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ORIGINAL CONTRIBUTIONS

Conversion of Laparoscopic Adjustable Gastric Banding to Gastric Bypass: a Comparison to Primary Gastric Bypass

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Abstract

Introduction Laparoscopic adjustable gastric banding (LAGB) has a considerable failure rate. Laparoscopic Roux-en-Y gastric bypass (LRYGB) is one of the rescue options. This study aims to compare the complication rates and outcomes between LAGB converted to LRYGB and primary LRYGB.

Materials and Methods A retrospective analysis was performed in all patients converted from LAGB to LRYGB between January 2007 and March 2017. This group was compared to a matched cohort of primary LRYGB patients operated during the same period. Early and late complications, weight loss, and improvement of comorbidities were analyzed.

Results One hundred sixty-one revisional LRYGB patients were compared to a similar number of primary LRYGB patients. Preoperative age, gender distribution, weight, and BMI were comparable. Mean operative time was longer in the revisional group (137.7 vs. 112.7 min, respectively, $P < 0.001$). The overall early complication rates were comparable between the groups (7.5 vs. 11.8%, $P = 0.16$), including postoperative leak rate (0.62%). Follow-up of at least 6 months was attained in 78% of the patients. Revisional cases demonstrated less weight loss (61.5 vs. 73.5%EWL, respectively, $P = 0.004$) and slightly less improvement of comorbidities (75.0 vs. 85.7%, respectively, $P = 0.09$). The late complication rate was comparable (8.1 vs. 8.1%, $P = 1.0$).

Conclusion Albeit longer operating time, revision of LAGB to LRYGB is a safe procedure, with similar complication rates when compared to primary LRYGB. Although revisional LRYGB does result in less weight loss than primary LRYGB, the procedure's safety makes it a very plausible option as a rescue operation for failed LAGB.

Keywords Failed LAGB · Revision · Gastric bypass · LRYGB · Complications

Introduction

Morbid obesity is a disease of increasing prevalence worldwide, and surgery is its only proven long-term treatment [1, 2]. One of the once most commonly practiced bariatric procedures was laparoscopic adjustable gastric banding (LAGB); however, high long-term failure rates have been associated with this operation, reported to be as high as 40–50% [1, 2]. As a consequence, the incidence of revisional surgery after LAGB reaches 20–40% [2–5].

Several factors may contribute to the failure of LAGB, including pouch dilation, food intolerance, gastroesophageal reflux disease (GERD), band slippage, esophageal dilatation, band erosion, band leak, infection, pseudoachalasia, failure of weight loss, or weight regain [1, 2]. Several revisional options have been proposed; however, there is no consensus regarding the procedure of choice. The most common revisional procedures include laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB).

At our institution, the revisional procedure of choice after failed LAGB has evolved to LRYGB for several reasons. Unlike LAGB and LSG, in addition to being restrictive in nature, this procedure has some hormonal and malabsorptive elements. In comparison to LSG, it is an excellent solution for GERD—a burden to a large proportion of these patients [6–8]. Finally, the performance of gastric bypass after failed banding avoids the need to create a staple line through the area adjacent

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to the previously scarred gastroesophageal junction (GEJ) and angle of His, theoretically decreasing the likelihood of postoperative complications, such as leak and stenosis.

Although some previous studies have shown significantly higher intraoperative and postoperative complication rates in patients undergoing LRYGB after failed LAGB, when compared to those undergoing primary LRYGB, it is our observation, and that of other studies, that these complication rates are quite similar to those of patients undergoing LRYGB as an initial bariatric procedure [9–11]. The purpose of this study was to evaluate the complication rates and outcomes of patients who underwent LRYGB after failed LAGB at our institution and to compare this group to a similar cohort of patients undergoing primary LRYGB.

