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ORIGINAL CONTRIBUTIONS

Conversion of Adjustable Gastric Banding to Adjustable Banded Roux-en-Y Gastric Bypass: Should We Leave the Band in Place?

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Abstract

Objective Laparoscopic adjustable gastric banding (LAGB) is rapidly becoming a deprecated bariatric procedure due to disappointing weight loss results and a high rate of band intolerance. Conversion to Roux-en-Y gastric bypass is a common revisional procedure after failed LAGB. The aim of this study was to evaluate the feasibility, safety, and risk profile of conversion to adjustable banded Roux-en-Y gastric bypass (ABRYGB).

Methods A retrospective patient file review of all consecutive laparoscopic conversions of LAGB to ABRYGB 2008–2017. Pre/perioperative data, weight change, and long-/short-term complications were retrieved.

Results Study population 98 patients. Mean BMI before revision was 40,15 kg/m^2. Most revisional procedures were performed for band intolerance and/or weight regain or weight loss failure. All procedures were performed laparoscopically. During follow-up, 16 bands had to be removed due to one of the following reasons: infection, anastomotic leakage, anastomotic peptic perforation, adhesions around the anastomosis, internal hernia around the tubing, adhesions to the tubing, tubing failure, and erosion of the band. Three of those bands were replaced with a non-adjustable Silastic (Minimizer) ring. In total, issues with tubing requiring an intervention were found in 20 patients after conversion to ABRYGB. Seven revisional procedures had to be performed for symptomatic internal hernias not related to the tubing and incidental internal hernias were found in another 7 procedures.

Conclusion Although conversion of LAGB to ABRYGB is technically feasible, initially well-tolerated, and has good weight loss results, the number of additional procedures during follow-up is rather high, suggesting that leaving the band in place should not be advised.

Keywords Obesity · Metabolic surgery · Bariatric surgery · Revisional surgery · Banded procedures · Gastric bypass · Gastric banding

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Introduction

Laparoscopic adjustable gastric banding (LAGB), having been one of the most frequently performed bariatric procedures in Europe, is rapidly becoming an abandoned weight-loss procedure. Despite the ease and safety of implantation, reversibility, adjustability, and good short-term weight loss, LAGB shows disappointing long-term weight loss results and a high rate of band removal [1–3].

While several strategies have been formulated to remedy failed gastric banding, conversion to classic Roux-en-Y gastric bypass (RYGB) is most commonly performed [4]. This strategy can be used in cases of weight regain, weight loss failure, band intolerance, and even band erosion. Salvage RYGB

weight loss results are comparable to those reported after primary RYGB, with the majority of patients achieving over 50% of excess weight loss [5–7]. However, as with primary RYGB, these patients are at risk of long-term weight regain.

In recent years, there has been increasing interest in performing non-adjustable banded Roux-en-Y gastric bypass (BRYGB) as a primary weight loss procedure. In a recent meta-analysis, Magouliotis et al. have shown similar short-term weight loss results for BRYGB when compared to RYGB but suggest superior weight loss maintenance in the long-term [8]. To our knowledge, no published studies have explored long-term results of conversion to either adjustable or non-adjustable banded RYGB after failed LAGB, although some studies have explored secondary placement of a gastric band after failed RYGB with mixed results [9–13].

In this paper, a series of 98 consecutive patients who underwent laparoscopic conversion from LAGB to adjustable banded Roux-en-Y gastric bypass (ABRYGB) is presented, leaving the adjustable band in place in an attempt to combine the long-term advantages of BRYGB with the adjustability of LAGB. The feasibility, safety, and perioperative risk profile of this procedure, as well as long-term complications and weight loss results are evaluated.

