel obstructions (SBO) can occur in 1.3–4.5% of patients after RYGB [125–130]. Obstructions

can be due to surgical adhesions (more common after open RYGB or prior open abdominal surgery) or an internal hernia (more common after laparoscopic RYGB) [125–127]. Other causes include small bowel intussusception, bezoars, port site hernias, and transverse mesocolic hernias (after a retrocolic Roux limb) [127]. Diagnosis is made with plain film radiographs and CT scan or at the time of surgery. In the setting of a complete obstruction, internal hernia on radiographic imaging, closed loop obstruction, or significant dilation of the biliopancreatic limb and gastric remnant, surgical treatment is indicated to correct the cause of the obstruction and possibly resect any nonviable bowel. Gastrostomy tube placement to provide decompression of the gastric remnant may be indicated.

Additionally, intermittent or chronic abdominal pain after RYGB in a patient with nondiagnostic imaging should warrant diagnostic laparoscopy or laparotomy to evaluate for an internal hernia or open mesenteric defects.

### Reversal

Indications to reverse RYGB are extremely rare and include, but are not limited to, severe intractable nausea, vomiting, excessive weight loss, psychological issues, chronic pain, recurrent anastomotic ulceration, and malnutrition related to a chronic complication of the procedure. Rare complications of RYGB that may necessitate reversal are severe neuroglycopenia, and recalcitrant hypocalcemia associated with hypoparathyroidism that is refractory to dietary and medical management; however, conversion to a SG may resolve the problem [131–133]. Additionally, patients who have extensive bowel resections after an abdominal catastrophe (internal hernia, volvulus of a long segment of small bowel) may require reversal of the bypass to obtain greater overall bowel continuity [134].

### Nonadjustable gastric banding

Nonadjustable gastric banding is no longer considered a standard bariatric procedure. Patients may present, however, with a remote history of band placement and require reoperation. Indications for band removal or conversion to another procedure include but are not limited to intractable nausea, vomiting, food intolerance, erosion, GERD, weight gain, or co-morbidity recurrence. The placement of a nonadjustable ring around the gastric pouch at the time of RYGB can also result in these symptoms and complications. The type of reoperative procedure performed (band removal, proximal gastrectomy with RYGB) is generally left to the discretion of the surgeon based on the type of band, presence of complications, and patient risk.

### LAGB

*Corrective treatment of acute complications.* Obstruction. The incidence of early postoperative obstruction after LAGB placement is .5–11.0% [135–137]. Causes of an early

postoperative obstruction include an over tight band, a large gastroesophageal fat pad within the band, postoperative edema, perigastric hematoma, acute gastric prolapse, or food impaction at the level of the band. Treatment may include removal of fluid from the band, a period of observation, removal of the band, replacement with a larger band, or endoscopic removal of impacted food. Acute gastric prolapse may present with severe abdominal pain and obstruction. If a prolapse is demonstrated on imaging and the pain is not relieved after removal of fluid from the band system, urgent surgical removal of the band is indicated to prevent ischemia or necrosis of the prolapsed stomach.

*Perforation.* The incidence of gastric or esophageal perforation at the time of band placement is <1% [138–142]. Causes of perforation include iatrogenic injury during band placement or a tear in the gastrogastric plication at the site of a suture (related to vomiting). Treatment is surgical and includes laparoscopic or open removal of the band, repair of the perforation if possible, drainage, and antibiotics.

*Corrective treatment of chronic complications.* Prolapse/pouch dilation. The incidence of prolapse or pouch dilation is .4–8.0% [140,143–146]. When a true band slippage/prolapse occurs, the treatment is usually surgical, with many authors suggesting band reposition or band removal with conversion to an alternate procedure. For the patient with successful weight loss and co-morbidity reduction after banding, salvaging the slipped band with replacement or repositioning has been reported to maintain the weight loss effects [20,53]. However, when the patient has not successfully achieved or maintained weight loss, removal of the LAGB and conversion to an alternate procedure such as SG or RYGB may be indicated [35,145,147–150]. Pouch dilation can be treated initially with band deflation and conservative management. Some of these patients may not lose additional weight or may experience weight gain and will require band removal and conversion to another procedure.

*Band intolerance.* Band intolerance occurs in approximately .6–6.2% of patients [53,143,151]. It is heralded by intrusive obstructive symptoms such as vomiting, esophageal spasm, and GERD in a patient that is not overly restricted (based on volume or imaging). If associated with poor weight loss or co-morbidity reduction, band removal and conversion is indicated. Some patients may not experience severe obstructive symptoms but may develop chronic esophageal dysmotility, esophageal dilation or mega-esophagus due to an over tight band or a band that is too small. These findings warrant removal of the band or conversion to another procedure [53,143,147].