Materials and Methods

A retrospective review of our prospectively maintained bariatric database was performed of all patients who underwent revisional surgery from LAGB to LRYGB at our institution from January 2007 to March 2017. This group of patients was matched, by gender, age, weight, and body mass index (BMI), by a 1:1 ratio to a randomly selected group of patients undergoing primary LRYGB at our institution during the same time period. The study was approved by our institution's ethics review board. Due to the retrospective nature of the investigation, no informed patient consent was required. All procedures performed in the study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All procedures were performed by two experienced minimally invasive surgeons. Preoperatively, all patients underwent assessment by our specialized multidisciplinary team, which includes a bariatric surgeon, a bariatric dietitian, and a clinical psychologist. All patients who underwent primary LRYGB met the minimal criteria for bariatric surgery (BMI higher than 40 kg/m^2 or higher than 35 kg/m^2 with obesity-related comorbidities) as proposed by the NIH Consensus Development Panel report of 1991 [12]. A minor proportion of the revisional cases did not meet these criteria, but were operated due to complications of LAGB.

All patients within the adult age group (≥ 18 years) undergoing revision from LAGB to LRYGB were included in the study. This cohort of patients served as the study group. As mentioned, the control group was formed from adult patients undergoing primary LRYGB. This cohort of patients was randomly selected by a single investigator, who had access to a list of operated primary bypass patients, which included demographic and preoperative data, but not operative and postoperative results, in order not to compromise the integrity of the study. Exclusion criteria for both groups included age < 18 years, pregnancy, alcohol or substance abuse, current malignancy, and the presence of predisposing endocrinologic causes for obesity (including hypercortisolism and untreated hypothyroidism). Patients undergoing LRYGB as a revisional procedure after failure of any bariatric surgery other than LAGB were also excluded from the study.

The majority of revisional procedures were performed in a one-stage fashion. Certain circumstances in which a two-stage revision was executed included patients presenting acutely with gastric band slippage, as well as cases in which the surgeon's intraoperative impression was that the quality of the gastric wall would jeopardize the anastomosis and staple lines (due to fibrosis, tissue trauma, or inflammation). In addition, patient preferences and bureaucratic issues led to the performance of a two-stage revision in a minority of patients.

The patients' data were reviewed for baseline demographic information, including age, gender, preoperative obesity-related comorbidities, and BMI. The time interval between the LAGB insertion and revisional LRYGB was calculated and the indication for revisional surgery was cited. Operative data and length of hospital stay were reviewed. The primary outcome included early complication rate (within 30 days postoperatively). Secondary outcomes included the occurrence of late complications (after 30 days postoperatively), weight loss (as demonstrated by percent of excess weight loss—%EWL), and the improvement or resolution of comorbidities.

The operative technique for primary LRYGB has been previously described [5, 10]. In the revisional group, the gastric pouch was constructed by dividing the stomach 2–3 cm distal to the band-related fibrotic capsule and 0.5–1 cm lateral to it at the angle of His, creating a pouch of roughly 25–35 mL. In both primary and revisional cases, a Roux limb of 150 cm and a biliopancreatic limb of 100 cm were formed. The gastrojejunal anastomosis was created using a linear stapler (45 mm) and a hand-sewn common enterotomy, while the jejunojejunostomy was totally stapled. For all patients, a strict postoperative standardized protocol was followed. On the first postoperative day, a Gastrografin upper gastrointestinal swallow was performed, followed by a plain abdominal X-ray to assess the passage of contrast material across the jejunojejunostomy. If no leak was demonstrated and if the patient was in satisfying clinical condition, liquid diet was initiated on the second postoperative day. After subsequent removal of the two operative drains, the patients were discharged on the third postoperative day. Patients were followed up at our multidisciplinary bariatric clinic 10 days after discharge, and then 1, 6, and 12 months postoperatively. Subsequently, yearly clinic visits were recommended, and included examination by a bariatric surgeon and dietitian, with review of recent blood tests. All patients were advised to initiate physical activity and received postoperative and subsequent dietary recommendations.

Statistical analysis was performed using SPSS version 20 (SPSS, Inc., Chicago, IL), and univariate analysis with *t* test was utilized to compare between the various subgroups. A *p* value of < 0.05 was considered statistically significant for all comparisons.