Materials and Methods

Surgical Technique

All conversions from LAGB to ABRYGB were performed by one of five experienced bariatric surgeons. Patients receive cefazoline 2000 mg and metronidazole 500 mg before induction of general anesthesia, as per hospital protocol. After establishing pneumoperitoneum with a Veress needle and placement of trocars, the adjustable band is released from adhesions using the diathermic hook, and subsequently opened. The fibrotic ring around the cardia is then excised using harmonic shears (Harmonic Ace, Ethicon, Cincinnati, USA), and a slightly longer gastric pouch (7 cm) is then created using powered linear endostaplers (Echelon Flex GST System, Ethicon, Cincinnati, USA). The longer pouch allows for more distance between the adjustable band and the gastrojejunostomy anastomosis, and it avoids creating an anastomosis through the fibrotic area. A 40fr orogastric tube is used to determine pouch width. Spillage of gastric or enteric juices is managed with simple aspiration.

Next, a standard laparoscopic Roux-en-Y is fashioned with a 60-cm biliary limb and 120-cm alimentary limb. The end-to-side gastrojejunostomy anastomosis is made according to the Lönroth technique, using a powered linear stapler; subsequently the remaining enterotomy is closed with a barbed resorbable suture (V-loc, Medtronic, Minneapolis, USA). The mesenteric defect at the enteroenterostomy is closed with a hernia stapler in all cases (Multifire Endo Hernia Stapler, Medtronic, Dublin, Ireland); the antecolic Petersen space has been closed in all procedures from September of 2016 onwards.

At the end of the procedure, the original band is repositioned near the gastroesophageal junction, at least 2 cm from the anastomosis, and closed. This is illustrated in Fig. 1. Initially, the band was covered with omentum in the first 13 patients. Later on, the technique was modified to a plication of the remnant fundus and antrum, suturing them onto the gastric pouch distal to the adjustable band with non-absorbable Goretex sutures in a Nissen-like fashion. This was dubbed a Greve-plication (Fig. 2).

In the original publication by Meesters et al. of this operative technique, the tubing of the adjustable band was left as is [14]. Due to the tubing-related long-term complications discussed below, the technique evolved in January of 2017 to affixing the tubing to the abdominal wall using non-absorbable sutures, and finally in June of 2018 to tunneling the tubing through the preperitoneal plane after detaching it from the subcutaneous port. It is also from this point on that all bands were desufflated at surgery.

