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ORIGINAL CONTRIBUTIONS

Revisional Bariatric Surgery for Insufficient Weight Loss and Gastroesophageal Reflux Disease: Our 12-Year Experience

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Abstract

Introduction Although bariatric surgery is increasing in Japan, revision surgery is uncommon. To clarify indications for the various revision surgeries available, we retrospectively assessed perioperative/postoperative outcomes of revisional weight loss surgeries performed at our medical center between July 2006 and July 2017.

Methods The study group comprised patients treated for insufficient weight loss (IWL group, $n = 15$) or intractable postoperative gastroesophageal reflux disease (GERD group, $n = 9$). Clinical characteristics and perioperative/postoperative outcomes were assessed for the total patients, per patient group, and per type of revision surgery performed.

Results In the IWL group, BMI decreased from 47.3 ± 9.2 kg/m^2 at the time of revision surgery to 36.9 ± 7.4 kg/m^2 1 year later, and excess weight loss (%EWL) reached 62.7 ± 14.6%. Among patients whose primary surgery was laparoscopic sleeve gastrectomy, %EWL and total weight loss (%) were greater after laparoscopic biliopancreatic diversion with duodenal switch (LBPD/DS) or duodenojejunal bypass (DJB) than after other revision surgeries. Complete or partial remission of the GERD was achieved in all GERD group patients (9/9, 100%), and six (6/9, 66.7%) were able to discontinue proton pump inhibitor therapy. Serious complications occurred in four patients (4/24, 16.7%) following laparoscopic Roux-en-Y gastric bypass (LRYGB): stump leakage in one, gastrojejunal leak in one, and gastrojejunal stricture in two.

Conclusion LBPD/DS or DJB as revision surgery appears to be effective for further weight loss in the medium term, and LRYGB appears to be effective for GERD remission. Bariatric surgeons should bear in mind, however, that the post-LRYGB complication rate appears to be relatively high.

Keywords Bariatric surgery · Revision bariatric surgery · Insufficient weight loss · Gastroesophageal reflux disease

Introduction

Bariatric surgery is the most effective treatment modality for achieving sustained weight loss, especially in most morbidly obese patients [1]. In 2016, 685,874 bariatric surgeries were performed worldwide [2]. With the increasing volume of bariatric surgeries has come an increasing need for revision surgeries. In 2015, revision surgeries accounted for 13.6% of all bariatric surgeries performed in the USA [3]. Insufficient weight loss (IWL) and complications such as gastroesophageal reflux disease (GERD) following primary surgery are two major indications for revision surgery.

In Japan, laparoscopic sleeve gastrectomy (LSG) was, in 2014, approved for payment by the national health insurance system, and the number of bariatric surgeries performed annually has increased gradually since then. Although approximately 470 bariatric surgeries were performed in Japan in 2017 [4], revision surgery is still not common. Because complications have been reported to occur at a higher rate after revision surgery than after primary surgery [5–9], it is important to carefully evaluate the indications for bariatric surgery and carefully select the appropriate surgical method, whether for primary or revision surgery. To clarify indications for the

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various revision bariatric surgeries, we conducted a retrospective study in which we assessed perioperative/postoperative outcomes of various revisional weight loss surgeries performed at Yotsuya Medical Cube.

Methods

Patients identified for inclusion in the study had undergone revision surgery at our center between July 2006 and July 2017. A total of 26 patients underwent revision surgery during this period, but because IWL and GERD are the two main indications for revision surgery, we omitted from the study 2 patients who, because of pain, underwent band removal only. We divided the remaining 24 patients into two groups according to the indication for revision surgery, whether insufficient weight loss (IWL group, $n = 15$) or intractable GERD (GERD group, $n = 9$). IWL was defined as a percent excess weight loss (%EWL) of 50% or less at 1 year after the primary surgery, and this was the criteria under which revision surgery was recommended to the IWL patients. A patient's desire for further weight loss was also considered. Endoscopy, barium study, and computed tomography were performed routinely before revision surgery was decided upon, and patients' eating behavior was evaluated by a dedicated dietitian.

