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CLINICAL RESEARCH

Revision of Laparoscopic Adjustable Gastric Banding: Success or Failure?

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Abstract
Background Laparoscopic adjustable gastric banding (LAGB) is a safe and frequently performed bariatric procedure. Unfortunately, re-operations are often necessary. Reports on the success of revisional procedures are scarce and show variable results, either supporting or declining the idea of revising LAGB. This study describes a large cohort of re-operations after failed LAGB to determine the success of revision.
Methods By use of a prospective cohort, all LAGB revisions performed between 1996 and 2008 were identified. From 301 *primary* LAGB procedures in our centre, 43 patients (14.3%) required a band revision. In addition, 51 patients were referred from other centres. Our analysis included in total 94 patients with a mean follow-up period of 38 months after revision.
Results Revision was mainly necessary due to anterior slippage (46%) and symmetrical pouch dilatation (36%), which could be resolved by replacing (70%) or refixating the band (27%). Weight loss significantly increased after revision (excess BMI loss (EBMIL), 37.2±36.3% versus 47.5±30.4%, $P<0.05$). After revision, 23 patients (24%) needed a second re-operation. Patients converted to other procedures (16%) during the second re-operation showed larger weight loss than the revised group (EBMIL, 64.3± 28.1% versus 44.3±28.7%, $P<0.05$).
Conclusions We report on a large cohort of LAGB revisions with 38 months of follow-up. Revision of failed LAGB by either refixation or replacement of the band is successful and further increases weight loss.

Keywords Bariatric surgery · LAGB · Re-operation · Complications · Follow-up

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Introduction

Bariatric surgery has established its place as a successful treatment modality for morbid obesity, in contrast to often unsuccessful noninvasive obesity therapies [1–3]. After the emergence of bariatric surgery in the 1970s, it was not until the 1990s that laparoscopic adjustable gastric banding (LAGB) became an important contributor [4–6]. The first gastric banding procedures had high rates of re-operations, causing concerns on this type of restrictive surgery [7]. However, the technique became more sophisticated, and successful weight loss was described in large groups of patients [8]. In the last decade, change of operating technique from the perigastric to the pars flaccida approach decreased complications and regained interest in LAGB. High-quality, long-term follow-up studies show successful weight loss compared to morbidly obese control groups [9]. Moreover, LAGB was shown to be equally successful compared to other more invasive procedures [10]. However, there are only few prospective reports assessing safety and long-term complications, and good evidence is needed [11]. Long-term complications often require re-operation; follow-

up reports on this topic are limited. For the patient, the level of success of bariatric surgery will stand or fall with its final anti-obesity effect. A primary LAGB procedure that fails in terms of unsuccessful weight loss or technical complications (slippage, erosion, etc.) could become successful in the end by choosing the right step at the moment of failure. Roughly, two options are available: revision of LAGB by refixating or replacing the band, or conversion to other restrictive or malabsorptive procedures such as sleeve resection, (banded) Roux-en-Y-gastric bypass (RYGB) or biliopancreatic diversion (BPD). Unfortunately, uniform evidence supporting one of these two directions has not been established. Therefore, we assessed the population of re-operated LAGB patients in our centre to determine the success of revision.

Materials and Methods

Patients

Based on the prospective register of revisional procedures, written and electronic patient records (clinical and outpatient) were double-checked for information by the two co-authors GHEJV and LP. In the period from December 1996 to December 2008, all band revisions after primary LAGB were included in our retrospective analysis. In this period, 301 *primary* LAGB procedures were performed in our centre. Of this group, 14.3% (43 out of 301) required a band revision. As our centre is a reference institute for revisional bariatric surgery, all patients referred from other centres were also included in the analysis. This group consisted of 51 patients, resulting in a total group of 94 LAGB revisions. In the analysis, we excluded patients that were converted to other bariatric procedures in case of failed LAGB (0.7%, $n=2$). In our centre, this group consisted of one band removal and one conversion to RYGB (two out of 301), which makes the total rate of revisions and conversions 15% (45 out of 301). In addition, three referred patients had a band removal and four were converted (one RYGB and three BPD).

Surgical Technique

All LAGB procedures performed in our centre were performed as described in detail before [12]. In all primary procedures performed in our centre, three to four sero-serosal tunnelisation sutures were used to fixate the band. However, the data on the primary procedures from referred patients were not always complete. Therefore, we were not able to assure that the referred population in all cases had received sero-serosal tunnelisation sutures during the primary procedure.