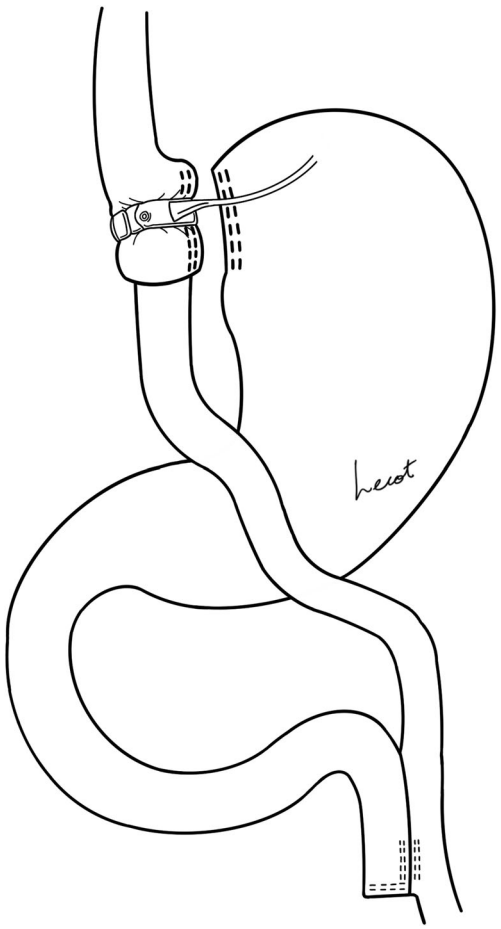

Fig. 1 Adjustable banded Roux-en-Y gastric bypass before plication

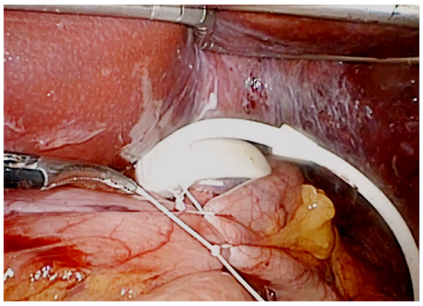

Fig. 2 Intraoperative view of a nearly completed Greve-plication

Data Collection

A retrospective file review of all consecutive laparoscopic conversions from LAGB to ABRYGB from 2008 to 2017 was performed, identifying 98 patients. Demographic data, pre-LAGB weight, and preoperative and perioperative data were evaluated. Weight evolution during follow-up, 30-day complications, and long-term complications were also retrieved, as well as data on preoperative comorbidities and postoperative band adjustments. Long-term complications were analyzed up to and including January of 2019. Postoperatively, all patients were seen in the outpatient clinic after 3–4 weeks. Follow-up visits took place at 3 months, 1 year, 18 months, and annually after 2 years. This study has been approved by our hospital ethics committee. All patients have given consent preoperatively for their patient file data to be used in future research.

Data Processing

Statistical analysis was performed using SPSS version 25 for macOS. Percentages of total weight loss (%TWL) and excess weight loss (%EWL) were calculated using starting weight prior to initial LAGB and also using weight prior to conversion to ABRYGB. Calculated ideal weight was based on a BMI of 25 kg/m^2. Band intolerance was defined as a total or almost total intolerance for solid food at minimal filling of the gastric band.

Results

Ninety-eight consecutive patients were identified for analysis, 78 of whom are female (79.6%). Demographics and comorbidities are defined in Table 1. Diabetes mellitus, hypertension, hypercholesterolemia, and depression were scored if patients received pharmacological treatment. Obstructive sleep apnea syndrome (OSAS) was scored if patients used nightly CPAP.

All procedures were performed laparoscopically. Indications for revision are summarized in Table 2. Band intolerance is defined as subjective discomfort or dysphagia.

Table 1 Patient demographics and comorbidities before revisional surgery

Female gender	78/98 (79.6%)
Mean age at primary LAGB	36.1 years (min 18, max 57)
Mean age at conversion to ABRYGB	43.1 years (min 24, max 62)
Hypertension	34/98 (34.7%)
Hypercholesterolaemia	15/98 (15.3%)
Diabetes mellitus	9/98 (9.2%)
Obstructive sleep apnea syndrome	7/98 (7.1%)
Depression	14/98 (14.3%)

Weight loss failure is defined as a patient not reaching 50% of EWL after gastric banding. Mean operating time is 139 min (min 49, max 300). There were no intraoperative complications. Type of plication used is omentum over the band in 13/98 patients (13.3%) and Greve-plication in 77/98 patients (78.6%); plication type is unknown in 8/98 patients (8.2%). Median day of discharge from hospital is on the first postoperative day (range 1–14).

Early Postoperative Complications

Four patients developed early postoperative complications within 30 days after surgery. The first patient developed an anastomotic leakage at the gastro-jejunostomy on the third postoperative day, necessitating laparoscopic removal of the adjustable band and endoscopic stenting of the defect. The patient also developed a catheter sepsis, treated with IV vancomycin. The stent was removed after 2 months.

The second patient developed early small bowel obstruction on the ninth postoperative day which necessitated readmission and operative adhesiolysis. The obstruction was caused by a fibrotic small bowel segment, just proximal to the jejuno-jejunostomy anastomosis. After conversion to laparotomy due to dense adhesions, the small bowel segment was resected along with the anastomosis and a new anastomosis was fashioned; further postoperative course was uneventful.