We reviewed the records of all study patients for the following clinical characteristics: type of primary bariatric surgery and type of revision surgery; time between the primary surgery and revision surgery; clinical characteristics, including sex, age at the time of revision surgery, body weight (BW), and body mass index (BMI) at the time of primary surgery; BW and BMI at the time of revision surgery; and %EWL and percent total weight loss (%TWL) at the time of revision surgery.

We also reviewed patients' records for the following perioperative/postoperative outcomes: operation time, postoperative hospital stay, complications, readmission, reoperation, operative death, BW and BMI 1 year after the revision surgery; and %EWL and %TWL 1 year after the revision surgery. Complications associated with the revision surgery were graded according to the Clavien-Dindo (C-D) classification system, with those that occurred within the first 30 days after the surgery considered early complications and those that occurred after 30 days considered late complications. We compared these study variables between the two groups.

Among the IWL group patients in particular, we identified those whose primary surgery was LSG and assessed weight loss in relation to each of the revision surgeries performed: laparoscopic biliopancreatic diversion with duodenal switch (LBPD/DS) or duodenojejunal bypass (DJB) (with or without laparoscopic re-sleeve gastrectomy [LRSG]), laparoscopic Roux-en-Y gastric bypass (LRYGB), and LRSG. Among the GERD group patients in particular, we assessed postoperative outcomes by comparing results of endoscopic examination performed before and after the revision surgery. We noted specifically the degree of erosive esophagitis (on the basis of visible mucosal breaks classified according to the Los Angeles Classification System [LA system]) and whether hiatal hernia was present.

Statistical Analysis

Data are shown as mean ± standard deviation (SD) values, as median and range values, or as the number and percentage of patients. Differences in continuous variables were analyzed by Student's t test or Mann-Whitney U test, and differences in categorical variables were analyzed by chi-square or Fisher's exact test. Microsoft Excel (Microsoft Excel for Office 365 MSO, Microsoft COP., Redmond, WA, USA) was used for the analyses, and $p < 0.05$. was considered significant.

Results Twenty-seven revision surgeries were performed in the 26 patients considered for inclusion in the study, accounting for 3.1% of the total 869 bariatric surgeries performed between July 2006 and July 2017. As noted above, the study included 24 patients: 15 IWL patients and 9 GERD patients. Eight (33.3%) of the 24 primary surgeries had been performed at another hospital. One of the 24 patients underwent revision surgery twice, and all 25 revision surgeries were performed laparoscopically.

The types of primary and revision surgeries are summarized per group in Table 1. The most common primary surgery was LSG in both the IWL group (10/15, 66.7%) and GERD group (5/9, 55.6%). The most common revision surgery was LBPD/DS or DJB (with or without LRSG) in the IWL group (6/15, 40.0%) and LRYGB (8/9, 89%) in the GERD group. LRYGB was used for treatment of GERD in both groups. Resection of the distal sleeve was performed with LRYGB in three patients because preoperative endoscopy revealed significant atrophic changes in the gastric mucosa.

Clinical variables and perioperative/postoperative outcomes are shown for the total patients and per group in Table 2. Mean age at the time of revision surgery differed significantly between the IWL group and GERD group, at 40.1 ± 8.7 years and 52.1 ± 8.3 years, respectively ($p = 0.004$). Both BW and BMI at the time of primary surgery and at the time of revision surgery were significantly greater in the IWL group than in the GERD group. No significant between-group differences were found in operation time, hospital stay, number and grade of perioperative/postoperative complications, or readmission and reoperation.