In our centre, all primary procedures after March 2001 were performed following the pars flaccida technique. Of the 43 revisional procedures from our centre, 23 procedures were revised after primary LAGB placement by use of the perigastric technique performed before March 2001.

Data Collection

Based on the revision register, information was collected from primary band placement until the last follow-up. We obtained outpatient and clinical data on the primary procedure, revision and, if applicable, following procedures. Primary outcome parameters were body weight, complications, surgical techniques, length of hospital stay, band type, re-operations, conversions and comorbidities. Peroperative data from the primary procedure of referred patients were frequently unavailable or incomplete. Attempts to recollect these data were difficult, partly due to the high level of international referral. Outpatient correspondence from referred patients was mostly restricted to intake body weight, length and comorbidity. Total weight loss (TWL) is expressed in percentages as $\%\mathrm{TWL} = [(\text{last weight} - \text{intake weight})/\text{intake weight} \times 100]$. Excess BMI Loss (EBMIL) is expressed as $\%\mathrm{EBMIL} = 100 - [(\text{follow} - \text{up BMI} - 25/\text{beginning BMI} - 25) \times 100]$

Statistical Analysis

Statistical analyses were performed with PASW Statistics 18.0 for Mac OS×10.6.4. Reported data are expressed as means± SD. Group parameters at different time points were compared using paired Student's t tests. Differences within the group were compared using unpaired Student's t tests. When data were not normally distributed, the related samples Wilcoxon signed ranks test was used. P values below an alpha of 5% (0.05) were considered to be significant.

Results

Preoperative Characteristics

The patient population consisted of 7 men and 87 women, with a mean preoperative BMI of 43.2±5.1 kg/m^2 and a mean weight of 120.9±17.9 kg (Table 1). The most frequent comorbidities were hypertension, type 2 diabetes and joint problems (Table 1).

Initial Procedure

During the initial procedure, the most placed band, the Vanguard™ band (Inamed, Santa Barbara, USA), was placed in 30.9%, followed by the Lapband 11cm™ (Allergan, Santa Barbara, USA; 12.8%), the Lapband 9.75 cm™ (Allergan,

Table 1 Preoperative group characteristics before initial LAGB

Variables	
M/F (*n*)	7:87
Age (years)	37±10
BMI (kg/m^2)	43.2±5.1
Weight (kg)	120.9±17.9
Comorbidity	Number
Hypertension	23
Type 2 diabetes	9
Joint problems	32
OSAS	2

Data are expressed as means±SD

M/F male/female ratio, *BMI* body mass index,*OSAS* obstructive sleep apnea syndrome

Santa Barbara, USA; 11.7%) and others (Swedish Adjustable Gastric Band (SAGB™; Ethicon Endo-Surgery, Cincinnati, USA), Swedish Adjustable Gastric Band Quick Close (SAGB-QC™; Ethicon Endo-Surgery, Cincinnati, USA), LAP-BAND AP™ system Small or Large (Allergan, Santa Barbara, USA)) (Table 2). Due to the limitations of a retrospective analysis and many referred patients, 26 initial band types were unknown. The mean length of hospital stay was 3.6±2.6 days (range, 2–17 days). During the initial LAGB, in two patients, the procedure was converted from laparoscopic to open placement (laparotomy). One conversion was necessary due to laparoscopically uncontrollable bleeding, and in the other patient, open placement was preferred because of the inability to achieve an adequate laparoscopic view. Other minor complications were small liver lesions (*n*=4), which were controlled diathermically during laparoscopy. Two patients had a postoperative obstruction, which was confirmed by contrast swallow imaging; both had a laparoscopic revision, 11 and 12 days respectively after the initial procedure. In both patients, the initially placed 11-cm lapband was replaced by a Vanguard™ band (all pars flaccida technique, replacement in old tunnel traject; Table 3).

Table 2 Band type used in initial LAGB

Band type	Number	%
Lapband 11 cm™	12	12.8
Vanguard™	29	30.9
A.P. small™	7	7.4
A.P. large™	2	2.1
Quick Close™	5	5.3
Lapband 9.75 cm™	11	11.7
Swedish band™	2	2.1
Total	68	72.3
Unknown	26	27.7

Revision

Indications for Revision

The most frequent indication for revision was anterior slippage (*n*=43, 45.7%) and symmetrical pouch dilatation (SPD, *n*=34, 36.2%). Other indications were posterior slippage (*n*=2, 2.1%), band intolerance (*n*=1, 1.1%), band leakage (*n*=4, 4.3%), port erosion (*n*=2, 2.1%), clockwise rotation (*n*=2, 2.1%), displaced bands (*n*=2, 2.1%), too tightly placed band (*n*=2, 2.1%) or a loose tubing (*n*=2, 2.1%). In the majority of the cases, the problems could be solved by either refixating (*n*=66, 70.2%) or replacing the band (*n*=25, 26.6%). In the other three patients (3.2%), refixation of the tubing—under local anaesthesia—was sufficient to solve the problem.