The third patient was re-admitted on the sixth postoperative day because of dyspnea. Computed tomography of the thorax and abdomen showed a subphrenic hematoma with reactive left-sided pleural fluid. Pleural drainage was performed with

Table 2 Summary of indications for conversion of LAGB to ABRYGB

Indication for revision	*n*/98
Band intolerance	8 (8.2%)
Weight regain	15 (15.3%)
Weight regain with band intolerance	29 (29.6%)
Weight loss failure	20 (20.4%)
Weight loss failure with band intolerance	26 (26.5%)

good results, pleural fluid cultures remained sterile, and the patient was discharged after 3 days.

The fourth patient developed an acute abdomen on the second postoperative day and was admitted to the intensive care unit. Diagnostic laparoscopy was performed and showed an iatrogenic perforation of the gastric remnant. The perforation was closed, and a drain was placed after irrigation and aspiration. The adjustable band was left in place, as there was only minimal contamination with gastric juice. Postoperative course was favorable, and patient was discharged from hospital on the 12th day after initial surgery.

Late Postoperative Complications

Non-band-related complications are as follows: There are two cases of gastro-gastric fistula. Both patients underwent laparoscopic partial resection of the gastric remnant, with concomitant removal of the adjustable band in one patient. The other patient had already undergone removal of the adjustable band; the fistula was endoscopically stented before definitive surgical intervention.

One patient underwent removal of the band and re-anastomosis of the gastro-jejunostomy for a perforated peptic ulcer; another patient also underwent re-anastomosis of the gastro-jejunostomy for a non-healing ulcer. One patient developed an incisional hernia necessitating surgical repair. One patient underwent laparoscopic adhesiolysis of a small bowel adhesion with obstructive symptoms.

Two bands were removed for late infection with an adjacent abscess without other findings during laparoscopy. There were two band slippages: One patient self-referred to another hospital before surgery could be planned; the other patient underwent laparoscopic repositioning of the band and conversion from omental plication to Greve-plication.

In patients with persistent non-specific abdominal pain, diagnostic laparoscopy is performed. Three patients underwent laparoscopic resection of a small bowel blind loop for candy cane syndrome. Seven patients underwent laparoscopic repair of symptomatic internal hernias not related to the adjustable band. In seven patients who underwent laparoscopy for other reasons (e.g., laparoscopic cholecystectomy), an open internal hernia defect was found and corrected. Laparoscopic adhesiolysis for small bowel adhesions around the gastric pouch was performed in seven patients, including three band removals. These adhesions often became symptomatic years after conversion to ABRYGB.

There are three erosions necessitating band removal: one erosion into the gastric pouch and two erosions into the gastric remnant after Greve-plication.

Late complications related to the tubing are summarized in Table 3. The subcutaneous port of the adjustable band was relocated in five cases because of chronic pain. In total, 16 adjustable bands (16.3%) have been removed for various reasons, three of which were replaced with a non-adjustable Silastic band (Minimizer Gastric Ring, Bariatric Solutions, Stein am Rhein, Switzerland) to prevent long-term weight regain. The reasons for band removal are listed in Table 4. There was no recorded mortality at the end of follow-up.

Table 3 Summary of tubing-related late-term complications

Finding at laparoscopy	Intervention	*n*
Internal hernia around tubing		
	Shortening of tubing	5
	Affixing of tubing to abdominal wall	6
	Preperitoneal tunneling of tubing	2
	Removal of band	4
Small bowel adhesions to tubing		
	Adhesiolysis	1
	Adhesiolysis and shortening of tubing	2
	Removal of band	1
Disconnection of tubing		
	Removal of band	1
Tubing breakage		
	Shortening of tubing and reconnection to new port	1

Weight Loss Data

Mean BMI at initial LAGB is 45.96 kg/m^2 (± 6.37 kg/m^2), while mean BMI at conversion to ABRYGB is 40.15 kg/m^2 (± 6.64 kg/m^2).

Follow-up at 1 year after conversion to ABRYGB is 93.9%; TWL is 33.49% (± 9.65%) and EWL is 75.84% (± 22.40%). Follow-up at 5 years after surgery is 53.2% (25/47 patients who are ≥ 60 months after surgery at time of analysis), TWL is 28.96% (± 11.67%), and EWL is 65.35% (± 24.92%). Initial and follow-up weight data is summarized in Fig. 3 and detailed in Table 5.