Serious early complications (C-D grade ≥ IIIa) occurred in four patients (4/24, 16.7%): stump leakage in one patient, gastrojejunal leak in one patient, and gastrojejunal stricture

Table 1 Types of primary and revision surgeries, per study group

	Primary surgery	Revision surgery
IWL group	LAGB ($n = 3$)	Re-LAGB ($n = 1$)
		LSG ($n = 2$)
	LSG ($n = 10$)	LRSG ($n = 2$)
		LBPD/DS with LRSG ($n = 3$)
		LBPD/DS ($n = 2$)
		DJB with LRSG ($n = 1$)
		LRYGB ($n = 2$)
	VBG ($n = 1$)	LRYGB ($n = 1$)
	LRYGB ($n = 1$)	Band on pouch ($n = 1$)
GERD group	LSG ($n = 5$)	Seromyotomy ($n = 1$)
		LRYGB ($n = 4$)
	LSG-DJB ($n = 3$)	Seromyotomy ➔LRYGB ($n = 1$)
		LRYGB ($n = 2$)
	VBG ($n = 1$)	LRYGB ($n = 1$)

Numbers of patients are shown

IWL insufficient weight loss, *GERD* gastro-esophageal reflux disease, *LAGB* laparoscopic adjustable gastric banding, *LSG* laparoscopic sleeve gastrectomy, *LRSG* laparoscopic re-sleeve gastrectomy, *LBPD/DS* laparoscopic biliopancreatic diversion with duodenal switch, *LRYGB* laparoscopic Roux-en-Y gastric bypass, *VBG* vertical banded gastroplasty, *LSG-DJB* laparoscopic sleeve gastrectomy with duodenojejunal bypass

in two patients. All four patients had undergone LRYGB. The stump leakage occurred in a patient who had undergone resection of the distal sleeve along with the LRYGB. Reoperation was required for the patient in whom stump leakage occurred and for the patient in whom gastrojejunal leak occurred. Endoscopic balloon dilatation was performed for both patients with gastrojejunal stricture. They recovered well and suffered no further adverse events. There was no operative mortality, but one patient died of liver dysfunction 10 months after the revision surgery.

Revision Surgeries and Outcomes in the IWL Group

LRYGB was performed as revision surgery in three patients (3/15, 20.0%) because they suffered not only IWL but also symptoms of GERD after the primary surgery. BW and BMI were 147.3 ± 32.6 kg and 55.8 ± 10.8 kg/m^2, respectively, at the time of primary surgery, and 124.4 ± 26.5 kg and 47.3 ± 9.2 kg/m^2, respectively, at the time of revision surgery. BMI decreased to 36.9 ± 7.4 kg/m^2 1 year after revision surgery. %EWL from the time of primary surgery to 1 year after revision surgery was 62.2 ± 15.1%. %EWL of ≥ 50% was achieved within 1 year after the revision surgery in 75% of patients in the IWL group.

Clinical characteristics, operative details, postoperative complications, and further weight loss of the 10 IWL group patients (10/15, 66.7%) who had undergone LSG as the primary surgery are shown in Table 3. Thirty-nine IWL patients had undergone LSG at our center. Thirty-two (82.1%) of these 39 patients did not undergo revision surgery. One patient underwent revision surgery despite the %EWL being 58.4% at 1 year after the primary surgery. This patient's BMI at 1 year was 40.3 kg/m^2, so he desired further weight loss. LBPD/DS or DJB (with or without LRSG) was performed for six patients (6/10, 60.0%) in the IWL group. Whether LRSG was added depended on the intraoperative findings. This is because preoperative examination (endoscopy and barium study) did not reveal significant fundus dilation in patients scheduled for revisional LBPD/DS or DJB. LRSG alone was performed in two cases (2/10, 20.0%)—in one case because significant liver cirrhosis put the patient at high risk for bypass-related complications and in the other case because the patient chose LRSG over bypass surgery. %EWL and %TWL of the 10 IWL patients from the time of revision surgery to 2 to 3 years after revision surgery are plotted in Fig. 1. For those who underwent LBPD/DS or DJB as revision surgery, %EWL and %TWL from the time of the primary surgery to the last follow-up examination were 63.8 ± 23.8% and 37.9 ± 15.1%, respectively. For those who underwent LRYGB as revision surgery, mean %EWL and %TWL from the time of primary surgery to the last follow-up examination were 47.4% and 24.6%, respectively. For those who underwent LRSG, mean %EWL and %TWL from the time of primary surgery to the last follow-up examination were 57.1% and 34.7%, respectively.