*Erosion.* Incidence of band erosion is 0–6.8% [35,36,137,145,147,152,153]. When this occurs, the treatment is band removal. The methods of removal include endoscopic, endoscopic/laparoscopic, or laparoscopic. After removal, patients will require conversion to another bariatric procedure to treat their obesity and co-morbid disease.

It is optimal to wait at least 3 months before conversion to another procedure to allow the perigastric inflammation to resolve. Placing another band after an erosion is generally not recommended [36].

**Port and tubing problems.** The incidence of port or tubing complications is 4.3–24% [154–156]. The most common problems in this regard are tubing leak and port dislocation. These are usually treated by replacing the tubing/port that is damaged or refixation of the dislocated port [154,155].

**Gastroesophageal reflux.** Post-LAGB, GERD may be exacerbated, or new-onset GERD can occur, with a long-term prevalence of 33.3% cited at 7 years postoperatively [157]. Intractable reflux is usually managed with band deflation and conservative management. If there is pouch dilation associated with hiatal hernia and intractable symptoms, or the symptoms are not controlled with band adjustments, the patient may require reoperation for band reposition/hiatal hernia repair versus conversion to RYGB [23,24,40,158]. Chronic GERD requiring band deflation may necessitate conversion to RYGB to treat the GERD and associated weight gain.

**Reversal.** Removal of the band is an acceptable option for the treatment of complications, band intolerance, or ineffective weight loss. While rare, there is occasion when the best approach is to restore the preband surgical anatomy. Common indications for reversal of adjustable gastric band include intractable nausea and vomiting, intractable dysphagia, intractable GERD, adjustable gastric band erosion, chronic or acute adjustable gastric band infection, esophageal dilation, or insufficient weight loss without desire for alternate procedure [148,152].

## SG

**Corrective treatment of acute complications.** **Leak.** Staple line leaks or gastric perforation occur in .5–5.8% of SG cases [159–161]. Patients with an early postoperative leak present with abdominal pain, fever, and sepsis. Treatment includes control of sepsis with percutaneous or operatively placed drains, closure of the perforation if possible, antibiotics, and nutritional support. Endoscopic stent placement to cover the site of perforation and facilitate closure is appropriate once measures are taken to control any intra-abdominal abscesses or collections [160–162].

**Obstruction/stricture.** Early obstruction most commonly occurs at the angularis incisura. Causes include edema, angulation at the incisura, or creation of a lumen that is too narrow. Treatment includes supportive therapy, endoscopic dilation or stenting, and, if obstruction persists, conversion to RYGB.

**Corrective treatment of chronic complications.** **Gastroesophageal reflux.** There is a 20–30% incidence of GERD in the long term after SG [54,163]. Factors associated with developing GERD after SG include hiatal hernia with transhiatal migration of the stomach, retained or dilated

gastric fundus, a stricture or angulation of the stomach at the incisura, or de novo reflux due to an incompetent lower esophageal sphincter in the setting of normal SG anatomy. Treatment is initially medical with acid suppression but if symptoms are refractory to medical therapy or if there is an associated anatomic etiology for the GERD, surgical revision may be required. This problem can be corrected with conversion to RYGB, though resection of the dilated fundus with repair of a hiatal hernia (if present) has been reported [54] and may be appropriate for patients that are not good candidates for RYGB.

**Late or recurrent leak.** Late leaks can occur months after SG and early leaks that appear to heal can recur weeks or months later. These may present as a recurrent abscess or a fistula (gastrocutaneous, gastropleural, gastrosplenic). Management of these late or chronic fistulas requires drainage of any abdominal collections, endoscopic therapy (stenting), and occasionally surgical treatment. Surgical options include resection of the fistula and the involved stomach, conversion to Roux-en-Y gastrojejunostomy, esophagojejunostomy, or fistulojejunostomy depending on the location and character of the fistula and condition of the stomach.

**Stricture.** Incidence of late stricture is 1.3–25% after SG [164]. This obstruction presents with severe dysphagia, solid food intolerance, or severe GERD. Treatment options include endoscopic dilation and stenting and resection of the stricture with conversion to a RYGB to alleviate the symptoms [160,161,164–166].

## VBG (or other nonbanded gastroplasty)

**Corrective treatment of chronic complications.** Patients require corrective surgery after VBG due to dysphagia, band erosion [67], staple line disruption (6.3–83.3%), GERD [68,76,167–170], and incisional hernias (5.6–16.0%) [68,171]. In studies with long-term (>5 yr postoperative) follow-up, reoperation rates have been observed between 10.0–56.0% [66,81,172]. Corrective surgical options to treat complications include revising the VBG (refixation/band replacement/restapling); however, many VBG operations are converted to RYGB as revising the VBG does not eliminate the potential mechanical complications of the operation and produces less weight loss than a conversion procedure. It should be noted that many VBG patients present with long-term mechanical complications (severe GERD) and weight gain requiring additional therapy.