Revisional Procedure

Mean preoperative BMI before revision was 36.1±6.3 kg/m^2 with a total weight loss (%TWL) of 16.1±14.2% and an EBMIL of 37.2±36.3%. The mean length of hospital stay was 5.0±3.3 days (range, 2–17 days). During the revision, placement via laparotomy was necessary in three patients. Peroperatively, three patients had diathermically controlled liver lesions, and one of the patients had a controllable splenic lesion (Table 4). One patient, with an acute herniation of the stomach through the band, had a poorly vascularized gastric pouch during the prompt revision; therefore, the band was left in the perigastric tunnel without being closed. Two days later, the pouch was laparoscopically revised and vital, with subsequent repositioning and closure of the band. One patient had a gastric perforation when the band was opened, which was laparoscopically sutured. One patient had a postoperative subphrenic abscess, which could be drained (CT-guided). One patient suffered from frequent vomiting due to passage problems, which was solved by complete desufflation of the band. One patient had a superficial wound infection that could be drained on the ward. One patient was severely nauseous and had insufficient intake that required total parenteral nutrition for 1 week.

Table 3 Technique used in initial LAGB

Technique	Number	%
Pars flaccida	47	50
Perigastric	16	17
Total	63	67
Unknown	31	33

Table 4 Per- and postoperative complications of revision

Complications	Percentage (%)
Peroperative	
Liver lesion (n=3)	3.2
Splenic lesion (n=1)	1.1
Ischemic pouch (n=1)	1.1
Gastric perforation (n=1)	1.1
Postoperative	
Subphrenic abscess (n=1)	1.1
Passage problems (n=2)	2.1
Wound infection (n=1)	1.1

Band Problems Requiring Second Revision

After revision, 23 patients (24.4%) required a second re-operation (Fig. 1). Mean time between both procedures was 25±13 months (range, 6–43 months). Eight (34.8%) of the 23 patients had a second revision, 13 patients (56.5%) had a conversion to another procedure and 2 patients (8.7%) had a permanent removal of the band. Anterior slippage was the most prevalent indication; this was solved by conversion to a banded RYGB (n=5), RYGB (n=1), refixation (n=1) and replacement (n=1). Band erosion required three band removals followed by conversion to RYGB (n=1), BPD (n=1) and gastric sleeve (n=1) during a second-stage re-operation. Incorrectly placed bands at revision (n=2) required replacement and refixation. Insufficient weight loss after band revision was a reason to convert four patients to other procedures (one RYGB, one BPD and two banded RYGB). Other problems were band intolerance (removal), band leakage (replacement), port dislocation (replacement), port discomfort (refixation), symmetrical pouch dilatation (refixation) and passage problems due to a too tight band (refixation). One patient developed a diaphragmatic gastric hernia and needed band removal.