Revision Surgeries and Outcomes in the GERD Group

Primary and revision surgeries; endoscopic findings before primary surgery, before revision surgery, and after revision surgery; and proton pump inhibitor (PPI) use after revision surgery are shown per GERD group patient in Table 4. All patients in this group (9/9, 100%) were on PPI therapy before the revision surgery. At least one mucosal break (LA System ≥ grade A) was observed in six patients (6/9, 66.7%), stenosis in four patients (4/9, 44.4%), and de novo hiatal hernia in four patients (4/9, 44.4%). Two patients had a life-threatening condition. One (patient 3) of the two patients suffered from intractable cough and several episodes of a high fever after the primary LSG-DJB, but the endoscopic findings were normal. Computed tomography revealed diffuse bilateral pulmonary opacities, and thus aspiration pneumonia resulting from acid reflux was diagnosed. The other patient (patient 9) suffered sudden extreme weight loss (14 kg within 2 months) with excessive vomiting 8 years after primary LSG-DJB. Endoscopic examination revealed serious sleeve stenosis, and upper gastrointestinal contrast study revealed twisting of the sleeve.

Table 2 Clinical variables and outcomes of the total patients and per study group

	Total patients ($n = 24$)	IWL group ($n = 15$)	GERD group (n = 9)	p value[a]
Female sex	13 (54.2)	8 (53.3)	5 (55.6)	0.92
Age at revision (years)	44.6 ± 10.0	40.1 ± 8.7	52.1 ± 8.3	0.004
Time from primary to revision surgery (years)	3.0 (2 months–25 year)	2.0 (1 year–15 years)	4.6 (2 months–25 years)	0.30
BW at primary surgery (kg)	135.4 ± 32.8	147.3 ± 32.6	115.6 ± 23.1	0.018
BMI before primary surgery (kg/m^2)	50.8 ± 11.8	55.8 ± 10.8	42.5 ± 8.2	0.004
BW at revision (kg)	107.0 ± 31.8	124.4 ± 26.5	77.9 ± 12.4	< 0.001
BMI at revision (kg/m^2)	40.3 ± 12.0	47.3 ± 9.2	28.7 ± 4.7	< 0.001
%EWL at revision	46.3 ± 32.7%	26.5 ± 17.6%	79.5 ± 23.7%	< 0.001
%TWL at revision	20.7 ± 14.0%	14.5 ± 11.1%	31.0 ± 12.9%	0.003
Operation time (min)	195.2 ± 71.7	205.3 ± 77.7	180.1 ± 62.4	0.40
Postoperative hospital stay (days)	3.4 ± 1.5	3.4 ± 1.6	3.4 ± 1.4	1.0
Complications				
Total	6 (25.0)	3 (20.0)	3 (33.3)	0.63
≤C–D grade II	2 (8.3)	1 (6.7)	1 (11.1)	1.0
≥C–D grade IIIa	4 (16.7)	2 (13.3)	2 (22.2)	0.61
Early	5 (20.8)	2 (13.3)	3 (33.3)	0.33
Late	1 (4.2)	1 (6.7)	0 (0)	1.0
Readmission	4 (16.7)	2 (13.3)	2 (22.2)	0.61
Reoperation	2 (8.3)	1(6.6)	1 (11.1)	1.0
Operative mortality	0 (0)	0 (0)	0 (0)	–
BW 1 year after revision (kg)	86.1 ± 17.7 ($n = 20$)	95.1 ± 14.8 ($n = 13$)	69.5 ± 7.0 ($n = 7$)	< 0.001
BMI 1 year after revision (kg/m^2)	32.8 ± 8.0	36.9 ± 7.4	25.7 ± 3.0	< 0.001
%EWL 1 year after revision[b]	76.6 ± 27.6%	62.7 ± 14.6%	102.4 ± 28.2%	< 0.001
%TWL 1 year after revision[b]	34.1 ± 9.1%	33.9 ± 10.6%	34.4 ± 6.0%	0.45