Table 4 Summary of reasons for band removal during follow-up

Reason for band removal	*n*	% of band removals
Band infection	2/98	12.5%
Perforated anastomotic ulcer	1/98	6.3%
Extensive small bowel adhesions to band or tubing at revision for abdominal pain	4/98	25.0%
Anastomotic leakage	1/98	6.3%
(Recurring) internal hernia around tubing	4/98	25.0%
Tubing disconnection	1/98	6.3%
Erosion of band into gastric pouch	1/98	6.3%
Erosion of band into gastric remnant	2/98	12.5%
Total	16/98	

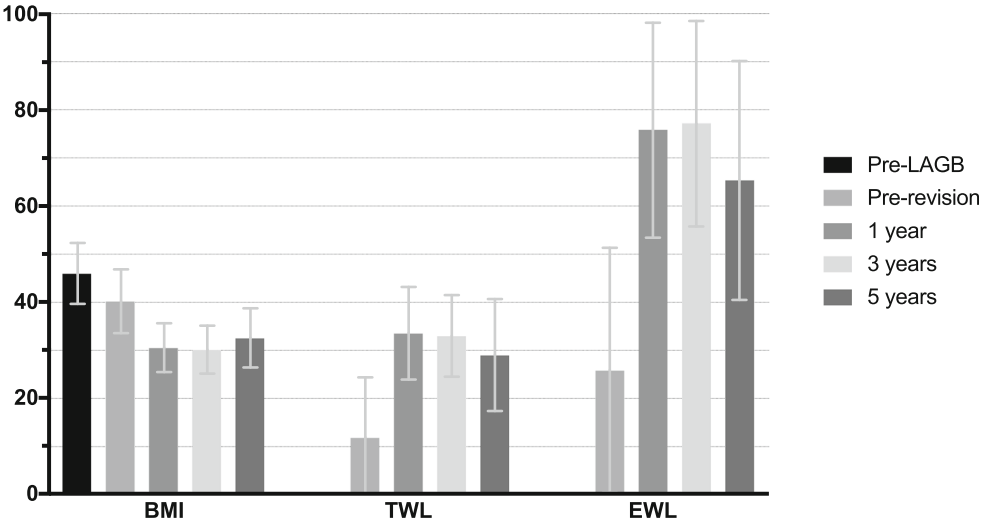

Fig. 3 Summarized weight data, compared to pre-LAGB baseline weight

Band adjustments were performed in 16/98 (16.3%) of patients for weight loss stagnation or for dysphagia.

Discussion

In this report, conversion of LAGB to ABRYGB was studied in a subset of patients with poor weight loss results after gastric banding.

In the past, several authors have reported using a combination of LAGB and RYGB. However, as summarized by Greve et al., in these procedures, the band is placed under the gastrojejunostomy anastomosis and is a form of gastric partitioning as opposed to pouch stapling in a conventional RYGB. These procedures are associated with a high number of erosions and band removals. In an expert meeting at the third annual meeting of the Italian Collaborative Study Group for the Lap-Band, the routine use of these procedures was not advised [15].

Conversely, the technique presented in this study places the band above the anastomosis as a supplemental means of restriction. Dillemans et al. describe a similar technique as a primary procedure for the super-super-obese (BMI > 60 kg/m^2), combined with a long limb RYGB [16]. The main technical difference is the type of plication used: suturing the gastric remnant above and below the band as opposed to below in this series. The follow-up weight loss data of the Dillemans series is unknown.