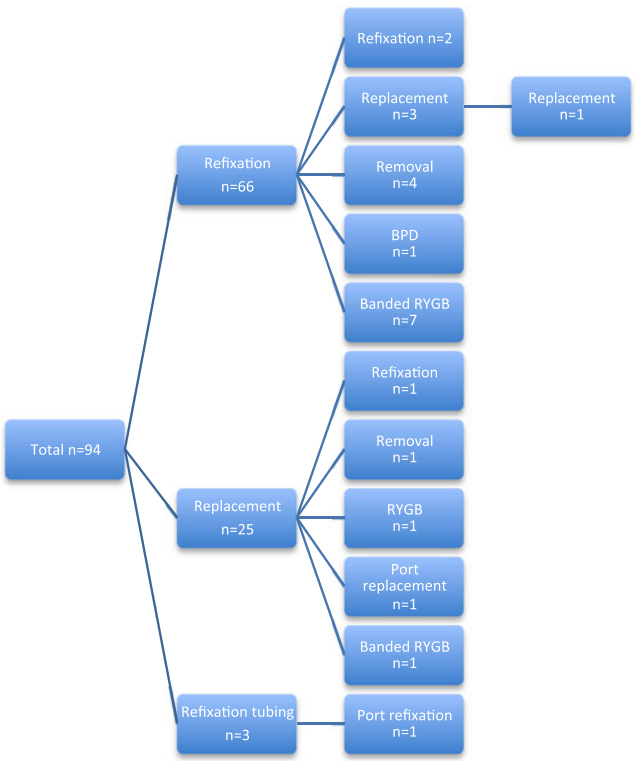

Fig. 1 Performed interventions during band revision and re-re-operations

Follow-up and Weight Loss

Follow-up after re-operation was 97% (91 out of 94), with a mean follow-up period of 38±21 months (range, 1–108 months). The most recent mean BMI of the patient population was 34.5±6.2 kg/m^2 (range, 22.5–53.1 kg/m^2), which was significantly different from the BMI before initial LAGB (P<0.001, Table 5). Excess BMI loss increased significantly after revision (EBMIL, 37.2±36.3% versus 47.5±30.4%, P=0.043; Fig. 2).

Band Revision Versus Conversion

Mean follow-up after revision was 38.4±21.6 months for the group that underwent revision and re-revision during the second re-operation (revision group, n=76) and 38.5±16.5 months for the group that was converted during the second re-operation (conversion group, n=13). After follow-up, the revision group did not show further weight loss (revision EBMIL, 44.3±28.7% versus follow-up EBMIL, 34.5±37.5%, P=0.070, Table 6). The conversion group showed equal results (conversion EBMIL, 64.3±28.1% versus follow-up EBMIL, 52.5±31.8%, P=0.362). When the revision and conversion group were compared, the initial weight and BMI before primary LAGB of the revision group did not differ from the converted patients (body mass, 119.9±18.6 versus 125.4±14.2 kg, P=0.319; BMI, 43.2±5.4 versus 43.6±2.9 kg/m^2, P=0.776, Table 6). Similarly, at the moment of revision, there were no significant differences between both groups. When the weight loss in both groups was compared after follow-up, there was a significantly larger weight loss in the group that underwent conversion

Table 5 Weight loss after follow-up (n=91)

Variable	Initial	Revision	Follow-up
Weight (kg)	120.9±17.9	101.3±19.6	96.1±19.2*
BMI (kg/m^2)	43.2±5.1	36.1±6.3	34.5±6.2
EBMIL (%)		37.2±36.3	47.5±30.4*

*P<0.05 (compared to revision)

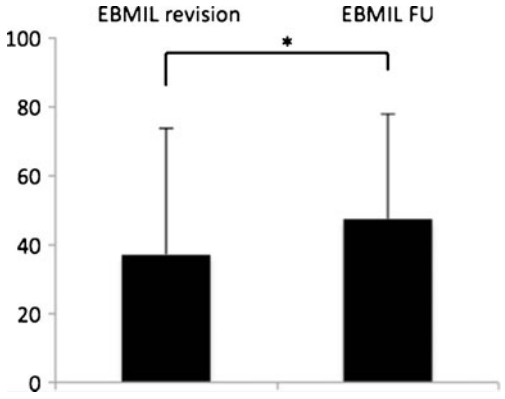

Fig. 2 Percentage excess BMI loss (%EBMIL). *FU* follow-up. Values shown are means+SD; *$P<0.05$

compared to the revision group ($n=76$; EBMIL, 64.3±28.1% versus 44.3±28.7%; $P=0.026$, Table 6).

Discussion

We present a series of 94 patients with failure after primary gastric banding who underwent revisional surgery in the form of band refixation or replacement of the band with a mean follow-up period of 38 months and a follow-up percentage of 97%. To our knowledge, this is the largest cohort of revisions described with this length of follow-up. In literature, several studies report contrasting conclusions on the success of revising a failed primary gastric band placement. We show that revision of primary failed LAGB is a feasible option with increased weight loss after a follow-up period of 38 months. After revision, the mean BMI also decreased to a level below the critical value of 35 kg/m^2, which is a strong predictor of comorbidity. Of the 94 revisions, 23 (24%) needed a second re-operation. During this procedure, most patients ($n=13$) were converted to other procedures.