Number (and percentage) of patients, mean ± SD values, or median (range) values are shown unless otherwise indicated

BW body weight, *BMI* body mass index, *%EWL* percentage excess weight loss, *%TWL* percentage total weight loss, *C-D* Clavien-Dindo

[a] IWL group vs GERD group

[b] from the time of the primary surgery

Endoscopic balloon dilatation was performed before revision surgery in three (3/4, 75.0%) of the four patients with sleeve stenosis. Balloon dilatation was not performed in the fourth patient (patient 2) (1/4, 25.0%) with sleeve stenosis, which occurred during the early postoperative period. Laparoscopic seromyotomy was initiated as revision surgery in two patients (2/9, 22.2%), but conversion to LRYGB was required in one of the two. LRYGB was performed as revision surgery in seven patients (7/9, 77.8%) in the GERD group. According to information gleaned from all nine (100%) patients in the GERD group, symptoms improved significantly after the revision surgery. For four patients (4/6, 67%) who had undergone revision surgery especially because of ≥ grade A erosive esophagitis, endoscopy performed after the revision surgery revealed improvement. Six patients (6/9, 66.7%) were able to discontinue the PPI therapy. %EWL in the GERD group reached 102.4 ± 28.2% at 1 year after the revision surgery, and no uncontrolled malnutrition was observed in any patient.

Discussion

In Japan, most bariatric surgeries performed in 2017 were LSGs (approximately 90%), followed by LSG-DJB and LRYGB [4]. LRYGB is not actively performed mainly because the prevalence of gastric cancer is comparatively high [10]. The gastric remnant is more easily inspected after LSG-DJB than after LRYGB [11]. Previously, we reported detection of an early gastric cancer at the distal gastric sleeve after LSG-DJB [12]. Thus, LSG was the most common primary surgery and LSG-DJB was second among patients who underwent revision surgery at our center.

In general, significant weight loss should be achieved within 1 year after the primary surgery. Therefore, for IWL patients who do not have an eating disorder we recommend revision surgery at 1 year after the primary surgery. As a result of our general practice, more than half of the IWL group patients expressed a strong desire for revision surgery before 2 years had passed. In addition, revision surgery was unavoidable for

Table 3 Clinical characteristics, operative details, postoperative complications, and further weight loss of the 10 IWL group patients who had undergone LSG as primary bariatric surgery

	Total patients ($n = 10$)	LBPD/DS or DJB ($n = 6$)	LRYGB ($n = 2$)	LRSG ($n = 2$)
Male/female ratio	4/6	2/4	1/1	1/1
Age at revision (years)	40.0 ± 9.2	41.8 ± 11.1	39.5	35
BW at primary surgery (kg)	165.6 ± 22.1	165.6 ± 15.0	147	184.3
BMI at primary surgery (kg/m^2)	61.3 ± 8.4	62.7 ± 9.1	53.1	65.5
BW at revision (kg)	137.2 ± 22.4	138.6 ± 29.5	135.7	134.5
BMI at revision (kg/m^2)	50.9 ± 9.0	52.1 ± 10.4	49	49.1
%EWL at revision	28.0 ± 19.8%	27.8 ± 21.1%	14.6%	41.9%
%TWL at revision	16.6 ± 12.2%	16.5 ± 13.1%	7.7%	25.5%
Operation time (minutes)	229.9 ± 75.3	244.5 ± 73.8	264	152
Postoperative hospital stay (days)	3.9 ± 1.7	4.3 ± 2.2	3.5	3
Complications	1	0	1	0
Follow-up after revision (months)	41.0 ± 26.9	41.2 ± 34.1	48.5	33
BW at last follow up (kg)	107.1 ± 24.2	103.8 ± 29.7	110	115.6
BMI at last follow up (kg/m^2)	40.0 ± 10.9	39.0 ± 10.7	40.3	43.4
Overall %EWL[a]	59.5 ± 25.7%	63.8 ± 23.8%	47.4%	57.1%
Overall %TWL[a]	34.6 ± 15.5%	37.9 ± 15.1%	24.6%	34.7%
Overall %EWL[b]	46.4 ± 27.3%	52.9 ± 24.3%	38.5%	34.8%
Overall %TWL[b]	21.9 ± 13.0%	25.8 ± 12.2%	18.3%	13.6%