Table 5 Overview of weight data at LAGB, conversion to ABRYGB and during follow-up. *BMI* body mass index, *%TWL* percentage of total body weight loss, *%EWL* percentage of excess weight loss. %TWL and %EWL are both presented in relation to pre-LAGB weight and pre-revision weight

Time point	Parameter	Follow-up	Mean	SD	Min	Max
Initial LAGB		98/98 (100%)				
	BMI		45.96	6.37	34.19	68.48
Revision to ABRYGB		98/98 (100%)				
	BMI		40.15	6.64	25.23	58.40
	%TWL		11.83	12.45	− 30.83	57.27
	%EWL		25.80	25.53	− 76.14	92.47
1 year		92/98 (93.9%)				
	BMI		30.47	5.10	20.38	49.48
	$\%TWL_{pre\text{-}LAGB}$		33.49	9.65	5.04	59.27
	$\%TWL_{pre\text{-}revision}$		23.72	11.03	− 12.71	47.56
	$\%EWL_{pre\text{-}LAGB}$		75.84	22.40	12.34	138.16
	$\%EWL_{pre\text{-}revision}$		66.92	33.20	− 60.06	163.79
3 years		32/64 (50%)				
	BMI		30.07	5.02	22.24	41.26
	$\%TWL_{pre\text{-}LAGB}$		32.94	8.52	14.92	49.51
	$\%TWL_{pre\text{-}revision}$		20.69	13.74	− 20.15	46.76
	$\%EWL_{pre\text{-}LAGB}$		77.18	21.42	30.79	124.02
	$\%EWL_{pre\text{-}revision}$		60.62	42.29	− 95.23	133.41
5 years		25/47 (53.2%)				
	BMI		32.52	6.18	24.44	44.71
	$\%TWL_{pre\text{-}LAGB}$		28.96	11.67	− 0.15	50.02
	$\%TWL_{pre\text{-}revision}$		16.23	15.09	− 26.74	43.64
	$\%EWL_{pre\text{-}LAGB}$		65.35	24.92	− 0.34	102.34
	$\%EWL_{pre\text{-}revision}$		46.68	48.79	− 126.38	131.01

Several groups have reported secondary LAGB as a salvage procedure after RYGB in small cohorts, with acceptable complication rates and fair additional weight loss [13, 17, 18]. However, in larger cohorts, Uittenbogaart et al. and Aminian et al. found a more modest additional EWL and an unacceptably high complication rate, with band removal rates of 16% and 21%, respectively [9, 10]. Interestingly, none of these groups report any tubing-related long-term complications.

Overall, short-term postoperative complications in the current study were low. There was only one case of anastomotic leakage (1.0%) and one case of iatrogenic perforation (1.0%) that led to surgical revision. In early cases, postoperative dysphagia was treated by simply deflating the band, which was emptied preoperatively in later cases. There were no cases of primary band intolerance after ABRYGB, which could have been expected with the Greve-plication possibly narrowing the pouch near the proximal anastomosis. Moreover, the plication is loose and short, comparable to a Nissen fundoplication, and long-term stenosis caused by Greve-plication has not been observed.

The rate of reoperation within 30 days is 4.1%. This is in line with recently published MBSAQIP data on complications after revisional RYGB after failed gastric banding [19]. In a retrospective analysis of primary versus revisional gastric bypass after failed gastric banding, Thereaux et al. describe a 6.8% early reoperation rate in the revisional group [20]. There were no instances of myocardial infarction or pulmonary embolism, and there was no postoperative mortality. With a median discharge from hospital on the first day after surgery, length of hospitalization is short. Mean operating time is just over 2 h, and there were no conversions or major intraoperative complications. These findings establish that conversion to ABRYGB is technically feasible and safe procedure in the short-term.

In the long-term, however, conversion to ABRYGB shows a number of serious drawbacks. In a meta-analysis comprising 31,320 patients after primary RYGB, Geubbels et al. report an internal hernia rate of 1%, although this varied widely among included studies [21]. The rate of non-tubing-related symptomatic internal hernias in this series is 7.1%.