**Reversal.** For patients with severe GERD or food intolerance who do not want a revision to RYGB or are not appropriate candidates for conversion to another procedure, reversal of VBG may be appropriate [173,174]. Performance of a gastrogastrostomy or removal or division of the band can be performed to provide symptom relief. Some patients also require endoscopic interventions for band or

mesh removal if this prosthetic material has eroded into the gastric lumen and is causing obstructive symptoms.

#### *Biliopancreatic diversion with or without duodenal switch*

**Corrective treatment of acute complications.** Approximately 2% of patients currently undergo BPD/DS as a primary operation in the United States. Early postoperative complication rates after BPD/DS are 2.9–16.3% [175,176]. These include anastomotic leaks, bleeding, strictures, and obstruction. The management of these early complications when they occur can be surgical or nonsurgical as described in the management of acute complications after RYGB. The specific management depends on the timing and severity of the complication and the clinical condition of the patient.

**Corrective treatment of chronic complications.** Protein-calorie malnutrition. The incidence of protein-calorie malnutrition after BPD or BPD/DS ranges from 1–6% [177–179] depending on the length of the common channel. Excessive reduction of the stomach size can also result in reduced oral intake and contribute to protein-calorie deficiency in the early months after a BPD/DS. Malnutrition after BPD/DS requires a careful nutritional evaluation and initial management should include the addition of oral pancreatic enzymes and nutritional support (enteral or parenteral if necessary) to improve protein stores before any revision. If these measures are not sufficient to improve weight and protein stores, surgery may be indicated to lengthen the common channel and increase the common channel absorptive capacity. This surgical revision is rarely necessary and is generally most helpful in patients with a common absorptive channel <100 cm in length. The intestinal limbs can be revised by creating a proximal enteroenterostomy between the biliopancreatic limb and the alimentary limb.

**GERD.** As with the SG alone, the sleeve portion of the DS operation can result in chronic GERD [54,163]. Conversion to RYGB to control these symptoms is not a favored option anatomically due to the extensive reconstruction involved and associated risks. If behavioral and medical control of GERD fails, and the gastric capacity is large or if there is dilated or retained fundus contributing to refractory GERD symptoms, a resleeve or fundectomy operation is has been reported to control the symptoms [54].

**Jejunioleal bypass.** Jejunioleal bypass is no longer performed due to the well-documented long-term complications. Reversal or conversion of jejunioleal bypass to SG or RYGB should be considered to prevent cirrhosis, oxalate nephropathy and renal failure, and chronic malnutrition [180]. If reversal or conversion is not indicated, regular follow-up and evaluation for metabolic complications must be continued.

## Conclusions and future directions

The current evidence regarding reoperative bariatric surgery includes a diverse group of patient populations and procedures. The majority of the studies are single institution case series reporting short- and medium-term outcomes after reoperative procedures. The reported outcomes after reoperative bariatric surgery are generally favorable and demonstrate that additional weight loss and co-morbidity reduction is achieved with additional therapy. The risks of reoperative bariatric surgery are higher than with primary bariatric surgery and the evidence highlights the need for careful patient selection and surgeon expertise. The specific type of reoperative procedure performed should be based on the primary operation, the patient's anatomy, the patient's weight and co-morbidities, and the experience of the surgeon.

Based on the Task Force's review of this complex issue and careful evaluation of the quality and content of the available evidence, additional guiding principles and future directions to clarify this topic are offered:

1. Morbid obesity is a chronic disease and acceptable long-term management after a primary bariatric procedure should include the surgical options of conversion, correction, or other adjuvant therapy to achieve an acceptable treatment effect in cases of weight recidivism, inadequate weight loss, inadequate co-morbidity reduction, or complications from the primary procedure.
2. "One bariatric procedure per lifetime" and other coverage policies that limit or prohibit reoperative bariatric surgery are not consistent with coverage policies provided for any other chronic disease process, and should be abandoned where they exist.
3. Short- and long-term outcomes after bariatric surgery should be reported as part of an accreditation or quality improvement program. As the number of reoperative bariatric procedures increases, ongoing data collection will be required to provide future recommendations regarding the efficacy and durability of specific reoperative procedures.
4. Outcomes of reoperative bariatric surgery are inconsistently reported in the literature. Arbitrary definitions of success and failure after bariatric surgery based on EWL do not accurately reflect control of the disease and vary widely based on the population being studied. If the disease of morbid obesity or obesity-related disease is still present after primary therapy, additional therapy is indicated.
5. Reoperative bariatric procedures should be performed by experienced bariatric surgeons in bariatric centers that have the resources to manage these challenging patients and can provide early rescue to patients who potentially develop postoperative complications.

## Disclosures

*The authors have no commercial associations that might be a conflict of interest in relation to this article.*



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