Number (and percentage) of patients are shown unless otherwise indicated

LBPD/DS laparoscopic biliopancreatic diversion with duodenal switch, *DJB* duodenojejunal bypass, *LRYGB* laparoscopic Roux-en-Y gastric bypass, *LRSG* laparoscopic re-sleeve gastrectomy, *BW* body weight, *BMI* body mass index, *%EWL* percentage excess weight loss, *%TWL* percentage total weight loss

[a] From time of primary surgery to last follow-up examination

[b] From time of revision surgery to last follow-up examination

patients who, after a few years, suffered de novo or persistent GERD that proved to be intractable, i.e., GERD that was non-responsive or inadequately responsive to potent PPI therapy. Early sleeve stenosis forced early revision surgery in two patients.

The reported perioperative morbidity rate associated with revision surgery is greater than that associated with primary surgery [5–9], and reported complication rates for laparoscopic revision surgery range from 0 to 33.3%, with conversion to open surgery ranging from 0 to 47.6% [7–9, 13–18]. In our patient series, there was no need for open surgery, and the C-D grade ≥II complication rate was 25%, a rate that falls within the range of previously reported rates.

In our patient series, all anastomotic complications occurred after LRYGB. No anastomotic complications developed after LBPD/DS or DJB. We believe the occurrence of anastomotic complications differed for two reasons: first, because in cases of LBPD/DS or DJB, we did not need to create an anastomotic stoma out of scarred or fibrosis tissues (the duodenum had not been dissected during the primary LSG), and second, because the diameter at the site of the duodenojejunal anastomosis created during LBPD/DS or DJB was greater than that at the site of gastrojejunal anastomosis created during LRYGB.

We included resection of the distal sleeve with LRYGB in patients for whom development of gastric cancer was considered a serious risk (on the basis of atrophic changes in the gastric mucosa and/or a family history of gastric cancer, for example). However, resecting the distal sleeve presents some disadvantage it extends the operation time. Further, there is an increased risk of organ injury attributable to adhesion formation related to the primary surgery. Stump leakage occurred in one of the three patients (1/3, 33.3%) who underwent resection of the distal sleeve along with LRYGB. In our opinion, this procedure should be considered when the benefits outweigh the risk of an adverse event.

As noted above, BMI of the 15 patients in the IWL group had decreased from 47.3 ± 9.2 to 36.9 ± 7.4 kg/m^2 1 year after revision surgery, and %EWL reached 62.7 ± 14.6% 1 year after revision surgery. These data suggest that satisfactory weight loss can be achieved, at least for the short term, without any further revision surgery.

It has been reported that LSG can result in mid-term weight regain [19], but selection of the type of revision surgery that should be performed after LSG is under debate. Some studies