The rate of band erosion into the gastric pouch in this series is 1.0%. This is in line with a systematic review by Egberts et al. of band erosions after primary LAGB, which reports a 1.46% erosion rate [22]. In a systematic review of salvage banding for failed RYGB, Vijgen et al. report a 2.1% erosion rate [12]. In two additional cases in this series, however, the band eroded into the gastric remnant instead of the gastric pouch, a complication unique to the Greve-plication. Management of this type of erosion is identical, i.e., removal of the adjustable band. A further confounding factor with ABRYGB is the use of many different types of adjustable band during primary LAGB.

Another drawback is the number of tubing-related complications. Tubing-related complications were found and addressed during 23 revisional procedures after RYGB. Internal herniation of small bowel around the tubing was an especially prevalent, and induced multiple changes in operating technique. As the current policy of tunneling, the tubing in the preperitoneal plane at conversion to ABRYGB is relatively recent, the effect on the incidence of internal hernia remains to be seen. However, at the time of analysis, there were no cases yet of tubing-related internal hernia after preperitoneal tunneling. The high rate of tubing complications is probably due to exposure of the small bowel after splitting the greater omentum, as well as the antecolic bowel. Tubing complications are exceedingly rare in primary LAGB, as the greater omentum completely covers the small bowel, thus protecting it from the tubing.

Tubing-related complications led to the removal of the adjustable band in 6.1% of patients. A possible alternative to definitive removal of the adjustable band is replacement with a non-adjustable gastric ring, in essence a conversion to BRYGB. This was performed in 3 cases in this series. Nonetheless, it is felt that a total band removal rate of 16.3% is probably too high to justify conversion to ABRYGB as a standard procedure for failed LAGB.

Due to the multitude of unique reasons for band removal, it is impossible to establish a correlation with preoperative factors such as pre-existing band intolerance. Most cases of band intolerance are due to either slippage of high band position. During conversion to ABRYGB, the band is reclosed over a long narrow pouch and repositioned if needed.

Conversely, follow-up weight loss data is encouraging. TWL and EWL at 1 year are comparable to published rates for conventional primary RYGB [23, 24]. In their analysis of primary versus revisional RYGB, Slegtenhorst et al. show inferior weight loss results for revisional RYGB after gastric banding, especially if weight loss failure or weight regain constituted the indication for conversion [25]. This suggests that patients with a failed LAGB are an especially difficult cohort to treat.

Follow-up rate at 5 years is only 53.2%, which is a common issue in bariatric surgery literature. The EWL of 65.4% and TWL of 29.0% at 5 years in this series is concordant with the meta-analysis of BRYGB by Magouliotis et al., and superior to the analysis of revisional RYGB by Slegtenhorst et al. [8, 25]. In their meta-analysis of long-term results of primary BRYGB, Buchwald et al. report an even higher EWL at 5 years, i.e., 72.5% [26]. The lower EWL in this series is possibly explained by the high incidence of band removal, which obviates the long-term benefits of banding on weight loss maintenance in a significant portion of the cohort.

Adjustments to band insufflation were performed in a relatively minor portion of the study population, owing perhaps to the good weight loss results and the uncommon occurrence of dysphagia. Follow-up weight data is insufficient to show a definitive advantage of band adjustability.

Conclusion

Conversion of LAGB to ABRYGB is technically feasible and safe in the short-term. It shows promising weight loss results in the long-term, with weight loss maintenance rates comparable to primary BRYGB. As it remains to be seen if preperitoneal tunneling of the tubing of the adjustable band reduces long-term complications significantly, long-term complications such as revisional surgery and band removal are felt to be too high to recommend conversion to ABRYGB as a standard approach to failed gastric banding. Although the evidence is currently lacking in published literature, conversion to non-adjustable BRYGB is possibly a better strategy after failed LAGB.

Compliance with Ethical Standards

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

Statements Regarding Ethics and Consent This study has been approved by our hospital ethics committee. All patients have given consent preoperatively for their patient file data to be used in future research.

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