Results

Between January 2007 and March 2017, 402 LRYGB surgeries were performed at our institution; of these operations, 161 (40.0%) were revisional procedures from LAGB. This study group was compared to a matched control group of 161 primary LRYGB patients. The preoperative data of both study groups is summarized in Table 1. The prevalence of baseline comorbidities was higher in the group of patients undergoing primary surgery ($P < 0.001$).

The indications for revision included weight regain/lack of weight loss (67.7%), vomiting (32.3%), GERD (14.3%), band slippage (12.4%), band tubing leak (4.3%), infections (3.1%), and gastric erosion caused by the band (1.2%). The mean time from LAGB to revisional surgery was 8.5 ± 3.6 years, with a range of 0.9 to 20 years. The majority of the patients, 75.2% (121/161), underwent gastric band removal and LRYGB during the same operation. Of the 40 patients who underwent gastric band removal and LRYGB in two separate operations, the mean time between the operations was 2.3 ± 2.5 years (median 1.1 years; range 1 month to 8.9 years). In this particular subgroup, the indication for band removal was slippage in 37.5%.

Upon analyzing operative data, the mean operative time was found to be significantly longer in the revisional LRYGB group when compared to that of the primary LRYGB group (137.7 ± 42.3 vs. 112.7 ± 35.7 min, respectively, $P < 0.001$). Adhesions were more commonly encountered intraoperatively in the revisional group (57.1 vs. 12.5%, $P < 0.001$); however, a comparable number of concomitant cholecystectomies (9.9 vs. 11.8%, $P = 0.67$) and hiatal hernia repairs (4.3 vs. 5.0%, $P = 0.95$) were performed.

The overall early complication rate was comparable between the two groups. No intraoperative complications were reported in either group, nor were any cases of conversion from laparoscopic to open surgery. There was no mortality in both groups. One leak was demonstrated in each group, both from the gastrojejunal anastomosis. Table 2 summarizes the comparison of the primary outcome between the study groups.

Of the 322 patients, a follow-up of more than 6 months was attained in 78%. Table 3 summarizes the postoperative weight loss in both groups, after a mean duration of follow-up of 19.4 ± 13.7 and 21.6 ± 13.6 months, respectively, for the revisional and primary LRYGB groups. Postoperative weigh loss was significantly lower in the revisional LRYGB group; however, this group achieved a %EWL of 61.5%.

The general improvement or resolution of comorbidities was slightly lower in the revisional surgery group when compared to that of the primary LRYGB group ($P = 0.09$). The improvement or resolution of DM was comparable between the two groups; however, that of HTN and hyperlipidemia/hypercholesterolemia was significantly more prominent in the primary LRYGB group when compared to that of the revisional LRYGB group (Table 4).

As demonstrated in Table 5, the rate of late complications was comparable between both groups. However, the rate of readmission to the hospital was significantly higher after primary LRYGB.

Discussion

Although once a frequently performed bariatric procedure, LAGB has largely lost its popularity over the past decade due to its relatively high long-term complication rates and poor weight loss results [1–4, 13, 14]. Due to the surgery's

Table 1 Baseline preoperative data

	Revisional LRYGB	Primary LRYGB	*P* value
Mean age (years)	43.1 ± 9.8	43.1 ± 12.0	0.96
% female	69.1%	69.1%	1.0
Preoperative weight (kg)	118.6 ± 22.2	118.9 ± 23.2	0.91
Preoperative BMI (kg/m^2)	42.5 ± 5.9	43.4 ± 6.8	0.18
Presence of comorbidities	58.4%	78.9%	< 0.001
DM	26.1%	55.9%	< 0.001
HTN	27.3%	47.7%	0.001
Hyperlipidemia/hypercholesterolemia	25.5%	52.2%	< 0.001
OSA	9.3%	11.2%	0.51

When relevant, the standard deviation is represented as ± SD

LRYGB laparoscopic Roux-en-Y gastric bypass, *BMI* body mass index, *DM* diabetes mellitus, *HTN* hypertension, *OSA* obstructive sleep apnea