With the huge number of patients operated with an adjustable band, re-operation of a failed LAGB will be more and more common. Several studies show revision of failed LAGB successfully increases or sustains weight loss. However, literature is still scarce and the advices strongly differ. Niville et al. report rebanding of ten eroded bands, with subsequent continuation of weight loss [13]. Two patients (20%) developed late complications that required re-revision. Schouten et al. described 33 re-operations, of which 28 are band revisions, in a LAGB cohort with a re-operation percentage of 14.7% [12]. After re-operation, the revised group continued to decrease in BMI and obesity-related comorbidities, and the re-revision percentage of 10% was low after 34 months of follow-up. In this study, we continued follow-up of this cohort in our centre. Foletto et al. performed 29 revisions and report sustained weight loss and 17% re-revisions after 27 months of follow-up [14]. In 19—both adolescent and adult—patients with anterior prolapse or SPD after primary LAGB ($n=425$), Brown et al. show maintained weight loss after revision with a 5% ($n=1$) re-revision rate [15]. However, follow-up at that moment was less than 1 year, and the performed procedure during revision is not reported. Bardsley et al. describe the largest cohort of band revisions and conclude that excess weight loss is sustained in a large series of 99 revised patients after a mean period of 19 months [16].

Beside revision of failed LAGB, conversion to both restrictive and malabsorptive procedures is suggested as an alternate option. The effect of conversion seems to be at least comparable in terms of weight loss, and is often applied after insufficient initial weight loss. Ardestani et al. report sustained weight loss after revising 71% of their failed primary LAGB patients ($n=66$) [17]. Interestingly, the authors choose only to revise patients who had good weight loss after primary band placement. Patients with insufficient weight loss after LAGB ($n=19$) were converted to RYGB, which eventually resulted in successful weight reduction. Re-re-operation varied from 5–23%, depending on the revisional procedure. Bueter et al. showed that revision of LAGB is only successful when the band was replaced [18]. After replacement of the band, persistent weight loss was achieved. Patients converted to RYGB showed a significantly higher weight loss. However, this study had no data concerning weight loss at the moment of re-operation. Weber et al. concluded that RYGB should be considered as the 'rescue' therapy of choice after prospectively comparing 30 rebanding procedures to 32 conversions to laparoscopic RYGB [19]. RYGB increased weight loss, while rebanding only sustained initial weight loss. However, both groups were treated in different, subsequent time periods, and follow-up of the converted group was significantly shorter. Lanthaler et al. did not show further weight reduction after RYGB in a smaller group (16 rebanding

Table 6 Band revisions ($n=76$) compared to conversions ($n=13$)

Initial procedure			Revision procedure		Follow-up	
Variable	Revision	Conversion	Revision	Conversion	Revision	Conversion
Weight (kg)	119.9±18.6	125.4±14.2	101.3±20.7	98.1±15.1	97.6±18.8	92.9±18.7
BMI (kg/m^2)	43.2±5.4	43.6±2.9	36.5±6.5	33.7±5.5	35.3±6.1	31.8±5.1*
EBMIL (%)			34.5±37.5	52.5±31.8	44.3±28.7	64.3±28.1*

*$P<0.05$ (revision versus conversion)

and 8 RYGB conversions) [20]. A study of 29 rebandings by Foletto et al. showed weight increase compared to the 'post-LAGB steady state' [14]. Suter et al. described a group of nine patients with unsatisfactory results in six patients, therefore considering rebanding as an unsuccessful re-operation [21]. Müller et al. emphasized on the high secondary failure rate of 45% in their rebanding group compared to 20% in the RYGB conversions described in a cohort of 44 rebandings and 30 conversions to RYGB [22]. In addition, the rebanded patients gained weight, in strong contrast to the converted group that further decreased weight. Therefore, conversion to RYGB after failed gastric banding is recommended by this group.

In this study, we report on re-operations after primary failed LAGB. At the moment of revision, patients had already established a successful weight loss. Therefore, the indication for revision was almost solely technical failure of the band. We here show that after revision for technical reasons, weight loss significantly increases. The success in terms of weight loss we report confirms the decision-making algorithm Schouten et al. described previously [12, 23]. This suggests revision of failed LAGB is indicated in case of technical problems, in contrast to poor weight loss or noncompliance that stress conversion. Therefore, we propose revision is successful when these factors are regarded. Nevertheless, 24% of the revised patients needed a second re-operation in order to achieve success of bariatric surgery. Compared to the initial re-operation percentage of 14%, this indicates that the percentage of re-operations increases after revision. However, we show that 76% of the revised patients have increase of weight loss after revision without complications after a follow-up of 38 months. To detect possible re-failure, intense follow-up of revised patients is important. In conclusion, the majority of the patients in this study benefit significantly from revision, but in 24% of the cases, a second re-operation was required. In this situation, conversion to another bariatric procedure such as gastric bypass was more efficient. Therefore, we propose revision as a successful option in case of technical failure after LAGB.

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

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