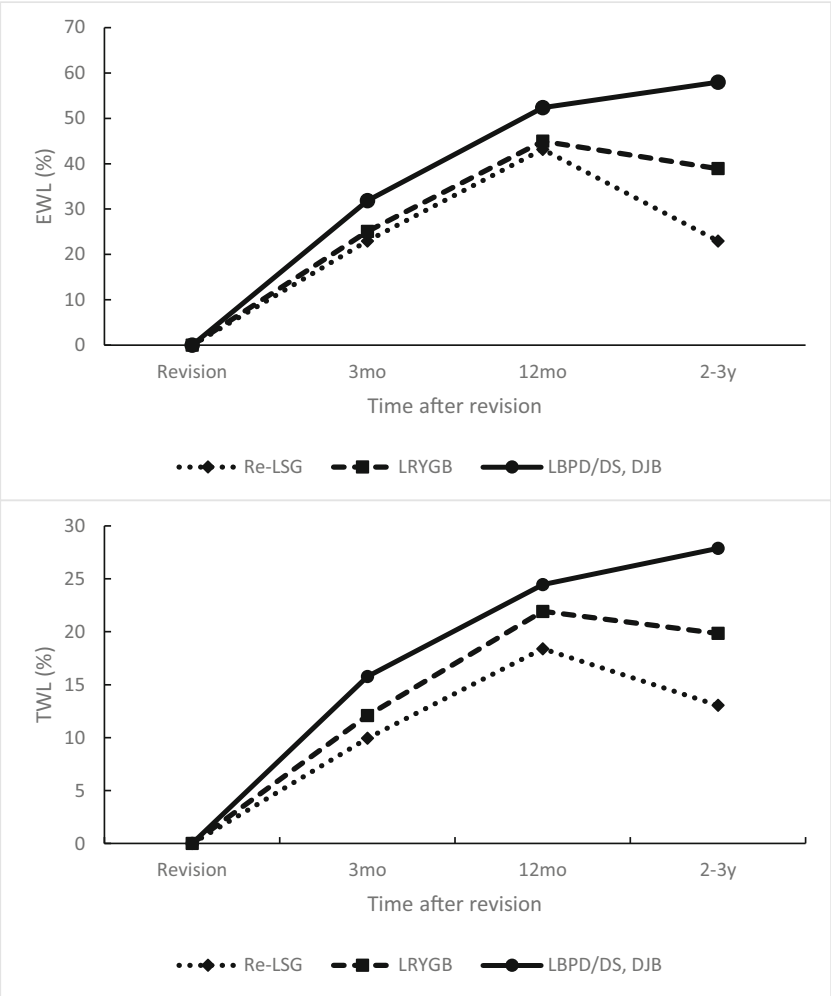

Fig. 1 Excess weight loss and total weight loss per type of revision surgery among patients whose primary surgery was LSG

have shown BPD/DS to be the most effective surgery for further weight loss after LSG [20–22]. BPD/DS has also been described as an effective revision surgery following failure of other bariatric surgeries (RYGB and gastric banding), yielding stable and significant weight loss outcomes [23–25]. One study compared outcomes of LRYGB performed after LSG against outcomes of LBPD/DS performed after LSG and revealed increased weight loss (along with an increased risk of vitamin deficiencies) after LRYGB and no difference in short-term complications between the two procedures [21].

We have described the safety and effectiveness of LSG-DJB as primary surgery [26]. In the patient series reported herein, revision LBPD/DS or DJB was shown to provide the greatest weight loss and without serious complications. Therefore, our strategy for IWL after LSG remains as follows: we regard LBPD/DS or DJB as the treatment of choice and apply it preferentially. LRSG is performed simultaneously with LBPD/DS or DJB when a dilated fundus is observed. For IWL patients with GERD symptoms, LRYGB is indicated. We regard performance of LRSG alone as an option limited to patients with a preoperatively diagnosed dilated fundus and who desire to avoid complications related to bypass surgery, such as anastomotic leakage, bowel obstruction, internal hernia, and nutritional disorders.