Table 2 Early postoperative complications (within 30 days postoperatively)

	Revisional LRYGB (%)	Primary LRYGB (%)	*P* value
Overall early complication rate	7.5	11.8	0.16
Intraoperative complications	0	0	1.0
Conversion from laparoscopic to open operation	0	0	1.0
Anastomotic leak	0.62	0.62	1.0
Major bleeding	2.5	5.0	0.17
PE	0.62	0.62	1.0
Pneumonia	0	3.1	0.08
Arrhythmia	1.2	1.2	1.0
UTI	0	0.62	0.16
Dysphagia	0.97	2.9	0.31
Bowel obstruction (early)	1.9	0.62	0.19
Re-operation within 1 month	4.3	2.5	0.36
Emergency room visits	10.6	7.5	0.28
Re-hospitalizations	9.3	5.6	0.41

Early postoperative complications included leak, major bleeding, surgical site infections, dysphagia, pneumonia, PE, UTI, arrhythmias, syncope, bowel obstruction, and re-operation

LRYGB laparoscopic Roux-en-Y gastric bypass, *PE* pulmonary embolism, *UTI* urinary tract infection

previous popularity, bariatric surgeons are now commonly faced with the dilemma of which revisional bariatric procedure to perform after LAGB failure. This current study demonstrates the safety of LRYGB as a revisional option for failed LAGB. Its strength lies in the fact that it evaluates a large number of patients that underwent revisional surgery from LAGB to LRYGB at a single institution and compares these patients to a matched cohort of primary LRYGB patients, in a case-control fashion.

Some reports in the literature have associated revisional LRYGB after LAGB failure with a significantly increased rate of adverse effects when compared with primary LRYGB. Worni et al. published a large, retrospective, population-based study, in which 63,171 primary bypass patients were compared to 301 patients undergoing a gastric band-related reoperation with concomitant gastric bypass [11]. In patients undergoing a revisional LRYGB, a significantly higher intraoperative complication rate was demonstrated compared to patients undergoing a primary gastric bypass (risk-adjusted odds ratio (OR) 2.3, $P = 0.002$). In addition, the risk of postoperative complications was higher in this group (risk-adjusted OR 8.0, $P < 0.001$), as was the risk of re-interventions or reoperations (risk-adjusted OR 6.0, $P < 0.001$). There were also significantly higher hospital charges and an increased length of hospital stay in this group. Carandina et al. published a series of 108 patients undergoing revisional bariatric surgery after failure of LAGB [15]. Conversion to LRYGB was performed in 74 (68.5%) patients, and to LSG in 34 (31.5%) patients, and all procedures were performed in a two-stage fashion. A significantly higher postoperative complication rate was shown in patients undergoing conversion to LRYGB when compared to those undergoing conversion to LSG (16.2 and 2.9%, respectively, $P = 0.04$). Higher percentage of EWL at 12 and 24 months, however, was demonstrated in patients undergoing LRYGB.

In contrast to the above-cited articles, this study demonstrates that patients undergoing revisional LRYGB after failure of LAGB have similar complication rates and postoperative courses when compared to patients undergoing LRYGB as a primary bariatric operation. This finding has been

Table 3 Postoperative weight loss

	Revisional LRYGB	Primary LRYGB	*P* value
Mean preoperative weight (kg)	118.6 ± 22.2	118.9 ± 23.2	0.91
Mean preoperative BMI (kg/m^2)	42.5 ± 5.9	43.4 ± 6.8	0.18
Mean postoperative weight (kg)	90.2 ± 18.8	84.4 ± 16.6	0.01
Mean postoperative BMI (kg/m^2)	32.4 ± 5.3	30.8 ± 5.0	0.01
Mean %EWL	61.5 ± 34.1	73.5 ± 32.0	0.004
Mean follow-up (months)	19.4 ± 13.7	21.6 ± 13.6	0.22