Several published follow-up studies have shown an increased prevalence of GERD after sleeve gastrectomy [19, 27–30]. In our patient series, the development of GERD appeared to be related to the sleeve stenosis and de novo hiatal hernia that occurred after primary LSG or LSG-DJB. There have been studies regarding diagnosis of de novo or worsening GERD after LSG [30–32]. However, it is difficult to evaluate which diagnostic test or tests (endoscopy, pH study, manometry, radiology, or histology) should be applied because the criteria used to diagnose GERD have differed. We usually perform endoscopy and radiology to evaluate the severity of GERD, but we regard patients' clinical history as important evidence. We were able to diagnose GERD-related aspiration pneumonia mainly on the basis of the patients' clinical history. Himpens et al. reported a 22% prevalence of GERD symptoms at 1 year, which decreased to 3% after 3 years and rebounded to 26%

Table 4 Primary and revision surgeries, endoscopic findings, and PPI use of each GERD group patient

				Endoscopic findings						
				Los Angeles Classification			Hiatal hernia		Stenosis	
Patient	Primary surgery	Time (primary to revision surgery)	Revision surgery	Before primary surgery	Before revision surgery	After revision surgery	Before primary surgery	Before revision surgery	Before revision surgery	PPI use after revision surgery
1	LSG	8 months	SM	N	D	C	+	+	+ →BD	–
2	LSG-DJB+ HHR	2 months	SM→ LRYG-B	B	C	B	–	–	+	–
3	LSG-DJB	4 years 8 months	LRYGB	N	N	N	–	–	–	+
4	LSG	2 years	LRYGB	N	B	N	–	+	–	–
5	LSG	6 years 8 months	LRYGB	N	N	N	–	+	–	–
6	LSG	6 years 1 months	LRYGB	A	B	A	+	+	+ →BD	–
7	VBG	25 years	LRYGB	unknown[a]	N	N	unknown[a]	–	N/A	–
8	LSG	4 years 5 months	LRYGB	N	A	NYD	–	+	–	As needed
9	LSG-DJB	8 years 9 months	LRYGB	N	C	NYD	–	+	+ →BD	As needed

PPI proton pump inhibitor, *SM* seromyotomy, *BD* balloon dilation, *LSG* laparoscopic sleeve gastrectomy, *LSG-DJB* laparoscopic sleeve gastrectomy with duodenojejunal bypass, *LRYGB* laparoscopic Roux-en-Y gastric bypass, *VBG* vertical banded gastroplasty, *HHR* hiatal hernia repair, *NYD* not yet determined

[a] Because patient was treated at another hospital

after 6 years [19]. Thus, prolonged follow-up is needed for patients who have undergone LSG or LSG-DJB. When GERD symptoms persist despite PPI use, invasive procedures such as balloon dilation and revision surgery are considered. Balloon dilation was tried before revision surgery in three of our four patients with sleeve stenosis. If balloon dilatation or stenting is ineffective, RYGB can be considered [33, 34]. Seromyotomy was offered to our first two patients with intractable GERD resulting from sleeve stenosis. Vilallonga et al. reported high complication and reoperation rates following seromyotomy, due mainly to leakage [35]. Although no leakage occurred our patients, one of the two patients required LRYGB after seromyotomy because the symptoms of reflux did not improve. Conversion of sleeve gastrectomy to RYGB is recommended when such symptoms or endoscopic abnormalities at the esophagogastric junction persist despite proper medical treatment [36, 37]; therefore, LRYGB has been our first choice for revision surgery in patients with intractable GERD.

We believe our study is the first reported documentation of the results of revision bariatric surgery in Japan. The study limitations—that all procedures were performed at a single center and that the study group was not large—limit our ability to draw strong conclusions. However, the number of revision bariatric surgeries performed in Japan is expected to increase, particularly the number performed after LSG. We believe our findings in this patient series will lead to progress in revisional bariatric surgery in Japan.

Conclusion

From our study data, we conclude that LBPD/DS or DJB is effective for further weight loss in the medium term and that LRYGB results in excellent GERD remission. Bariatric surgeons should bear in mind that the post-LRYGB complication rate appears to be relatively high.

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Compliance with Ethical Standards

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

Ethical Statement All procedures performed in our study involving human participants were in accordance with the ethical standards of the institutional and/or Japanese national research committees and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Consent to use their anonymized data for research purposes had been obtained from all patients included in the study.

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