When relevant, the standard deviation is represented as ± SD

LRYGB laparoscopic Roux-en-Y gastric bypass, *BMI* body mass index, *%EWL* percentage of excess weight loss

Table 4 Postoperative improvement or resolution of comorbidities

	Revisional LRYGB	Primary LRYGB	*P* value
Overall improvement or resolution of at least one comorbidity	75.0% (45/60)	85.7% (90/105)	0.09
Improvement or resolution of DM	78.1% (25/32)	80% (64/80)	0.83
Improvement or resolution of HTN	30.8% (8/26)	55.2% (37/67)	0.03
Improvement or resolution of hyperlipidemia/hypercholesterolemia	36.7% (11/30)	61.8% (42/68)	0.02

LRYGB laparoscopic Roux-en-Y gastric bypass, *DM* diabetes mellitus, *HTN* hypertension

supported by previous publications. Thereaux et al. compared between 831 patients who underwent primary LRYGB and 177 patients who underwent a revisional LRYGB after failure of LAGB [13]. Similar rates of major adverse outcomes in the first 30 postoperative days were shown between the two groups (7.8 and 8.5%, respectively, $P = 0.77$). Jennings et al. published a series of 722 patients undergoing LRYGB, 55 of which were revisional surgeries after failure of LAGB [16]. No difference was demonstrated in morbidity, mortality, or duration of hospitalization, between patients who underwent revisional surgery and those who underwent primary LRYGB. In addition, no statistically significant difference in postoperative weight loss trends was seen at 6, 12, and 24 months. Slegtenhorst et al. compared 66 revisional LRYGB patients with 226 primary LRYGB patients, also demonstrating no statistically significant difference in rate of complications (14.7 and 15.2%, respectively, $P = 0.962$) or in hospitalization time [17]. Delko et al. published a case-matched analysis, comparing 48 revisional gastric bypass operations to 48 primary gastric bypass operations [18]. Similarly, no difference in early and late complication rates was demonstrated between the two groups.

The majority of our patients (75.2%) underwent gastric band removal and LRYGB in the same operation. Several publications have demonstrated the safety of conversion from LAGB to LRYGB in a single-step procedure [19]. Aarts et al. published a series of 195 patients who underwent band removal and conversion to gastric bypass in one procedure [10]. A perioperative complication rate of 9% was reported in these patients, a rate comparable to that in primary bypass cases from other publications [13, 17]. Ramly et al. recently published a study analyzing patients from the American College of Surgeons' National Surgical Quality Improvement Program (ACS-NSQIP), comparing 64,866 primary LRYGB procedures with 1212 procedures in which LRYGB was performed along with LAGB removal [9]. LRYGB with LAGB removal was not associated with higher morbidity and mortality when compared to primary LRYGB, and it was concluded that it can be performed safely as a one-stage procedure. Advantages of a single-step procedure include less hospital stay, cost benefits, and the lack of a period between the two operations in which the patient may potentially gain weight.

It has been proposed by some that LSG is a safe option for revisional bariatric surgery after failure of LAGB [3, 20–22]. Janik et al. reported a postoperative leak rate of 1.18% in patients undergoing revision from LAGB to LSG, compared to a leak rate of 2.07% in those undergoing revision to LRYGB ($P = 0.07$) [23]. Similarly, Noel et al. demonstrated similar leak rates in patients undergoing revision from LAGB to LSG and those undergoing primary LSG [24]. Other reports have shed doubt on the procedure's safety. In Yazbek et al.'s investigation of 90 revisional LSG patients after LAGB, the procedure was advocated as a good bariatric option for failed LAGB [21]. However, in this cohort of patients, a relatively high leak rate of 5.5% was reported, a rate definitely not comparable to that of primary LSG. In Goitein et al.'s study, a leak rate of 7.7% was demonstrated when a one-stage band removal and LSG was performed [25]. Similarly, Stroh et al.

Table 5 Late postoperative complications (after 30 days postoperatively)

	Revisional LRYGB (%)	Primary LRYGB (%)	*P* value
Overall late complication rate	8.1	8.1	1.0
Small bowel obstruction	1.2	1.9	0.95
Gastro-gastric fistula	1.2	1.2	1.0
Marginal ulcer	2.5	3.1	0.56
Trocar-site hernia	0	1.2	0.08
Documented anemia	2.5	2.5	1.0
Emergency room visits	16.1	23.6	0.08
Re-hospitalizations	13.0	23.0	0.02

LRYGB laparoscopic Roux-en-Y gastric bypass

demonstrated a 4.4% leak rate when band removal and LSG is performed [26]. This high leak rate seems to be secondary to the scar or capsular tissue that is commonly present at the GEJ and angle of His after band removal, and the fact that if a proper LSG is to be performed in this situation, the staple line must inevitably pass through this "unhealthy" tissue. One can easily avoid passing through this tissue when performing LRYGB, and the staple line can simply be formed distal and lateral to the band-related fibrotic capsule without compromising the integrity and effect of the operation. Therefore, it is the authors' belief that this procedure seems to logically be the safer option for revision of failed LAGB. However, the bariatric surgeon should always consider the condition of the gastric wall after removal of the band and should always reserve the option to postpone the revision to a second procedure to ensure the viability of the anastomosis and the safety of the patient.

Weight loss after any revisional surgery is a concerning issue. In our study, patients undergoing revisional LRYGB showed less postoperative weight loss than those undergoing primary LRYGB (61.5 vs. 73.5%EWL, $P = 0.004$). This paucity in weight loss in the revisional surgery group has previously been demonstrated in the literature. Slegtenhorst et al. reported similar results, with an excess weight loss of 48.4% in those who underwent revisional LRYGB compared to 71.6% in primary LRYGB patients ($P < 0.0001$) [17]. Aarts et al.'s investigation demonstrated a %EWL of 60% in patients undergoing revision from LAGB to LRYGB [10]. It is generally accepted that the weight loss achieved after revisional bariatric surgeries is less than that in primary surgeries [17, 18]. That said, the %EWL of 62% achieved in our revisional group is a favorable outcome.

Available literature has demonstrated superior weight loss results in patients undergoing revision from LAGB to LRYGB when compared to those undergoing revision to LSG. Carandina et al. demonstrated a mean EWL of 70.2 and 59.9% in revisional LRYGB and LSG patients, respectively, after 2 years of follow-up ($P = 0.01$) [15]. Similarly, Yeung et al. demonstrated a trend of superior EWL at 12 months in those undergoing revisional LRYGB (51.19 vs. 34.89%) [27].

The improvement or resolution of preoperative comorbidities after revisional LRYGB is not a topic extensively discussed in the literature. In our study, there seems to be less improvement or resolution of comorbidities in the revisional group than in the primary bypass group, although not with regard to DM in particular. Apparently, the resolution of comorbidities at least partially parallels weight loss, and therefore occurs more prominently in patients undergoing primary LRYGB. However, further studies are required to validate this statement.

This study has its limitations, the most prominent being its retrospective nature. Unfortunately, the literature lacks prospective randomized trials comparing the revisional options for failed LAGB, which could provide high-quality evidence to support a certain revisional procedure over another. The fact that only a representative cohort of primary LRYGB patients was included in the study (although randomly chosen) could have led to selection bias. Despite that fact, the outcomes of the revisional LRYGB patients are definitely acceptable, even when standing alone without comparison to primary LRYGB patients.

Conclusion

LRYGB is a valid option after failure of LAGB. It is a safe procedure, even as a one-step operation, with early and late complication rates that are comparable to those of primary LRYGB. Excess weight loss is lower than in primary LRYGB, and there appears to be decreased improvement or resolution of comorbidities. However, the procedure's safety vis-a-vis fair to good postoperative weight loss makes it a very plausible option as a rescue operation after failed LAGB.

Compliance with Ethical Standards The study was approved by our institution's ethics review board. Due to the retrospective nature of the investigation, no informed patient consent was required. All procedures performed in the study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of Interest The authors declare that they have no conflict of interest.

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